ENCYCLOPÆDIA BRITANNICA

VOLUME
4

First Published in 1768
by A Society of Gentlemen in Scotland

ENCYCLOPÆDIA BRITANNICA, INC.

William Benton, Publisher

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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED"

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FOUNDED A.D. 1768

ENCYCLOPÆDIA BRITANNICA

Volume 4

Botha *to* Carthage

BOTHA, LOUIS (1862–1919), South African general and statesman, who, as the first prime minister of the Union of South Africa, strove to reconcile the Boers and the British, and to create a unified nation, was born on a farm near Greytown, Natal, on Sept. 27, 1862. In 1869 the family moved to the Orange Free State where Louis was brought up as a typical Boer farmer's son. He had little formal education, and he never acquired much taste for reading or confidence in the use of the English language; but he did possess a natural flair for getting on with people.

In 1884 he took part in the formation of the New Republic in the Vryheid area and settled on a farm to which he took his bride, Annie Emmett, in 1886. The New Republic was incorporated in the South African Republic in 1888, and in 1897 Botha was elected to the *volksraad* (parliament) where he sided with those who, led by Piet Joubert, were critical of President Paul Kruger's policy toward the *Uitlanders*. But when the South African war broke out in 1899, Botha, who had been appointed field cornet of Vryheid in 1894, did not hesitate to do his duty by his country.

Service in the South African War.—Botha gained rapid promotion, and commanded the southern force investing Ladysmith with verve and success. His force ambushed an armoured train, taking Winston Churchill among the prisoners. It was his strategy which drove back General Buller at Colenso, and his determination brought success at Spion Kop and Vaal Krantz. In March 1900, after Joubert's death, Botha was appointed commandant general of the Transvaal. He could do nothing to prevent Lord Roberts' march to Pretoria because British reinforcements were streaming into the country, and General Cronjé had surrendered with a large force at Paardeberg in Feb. 1900. After the fall of Pretoria he organized guerrilla warfare, and became a brilliant exponent of it. He entered into negotiations with Lord Kitchener at Middelburg in March 1901, but was not satisfied with the terms of the British peace offer and continued the increasingly hopeless struggle. At the conference of representatives of the Boer commandos at Vereeniging in May 1902 he recommended that they should come to terms, since further resistance would be suicidal. This was done, and he was a signatory of the peace agreement.

Prime Minister of the Transvaal.—After the war Botha, assisted by Jan Christian Smuts, took the lead in organizing the Transvaal Boers for political action. He agitated for self-government and against the importation of Chinese labourers; he became chairman of *Het Volk* ("The People") when the party was founded in 1905; and when self government was granted in 1907 he became prime minister of the Transvaal. He believed that the divisions and bloodshed of the past should be forgotten; that Boer and British South Africa should fuse into a new nation; that the four British African colonies should be united and, like Canada, Australia and New Zealand, should have full control of their internal affairs but be linked with Great Britain and the rest of the empire for defense and for trade. These were probably his hopes even in 1902; the generosity of Sir Henry Campbell-Bannerman and his cabinet in granting self-government to the Transvaal and the Orange River Colony in 1907 made them his ardent convictions, and for the rest of his life he steadfastly adhered to them. His patent sincerity gradually gained him the respect and the confidence of many British white South Africans and of the British government and people.

Although Smuts was mainly responsible for the detailed labours which produced the Union of South Africa, Botha's personality and tact were also a major factor. He intervened decisively in several crucial debates in the national convention (1908–09) in favour of a unitary and not a federal constitution, for the maintenance of an absolute political colour bar in the northern provinces, and to make Pretoria the administrative capital of the Union. And he, more perhaps than anyone else, persuaded the English-speaking delegates in the convention and a large majority of the English-speaking electorate that union was not a plot for Afrikaner domination of South Africa, but a wise and necessary basis for nationhood and prosperity.

Prime Minister of South Africa.—Botha was the natural choice as first prime minister of the Union. He assumed the office on May 31, 1910, and held it until his death. He included English-speaking politicians in his Union cabinet, as he had in his Transvaal cabinet, and in the general election of Sept. 1910 his government was given a clear majority. The official opposition was the Unionist party, led by L. S. Jameson and supported by most of the English-speaking voters. In 1911 Botha founded the South African party, an amalgamation of the anti-imperialist parties which had been in power in the Cape Colony, the Transvaal and the Orange River Colony before Union.

The challenge to Botha's policy came not from the British but from the Afrikaner side. Already before Union some Afrikaners had thought that Botha's conciliatory policy toward British South Africans and Great Britain was being carried too far; that it endangered the survival of Afrikaners as a distinct national group and sacrificed the interests of South Africa for those of Great Britain. Through his firm hold over the *Het Volk* party organization, Botha had kept such people under control in the Transvaal colony; but the *Orangia Unie* party in the Orange River Colony was strongly influenced by the former president M. T. Steyn, who was inclined to brood over the past, and led by men like J. B. M. Hertzog, who emerged as a prophet of an Afrikaner revival, unsullied by alien influences. The cracks were papered over when Hertzog joined Botha's government in 1910, but within three years the paper had torn apart and Hertzog had founded an Afrikaner Nationalist party eroding Botha's Afrikaner support.

This process was accelerated during World War I. Botha unhesitatingly accepted the fact that once Great Britain was at war with Germany, so was South Africa; he offered that South Africa should undertake its own defense, so that the imperial troops could be used elsewhere, and when Britain asked that South African forces should deal with the German radio station at Windhoek and occupy German South-West Africa, he agreed. This decision precipitated a rebellion of about 12,000 Afrikaners, led by heroes of the South African War, including C. F. Beyers and C. R. De Wet, and not publicly repudiated by Steyn and Hertzog. Though Botha mastered the rebellion and extended clemency to the rebels, he was thenceforth regarded by extreme Afrikaner nationalists as having missed a glorious opportunity to regain the republican independence which had been lost at Vereeniging.

After the surrender of the last rebels in Feb. 1915, Botha organized the conquest of South-West Africa. He himself took command of the Union forces and his well planned campaign resulted in the surrender of the territory on July 9, 1915. Back in the Union, he had to fight an election in which the Nationalists cast doubts upon his personal integrity and increased their representation in the house of assembly to the point where he became dependent on the support of the Unionists for the measures necessary for the conduct of the war. Botha remained in South Africa, the object of continuous Nationalist criticism, until after the armistice. He then went to Paris, where he supported the claims for the recognition of the dominions as international entities and, with memories of 1902, pleaded for lenient terms for the vanquished. He signed the treaty of Versailles with misgivings and then returned, a sick man, to South Africa. He died in Pretoria on Aug. 27, 1919.

Character.—Like most Boers who had grown up in a 19th-century republican environment, it was natural for Botha to believe that political power in Africa should be a white monopoly; and it was during his premiership that the Natives Land act (1913), limiting the areas in which natives could purchase land, was enacted. He spoke Zulu and Sesuto fluently, and was humane in his personal dealings with Africans, but his vision for the future of his country was of a white minority ruling a nonwhite majority.

Botha's greatness lay in his magnanimous and wholehearted attempt, first to end the century-old friction between Boer and Briton in South Africa by promoting their fusion into a single nation, and second, to draw united South Africa out of its potential isolation into effective membership of the evolving British Commonwealth. His tragedy lies in his gradual alienation from many of his own Afrikaner people, whose exclusiveness he underestimated. *See* also South Africa, Republic of: *History*.

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BOTHE, WALTHER WILHELM GEORG FRANZ (1891–1957), German physicist, was awarded with Max Born (*q.v.*), the 1954 Nobel prize for physics, for his invention of the coincidence method and his discoveries with this method. Bothe was born at Oranienburg, Ger., on Jan. 8, 1891. He was educated at the University of Berlin, where he obtained his doctorate of philosophy in 1914. Later he taught in the universities of Berlin, Giessen and Heidelberg.

In 1934 Bothe was appointed director of the Institute of Physics in the Kaiser Wilhelm Institute (later the Max Planck institute) for Medical Research, Heidelberg, and from 1946 he also held the chair of physics in the University of Heidelberg. He introduced coincidence methods into counting techniques in modern physics and with Hans Geiger he applied these methods to study the Compton effect. With W. Kolhörster in 1929 he devised a new method for the study of cosmic rays: by passing these rays through suitably arranged Geiger counters, it was found possible to establish the presence of penetrating charged particles and to define more or less accurately the path of individual rays. In 1930 Bothe discovered an unusual radiation emitted by beryllium bombarded by alpha rays, and this was later identified by Sir James Chadwick as the neutron. He died on Feb. 8, 1957, at Heidelberg. (D. McK.)

BOTHWELL, JAMES HEPBURN, 4th Earl of (*c.* 1536–1578), duke of Orkney and Shetland (May 12, 1567), was instrumental in the murder of Lord Darnley, second husband of Mary Stuart, whom he himself subsequently married. He was born *c.* 1536, the son of Patrick, 3rd earl of Bothwell, whom he succeeded in 1556, and of Agnes, daughter of Henry, Lord Sinclair. Although a Protestant, Bothwell supported the Catholic regent, Mary of Lorraine, for whom he led a successful raid into England in Dec. 1558, and seized, in Oct. 1559, £1,000 sent secretly by Queen Elizabeth I to the Protestant lords of the congregation. The queen regent having died in June 1560, Bothwell joined Queen Mary at Paris in September and was sent to Scotland as a commissioner to summon parliament. He was chosen a privy councilor in Sept. 1561, but became involved in partisan feuds and in March 1562 was accused by the deranged earl of Arran of plotting to seize the queen. He was imprisoned in Edinburgh castle, but escaped in Aug. 1562, and after a period of detention in England, reached France in Sept. 1564.

After Mary's marriage with Lord Darnley (July 29, 1565), Bothwell was recalled to Scotland to help suppress the earl of Moray's rebellion. He married Jean Gordon, sister of George, Lord Gordon (afterward restored to his father's forfeited title of earl of Huntly), who thenceforth became his consistent ally. The murder of Mary's secretary, David Rizzio, on March 9, 1566, with Darnley's connivance increased the queen's dislike of her treacherous husband; and Bothwell, whose loyalty and resource during the crisis had done much to preserve her throne, acquired a growing ascendancy over her affections. His appointment as keeper of Dunbar castle (1566) and other marks of royal favour made him the most powerful noble in the south of Scotland and encouraged him to aspire to Darnley's place. The disposal of Darnley was discussed at Craigmillar in Dec. 1566, by a group that included the queen, Bothwell and Lord Gordon; it was later asserted that a murder bond was afterward signed by Bothwell and others. There is undoubted proof that Bothwell himself superintended the preparations for the murder of Darnley at Kirk-o'-Field on the night of Feb. 9–10, 1567.

Public opinion soon accused Bothwell of the crime and Mary of guilty foreknowledge, but after his acquittal at a mock trial on April 12, her intention to marry him was made public; on April 19 he obtained the consent of the leading Protestant nobles. His probably collusive kidnapping of the queen on April 24 was soon followed by his divorce and their marriage on May 15 by Protestant rites. But a coalition of Protestant and Catholic nobles forced them in June to flee to Dunbar, whence they marched in force on Edinburgh, the rival armies meeting on June 15 at Carberry Hill. After Bothwell had been forbidden by Mary to engage in single combat, desertions from the queen's army made her surrender inevitable. Bothwell, however, was allowed to escape; he went north, visited Orkney and Shetland and finally escaped to Karm sound in Norway (then ruled by the Danish kings). He was sent to Copenhagen in Sept. 1567, and removed to Malmö in Scania (a Danish province in Sweden), but King Frederick II, possibly influenced by his offer to restore the Orkneys and Shetlands to Denmark, refused repeated requests for his extradition or execution. Mary and Bothwell are said to have corresponded at this time; and he may have assented to the annulment (Sept. 1570) of their marriage. After the final collapse of the queen's cause in Scotland, Bothwell was in June 1573 placed in solitary confinement in the castle of Dragsholm in Zeeland, where he died, probably insane, on April 14, 1578.

Bothwell's association with Queen Mary proved disastrous to both. As a man of action, he possessed virtues of personal courage and absolute loyalty to the crown, both conspicuously lacking in his leading contemporaries; as a political figure, his lax morality and reckless violence proved fatal to his high ambition. *See* also MARY (Mary Stuart).

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BOTHWELL, a town in Lanarkshire, Scot., lies on the right bank of the Clyde, 9 mi. E.S.E. of Glasgow. Pop. (1961) 4,120. At Bothwell bridge a monument commemorates the Covenanters who fought in the battle of June 22, 1679, when the duke of Monmouth crushed the Westland rising. The restoration (1898) of the 14th-century chancel of the collegiate church of St. Bride and the renovation (1932) of the early 19th-century nave have provided an impressive setting for the stained glass windows designed by Sir Edward Burne-Jones. A mile beyond St. Bride's, the towers and walls of Bothwell castle (mainly 13th century) crown a riverside cliff of red sandstone. At Orbiston, 2 mi. N.E. of Bothwell, some of Robert Owen's disciples attempted to carry out (1825) his ambitious project of communal living.

BOTOŞANI, a town of northeast Rumania in the Suceava region, lies in a rich farming district of northern Moldavia. Pop. (1966) 35,185. Botoşani was founded in the 14th century, taking its name from Batu Khan, grandson of Genghis Khan, who occupied the country in the 13th century. The St. George's church dates from 1551. Botoşani is an important commercial centre with extensive flour mills. Industrial developments after World War II include factories for textiles, clothing and vegetable oils. The town is on the highway and on a branch line from the railway linking Bucharest and Chernovtsy, U.S.S.R.

BO TREE (BODHI TREE), the name given by the Buddhists of India and Ceylon to the pipal (peepul) tree, or sacred fig (*Ficus religiosa*). It was a tree of this species beneath which the Buddha is traditionally supposed to have attained enlightenment, at Buddh Gaya (*q.v.*), still the most important site of Buddhist pilgrimage in India. The bo tree at Anuradhapura (*q.v.*) in Ceylon, grown from a branch of the parent tree sent to Ceylon by King Asoka in the 3rd century B.C., also is venerated by thousands of pilgrims every year. *See* also FIG.

BOTRYTIS, a minute fungus which appears as a brownish-gray mold on decaying vegetation or on damaged fruits. Under a magnifying glass it is seen to consist of tiny, upright, brown stalks which are branched at the tips, each branchlet being crowned with a naked head of pale-coloured spores. It is very common, growing everywhere in the open or in greenhouses, and can be found at almost any season. Some species are known to cause destructive plant diseases. The fungi placed in the genus *Botrytis* are in part stages in the life history of members of the genus *Sclerotinia.* These are characterized by the possession of a *sclerotium,* which is a compact mass of fungal filaments from which a cuplike ascophore arises.

See FUNGI: *Ascomycetes* (*Sac Fungi*).

BOTSARIS, MARKOS (Italian MARCO BOZZARI) (*c.* 1788–1823), a hero of the War of Greek Independence, was born at Souli in southern Epirus of a leading Albanian family. In 1803, after the capture of Souli by Ali (*q.v.*) of Janina, Markos, with the remnant of the Souliots, crossed over to the Ionian Islands, where he ultimately took service in an Albanian regiment in French pay. In 1814 he joined the Greek patriotic society known as the Hetairia Philike. In 1820, with other Souliots, he made common cause with Ali of Janina against the Turkish sultan's government. On the outbreak of the Greek revolt, he fought as a partisan leader in the fighting in western Hellas and was conspicuous in the defense of Missolonghi during the first siege (1822–23). On the night of Aug. 21, 1823, at Karpenisi, he led 350 Souliots against the 4,000 Albanians who formed the vanguard of the army advancing to reinforce the besiegers. The rout of the Turks was complete, but Botsaris was killed.

BOTSWANA, formerly, as BECHUANALAND, an internally self-governing British protectorate in southern Africa, became an independent republic within the Commonwealth of Nations on Sept. 30, 1966. Named after its principal inhabitants, the Tswana (Botswana, Batswana, or Bechuana), a group of Bantu tribes of Sotho origin, Botswana is bounded east and south by Rhodesia and South Africa, and west and north by South West Africa. Its area is 231,805 sq.mi. (600,375 sq.km.). The capital is Gaborone, where it was transferred in February 1965 from Mafeking, in South Africa. Botswana once also included British Bechuanaland, which was annexed to Cape Colony in 1895 and now forms part of the Cape Province of South Africa.

Physical Features.—The southern boundary of Botswana is the Molopo River and the Ramatlabama. The country has a mean altitude of about 3,300 ft. (1,000 m.). The eastern side, along the South African border, is hilly, but the hills soon slope away westward into the Kalahari Desert (*q.v.*).

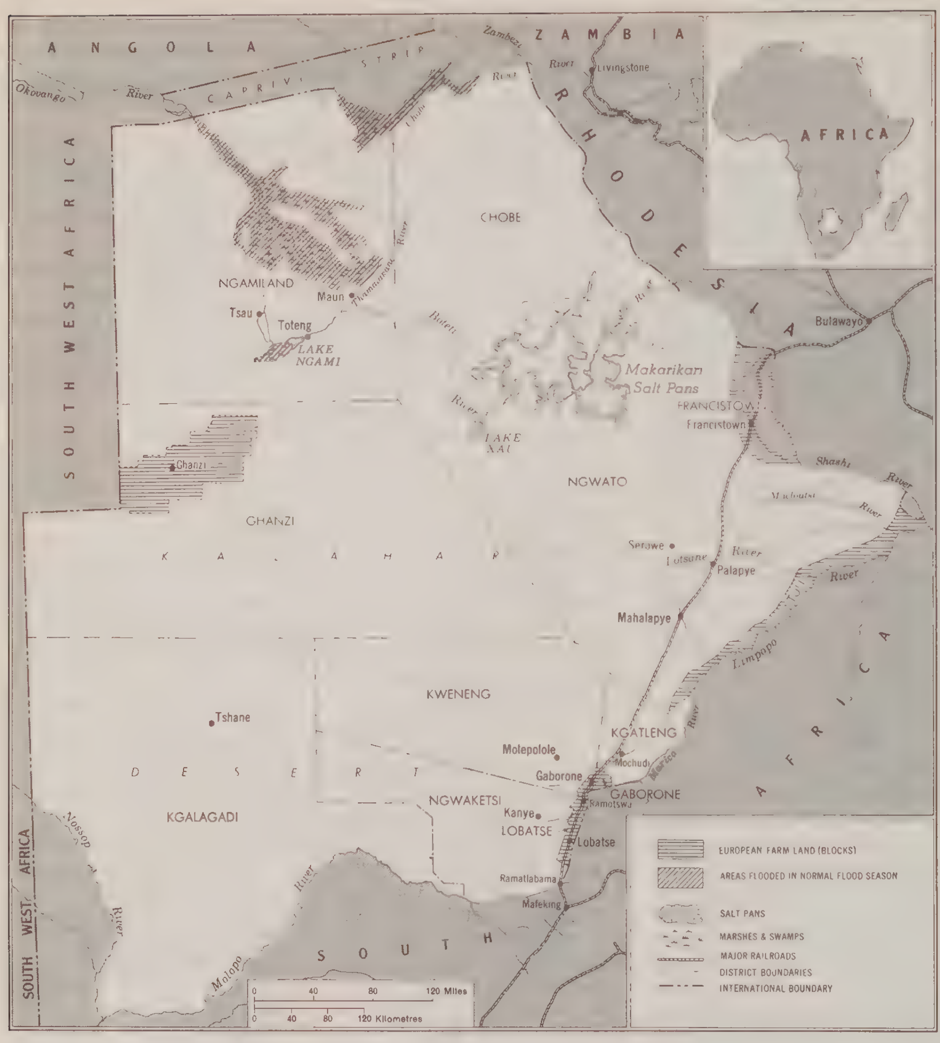
Except for the Okovango and Chobe rivers in the northwest, the Marico and Limpopo (Crocodile) in the east, and a few streams on the eastern side, the rivers flow only a few days of the year. The need for more water compels recourse to several expedients; apart from ordinary wells, by digging holes in the beds of the sand rivers plentiful supplies of water may be obtained months after the river has ceased to flow. A considerable program of borehole and dam construction is also under way. The delta of the Okovango River, lying in the region known as Ngamiland, in the northwest, differs in aspect and character from any other part of the republic. The Okovango enters the country from Angola, across the Caprivi Strip, in a fine broad stream; but after 60 mi. (100 km.) of comparatively uninterrupted flow it becomes choked with papyrus and dissipates itself in vast swamps which drain into the Thamalakane River by a few channels themselves much obstructed by vegetable growth. The Thamalakane discharges in two directions: eastward for 160 mi. (260 km.) along the Boteti River to the great Makarikari Salt Pans, and southwestward by the Lake River into Lake Ngami (*q.v.*) at the lower end of the swamps. Lake Ngami receives water only during occasional floods.

The climate of the country is subtropical, varying to temperate. Winter days are often pleasantly warm and the nights cold, with occasional frosts. The summer is hot. In August seasonal winds from the west carry sand and dust across the whole country. The average annual rainfall is 18 in. (460 mm.), but this varies from 27 in. (685 mm.) in the north to 9 in. (228 mm.) or less in the southwestern Kalahari. Most of the rain falls between December and the end of April in heavy, short showers.

True forest, except in a large area on the banks of the Chobe, is rare. Much of the territory is covered with woodland savanna, species of *Acacia* predominating. In the northeast, however, mopane (*Colophospermum mopane*), mongonono (*Terminalia sericea*), and mokusi (*Baikiaea plurijuga*) are usually dominant, as morukuru (*Spirostachys africanus*) often is in the middle Kalahari. The Chobe forest consists chiefly of mokwa or bloodwood (*Pterocarpus angolensis*), mokusi, and monato or Rhodesian ash (*Burkea africana*). There is much good grazing in the country. Typical grasses are *Aristida, Eragrostis, Panicum, Urochloa, Digitaria, Schmidtia, Cenchrus,* and *Setaria.*

The fauna of Botswana consists of various South African animals. Game reserves and bird sanctuaries contain many species of antelope as well as the hippopotamus, giraffe, buffalo, pelican, ostrich, bustard, etc. Crocodiles are found in some of the rivers. The principal fish are the catfish, tiger fish, and *Tilapia,* the last two especially in the Okovango and the Chobe rivers. Puff adders, cobras, and other poisonous snakes are numerous, as are scorpions, tarantulas, and many kinds of spiders, termites, mosquitoes, and other insects.

Before independence there were 104,069 sq.mi. (269,540 sq.km.)


ANGOLA
ZAMBIA
Zambezi
River
Livingstone
Okovango
River
CAPRIVI STRIP
Chobe
SOUTH WEST AFRICA
RHODESIA
AFRICA
CHOBE
NGAMILAND
Maun
Thamalakane
River
Tsau
Toteng
LAKE NGAMI
Boteti
River
Makarikari Salt Pans
Bulawayo
FRANCISTOWN
Francistown
LAKE XAU
Ghanzi
GHANZI
NGWATO
Shashi River
Macloutsi River
Serowe
Lotsane River
Palapye
KALAHARI DESERT
Mahalapye
Limpopo River
KWENENG
Tshane
KGATLENG
Molepolole
Mochudi
Marico
Gaborone
GABORONE
NGWAKETSI
Ramotswa
Kanye
LOBATSE
Lobatse
KGALAGADI
Nossop
Auob River
Ramatlabama
Mafeking
Molopo River
SOUTH AFRICA
EUROPEAN FARM LAND (BLOCKS)
AREAS FLOODED IN NORMAL FLOOD SEASON
SALT PANS
MARSHES & SWAMPS
MAJOR RAILROADS
DISTRICT BOUNDARIES
INTERNATIONAL BOUNDARY
0 40 80 120 Miles
0 40 80 120 Kilometres

BOTSWANA

of crown land that are now vested in the state.

(Ay. Sy.; N. C. P.)

The People.—Botswana is occupied by peoples of diverse origins and cultures. The original inhabitants were Bushmen. The northwestern Bushmen groups, the Naron, Auen, Kung, and Heikum, living in Botswana and adjoining parts of South West Africa, number about 25,000. They are called Sarwa (Masarwa) by the Bantu-speaking tribes, who regard them as serfs and inferiors. They perform menial duties for the Bantu and do not intermarry with them.

The most numerous group is the Tswana, which consists of a cluster of tribes, similar in culture and language, of the western Sotho (*q.v.*) linguistic grouping of the southern Bantu. The Tswana of Botswana includes the tribes known as Rolong, Hurutshe, Kwena (including the Ngwato, Tawana, and Ngwaketse), the Kgatla, Tlokwa, and Malete. There are other Tswana outside Botswana in South Africa. The first Bantu-speaking tribes to enter Botswana were probably the Kgalagadi, who intermingled with the Bushmen and are usually classed with them. They were followed by the ancestors of the Rolong and the Tlhaping and later by the remaining Tswana groups. Tswana tribes were in these regions by A.D. 1600 but were probably not in the modern Botswana before 1700.

During the 19th century there was continual pressure from other Bantu tribes to the east, mainly Nguni-speakers, and many Tswana groups fled into the drier parts of the area, near the Kalahari, forming numerous small splinter groups as they seceded from the originally large clusters. Others followed into Botswana as a consequence of Boer pressure in the Transvaal. Under British administration the main tribes became independent chiefdoms, each under the rule of a hereditary chief. The chiefs of the principal Tswana tribes claim descent from a legendary ancestor named Masilo, supposed to have lived in the 17th century or earlier. Others trace a genealogy to an ancestor even more remote. Most Tswana are at least nominal Christians, missions having worked in the country since the early 19th century. Many Tswana find employment outside Botswana, especially in the Transvaal mines.

At the 1964 census the population of Botswana was 543,105, of which the non-African population, mostly European and Asian missionaries and traders, accounted for less than 4,000; Eurafricans numbered 3,489. The total population was estimated at 610,788 in 1968. Most of the African population live on tribal lands which occupy about 107,500 sq.mi. (278,425 sq.km.). These contain towns which are fairly large by African standards; Serowe (*q.v.*), capital of Ngwato District, had a population of 34,182 in 1964, and Kanye, capital of Ngwaketsi District, had 34,045. Most European farmers are concentrated in a few "blocks" covering 7,500 sq.mi. (19,425 sq.km.). For accounts of the culture and social organization of the non-European groups *see* BUSHMAN and TSWANA. (*See* also AFRICA: *Ethnography* [*Anthropology*].)

(J. F. M. M.)

History.—Sotho peoples arrived in southern Africa at the time of the Bantu migrations; *i.e.*, mainly by 1600 or 1700 (see *The People* above). Some of the Tswana only recently occupied their present homes.

A European expedition headed by J. Trüter and W. Somerville visited the Tlhaping of southern Botswana in 1801. These early visitors were followed by the traveler Martin Heinrich (Henry) Lichtenstein and the naturalist W. J. Burchell. John Campbell, having in 1813 been invited by the chief of the Tlhaping to "send instructors," the London Missionary Society established a mission on the Kuruman (properly Kudumane) River. Under Robert Moffat, who took charge in 1821, Kuruman became one of the foremost Protestant missions of southern Africa. About this time the rise of the Zulu power had set up a chain of destructive movement across the continent. Thousands of refugees, fleeing from Shaka's Zulu armies, roamed the countryside pillaging and plundering and in their turn starting fresh waves of migration. In 1823 the Tlhaping, threatened by one such horde, were saved only by Moffat's enlisting the help of Griqua mounted riflemen. In the same year Sebetwane started from the Vaal River and, after fighting his way through Botswana, founded the powerful but short-lived empire of the Makololo in the Zambezi Valley.

About 1826 Mzilikazi (Umsilikazi, Mosilikatze), son of Machobane, one of Shaka's captains, after breaking away from the Zulu king, settled with his people, the Ndebele (*q.v.*), in what is now the western Transvaal. From there he raided extensively into Botswana. These depredations continued even when the Ndebele, after their defeat by the Boers in 1837, had moved to the north. The Great Trek of the Boers from the Cape Colony (1835 and after) brought the *voortrekkers* across the Vaal River to the frontiers of Botswana. The Boers disliked the proximity of powerful, independent chiefs; thought that the penetration of Botswana by the missionaries of the London Missionary Society and by British traders and hunters would curb Boer expansion northward; and claimed a western boundary that included the "missionaries' road," the highroad from the Cape to the interior, which ran through Botswana. They came sharply into conflict with David Livingstone (*q.v.*), who had landed in Africa in 1841 and had settled among the Kwena, a senior Tswana tribe, whose chief, Sechele (Setshele), became a Christian. Livingstone sided with the Africans in their resistance to the various demands of the Boers, who further suspected him of supplying Sechele with firearms. In 1852 a raid was made on Sechele's town of Dimawe. During the raid Livingstone's mission at Kolobeng, near Dimawe, was ransacked, though by whom was never conclusively proved. The widely publicized raid on Dimawe was only one incident in a struggle that lasted for many years. (*See* further TRANSVAAL.)

In 1867 gold was discovered near the Tati River, in country claimed both by the Ngwato and by the Ndebele. Pres. Marthinus Pretorius of the Transvaal in 1868 proclaimed the annexation of a huge area including the goldfields, but the British government refused to recognize this. At the same time Macheng (Matsheng), chief of the Ngwato, sought without success to persuade the British to occupy the goldfields. In the south the arbitration award of R. W. Keate, lieutenant governor of Natal, in 1871, purporting to define a boundary between the Rolong and the Transvaal, did nothing to abate Boer encroachment. Disorders among the tribes in 1878, quickly suppressed, led to the occupation of southern Botswana by a small police force. On the withdrawal of this force in 1881 the country relapsed into anarchy.

The Pretoria Convention of 1881 defined the boundaries of the Transvaal on all sides for the first time but still did not curb Boer encroachment. The chiefs relied on European supporters (not all of them Boers), to whom they promised land and cattle. These so-called "volunteers" then set up the two little republics of Stellaland and Goshen, threatening the "missionaries' road." In 1883 Pres. S. J. P. Kruger of the Transvaal led a deputation to London to seek a revision of the Pretoria Convention. The London Convention of 1884 conceded to the Boers, among other things, small alterations in the western frontier; but Kruger failed to get the "missionaries' road," though he tried hard to do so. About this time, moreover, German colonization in South West Africa was causing concern to the British. Humanitarians, inspired by John Mackenzie, a successor of Moffat at Kuruman and a vehement campaigner for African rights, were opposing the extension of Boer authority and advocating that the country should be taken under British protection. Cecil Rhodes (*q.v.*) meanwhile threw all his weight into a campaign for the annexation of Botswana to the Cape Colony. The British government then decided to establish a protectorate over the territory that later became British Bechuanaland and sent John Mackenzie as the first deputy commissioner. Mackenzie, without men or money, was unable to make much headway against the prevailing anarchy. He was soon superseded by Rhodes, who did no better.

Freebooters from Goshen attacked Mafeking, Kruger annexed the country of the Rolong, the republican flag was hoisted at Mafeking, and the freebooters proceeded to carve up the adjacent African-held lands. The British government, prompted by these aggressions, sent a strong force under Sir Charles Warren to set matters in order (which he did without firing a shot) and then extended the protectorate northward to the 22nd parallel of south latitude and westward to the 20th degree of east longitude (March 1885). The territory south of the Molopo River was constituted as the crown colony of British Bechuanaland (September 1885; annexed to the Cape Colony, 1895). In 1892 another proclamation considerably enlarged the protectorate by adding to it the territory between the Shashi and Motloutsi rivers; the Tati district; those territories north of latitude 22° claimed by Khama (Kgama), chief of the Ngwato since 1875; and some vast ill-defined areas lying north and west of Khama's country.

In the early 1890s the protectorate, as Rhodes had intended, became the springboard for the British South Africa Company's colonization of Southern Rhodesia. But in 1895 a plan to hand the administration of the protectorate over to the company was frustrated by the action of the three chiefs Khama, Sebele, and Bathoen, who, supported by the missionaries, traveled to London and wrung from Joseph Chamberlain an assurance that their people would remain under the protection of the crown. In return they had to surrender strips on the east of their countries for the construction of a railway. The Jameson Raid at the end of 1895 completed the ruin of any plans for the company's administration of the protectorate.

South Africa often expressed the wish that the administration of Botswana (with Lesotho [Basutoland] and Swaziland) should be handed over to it. The British government's position was made public on June 20, 1935; no transfer was to take place until the inhabitants had been consulted and until Parliament had expressed its opinion. On several occasions subsequent British governments confirmed that there had been no change in this policy.

In 1948 Seretse, son of Khama's son Sekgoma II and heir to the Ngwato chieftainship, married an Englishwoman, Ruth Williams, while he was studying in Britain. The British government, it is thought because of pressure from South Africa (Khama was declared a prohibited immigrant in that country), refused to recognize him as chief and he was banished from Botswana.

WIDE WORLD

VILLAGE IN BOTSWANA

Until 1961 the country was administered by a resident commissioner under the direction of the British high commissioner in South Africa and with the assistance of an advisory council of chiefs. In 1961 executive and legislative councils, the latter with an unofficial majority, were introduced. In 1965 a constitution granting internal self-government was introduced, and at the first general election the Bechuanaland (later Botswana) Democratic Party (BDP) formed the government that led the new state to independence. The BDP was headed by Seretse Khama, who had been permitted to return as a private citizen in 1956. In an 80% poll the BDP received 113,177 votes and 28 of the Legislative Assembly's 31 seats. The Botswana People's Party received 19,664 votes and the remaining 3 seats.

The Republic of Botswana became an independent member of the Commonwealth of Nations on Sept. 30, 1966. It was also admitted to the United Nations in that year. By terms of the constitution, the prime minister (Sir Seretse Khama) became the first president and the Legislative Assembly elected in 1965 became the first National Assembly. Future presidents were to be elected by the National Assembly constituted as an electoral college. The president, who is not a member of the assembly, has power to summon, prorogue, or dissolve it at any time. The assembly initiates legislation with the approval of the president. If the assembly returns a measure that the president has rejected he must then accept it. The president has the power to make regulations for securing public safety, the defense of Botswana, the maintenance of public order, and the suppression of violence. He may declare a state of emergency but his action must be ratified by the assembly within a week of its proclamation. Emergency powers could then last for six months, after which they would automatically be canceled unless renewed by the assembly. Botswana decided not to establish an army but to create an efficient police force.

South Africa changed its previous attitude to the former high commission territories (Bechuanaland, Basutoland, and Swaziland). In 1965 the prohibition on Seretse Khama's entering South Africa was lifted. South African Prime Minister B. J. Vorster later stated that Botswana's becoming independent was not a development that caused concern and that it was in keeping with South Africa's own policy. Sir Seretse Khama (he was knighted just before independence), however, dismissed a suggestion, coming from unofficial quarters, that Botswana should join a southern African federation. This, he said, would prevent Botswana from having ties with black Africa and prevent Botswana from acting as a bridge between north and south. Moreover, this would make Botswana a "Bantustan," which could not be permitted. This did not mean, however, that Botswana would not maintain its close economic, currency, transport, and customs links with South Africa. Its policy of maintaining friendly relationships with neighbouring states was unaffected.

In the general elections of October 1969, the BDP retained its majority, although it lost four seats in the National Assembly, and the Botswana People's Party retained its three seats. The Botswana Independence Party won a seat, and the Botswana National Front, a new party whose program called for closer relations with South Africa and Rhodesia, won three seats. Sir Seretse Khama was sworn in for his second term as president.

Social Conditions.—In the early 1970s Botswana had 280 primary schools, 10 secondary schools, a home craft centre, and 2 teacher training colleges. Botswana students go to the university situated near Maseru, Lesotho, which their country shares with Lesotho and Swaziland. The practice of providing segregated schools for white children was discontinued in 1964.

The system of law is South African law, amplified by the Cape Statutes promulgated up to June 10, 1891, and by Bechuanaland orders in council, proclamations, and high commissioner and government notices subsequently enacted. Botswana has its own independent system of courts with a chief justice presiding over the High Court. There are four groups of subordinate courts including courts presided over by chiefs and their councilors.

The Economy.—The economy of Botswana in the early 1970s remained based mainly on crop and cattle raising, with emphasis on the latter. Because of the lack of industries, migrant workers (about 3,000 in 1968) went to South Africa to work. The discovery of large quantities of minerals in the late 1960s, however, has resulted in the diversification and upgrading of Botswana's economy and the creation of more local jobs for the country's workers. Canada granted a 50-yr., interest-free loan of $16,800,000 to help develop the electric power needed for the new mining industry.

Agriculture.—With the scanty rainfall and poor methods of cultivation, agriculture among the Africans (maize [corn], sorghum, millet, cowpeas, peanuts, and tobacco) rarely provides much above the subsistence level. There is an agricultural experimental station at Mahalapye, and extension work is carried out in the reserves. There is also an irrigation scheme at Mogobane. There are more than 1,300,000 cattle in the country, and many sheep and goats. Foot-and-mouth disease is a great danger to livestock and stringent precautions are taken against it.

Mining.—Export of manganese and asbestos earned about £200,000 (U.S. $480,000) annually in the mid-1960s. There are also small deposits of gold. Important discoveries of copper, sulfur, gypsum, nickel, antimony, coal, and kimberlite diamond pipes were made in 1968. An important function of the geological survey, financed by Commonwealth Development and Welfare funds, has been development of underground water resources.

Trade and Finance.—The principal commercial activity is the export of livestock and livestock products to South Africa, Rhodesia, Zambia, and the Congo. The main channel is the abattoir and cold-storage depot at Lobatse which were built with assistance from the Commonwealth Development Corporation. About 200,000 cattle are slaughtered annually for export. There is also a substantial trade in by-products, such as hides, horns, and bones, as well as a small trade in dairy products. A drought in 1964–65 had a disastrous effect upon the cattle industry.

The chief imports are textiles, general merchandise, vehicles, and foodstuffs. The main sources of ordinary revenue, which in the past included contributions from U.K. Commonwealth Development and Welfare and grant-in-aid funds, are taxes and duties, postal and telegraph services, and revenues from government property. There is a poll tax of £2 (U.S. $4.80) a year on adult African males, 50% of which goes to tribal treasuries; there is also an income tax, but very few Africans have sufficient income to qualify for this. Botswana belongs to the South African monetary area, and South African currency is legal tender. Rhodesian currency is used to a large extent in northern Botswana, and South West African currency is also accepted at par.

Communications.—With few exceptions the roads of the republic are of earth or sand. A good earth road runs through the country beside the railway from south to north, and serviceable roads connect the main road with Kanye, Ramotswa, Molepolole, Mochudi, and Serowe. The Francistown-Maun road has been much improved, as also has the Lobatse-Ghanzi road across the most forbidding part of the Kalahari.

The single-track railway from Cape Town to Rhodesia and Zambia runs through the country, entering at Ramatlabama on the southern boundary, running more or less parallel to the eastern boundary of the republic, and leaving at Ramokgwebana. Formerly owned and operated by Rhodesia Railways Ltd., the railway was transferred to a statutory body established under the laws of Rhodesia and operating under the laws of Rhodesia, Zambia, and Botswana. There are several airports and landing strips served by Botswana Airways Corp., Ltd.

A government-owned radio service provides for the transmission of telegrams when there is no other form of telegraphic communication available. At Maun the South African government controls a large radio station providing assistance to civil aviation.

(AY. SY.; S. TR.; X.)

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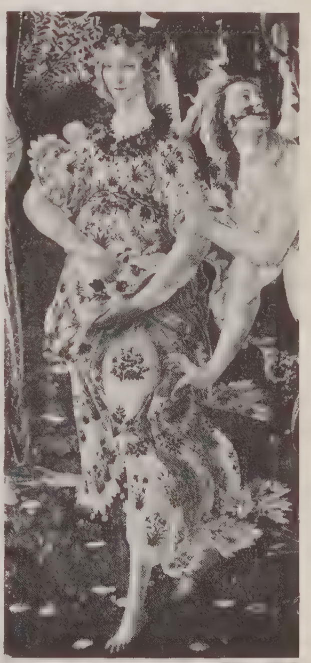
BOTTA, CARLO GIUSEPPE GUGLIELMO (1766–1837), Italian-born historian and politician who supported Napoleon, was born at San Giorgio del Canavese, Piedmont, on Nov. 6, 1766. Having graduated in medicine at Turin in 1786, he was in his youth greatly inspired by the ideas of the French Revolution. Arrested as a spy in 1794, he left Italy for France the following year and from 1796 to 1798 served as a doctor in Napoleon's campaigns against Italy and Corfu. He published a history of Corfu in 1799 and in the same year became a member of the Franco-Italian government of Piedmont. An ardent supporter of Napoleon, though he later contributed to his fall, he was elected vice-president of the French legislative assembly in 1808. In 1815 he became a French citizen and was subsequently appointed rector of the academies of Nancy and Rouen. He died in Paris on Aug. 10, 1837. His main work is a fanciful history of the American Revolution, though it is based on contemporary documents and material supplied by Lafayette. An English translation, *History of the War of the Independence of the United States of America*, was published in Philadelphia (1820–21).

BOTTICELLI, SANDRO (properly Alessandro di Mariano di Vanni Filipepi) (1444/5–1510), one of the greatest of the Italian Renaissance painters, was born at Florence in 1444/5, the son of a tanner. The name Botticelli, by which he was generally known, derives from his eldest brother Giovanni, who bore the nickname "Botticello" (little barrel). A tax return prepared by his father in 1458 describes Botticelli as aged 13, backward, and weak in health. At some uncertain date, probably before 1460, he was apprenticed to Fra Filippo Lippi, and a number of his earliest works (among them the Guidi da Faenza Madonna in the Louvre, Paris, and half-length Madonnas in the Museo di Capodimonte, Naples, the Accademia in Florence, the Musée des Beaux-Arts at Strasbourg and the National gallery, London) reflect Lippi's types and compositional schemes.

Before 1470 Botticelli seems to have become associated with the workshop of Verrocchio, and the latter's style is the dominant factor in his first dated work. This is a figure of Fortitude forming part of a series of seven paintings of Virtues (now in the Uffizi, Florence) commissioned to Piero del Pollaiuolo for the Mercanzia at the end of 1469. The commission for the "Fortitude" was withdrawn from Pollaiuolo and allocated to Botticelli in May 1470 at the instance of Tommaso Soderini, perhaps on the instructions of Lorenzo de' Medici; this was the first official recognition of Botticelli's work. To the period about 1470 belongs the S. Ambrogio altarpiece in the Accademia, Florence, and a painting of the Trinity designed for the high altar of the church of the Convertite (Courtauld gallery, University of London). In the four predella panels of this altarpiece (Philadelphia Museum of Art) there appears for the first time the linear figure style with which the name of Botticelli is associated. To the same date may be assigned two small paintings, "Judith With the Head of Holofernes" and the "Assyrians Discovering the Body of Holofernes" in the Uffizi. The nude figure of Holofernes in the latter is in turn connected with a painting of St. Sebastian executed for Sta. Maria Maggiore in 1473–74 (Dahlem museum, Berlin).

Before 1470 Botticelli also executed the first of his many paintings of the Adoration of the Magi, on an oblong panel, in the National gallery, London. A second, circular painting of the same subject in the same gallery is of somewhat later date and was followed in about 1476 by Botticelli's best-known rendering of the subject, a painting in the Uffizi, commissioned for Sta. Maria Novella by Gaspare di Zanobi del Lama and containing portraits of members of the Medici family and a self-portrait. Almost a decade later Botticelli painted two more pictures of the Adoration of the Magi. One of these is in the National Gallery of Art, Washington, D.C., and the other in the Uffizi. In both cases the scheme is influenced by the S. Donato a Scopeto "Adoration of the Magi" of Leonardo da Vinci now in the Uffizi. The changes that can be traced in this sequence of paintings form an index to the development of Botticelli's style between about 1468 and 1485.

The commission for the "Fortitude" and the portraits in the Uffizi "Adoration of the Magi" provide the earliest evidence of the association with the Medici that inspired some of Botticelli's greatest paintings. Among these, pride of place belongs to the "Allegory of Spring" and the "Birth of Venus" (both in the Uffizi). The first, painted probably in 1478 for the villa of Lorenzo di Pierfrancesco de' Medici at Castello, owes its title of "Primavera" to a passage in G. Vasari's life of Botticelli. Representing Venus in a flowery meadow against a grove of trees with, on the left, the three Graces and Mercury, and on the right, Flora, a zephyr and the figure of a maiden generally identified as that of Spring, it illustrates a complex humanist program probably drawn up by Marsilio Ficino. Of somewhat later date is the "Birth of Venus," also painted for Lorenzo di Pierfrancesco de' Medici. This, Botticelli's masterpiece, appears to have been inspired by descriptions of the lost "Aphrodite Anadyomene" of the Greek painter Apelles, and to depend primarily on the poem "La Giostra" of Politian. Both paintings were originally planned as Neoplatonic allegories and not as simple narratives, but their enduring fame is due to their lyrical treatment and to their transcendent quality as works of art.



ALINARI

Detail from "Primavera," showing Flora and Spring. By Sandro Botticelli. In the Uffizi gallery, Florence, Italy

To the same group of Medicean commissions belongs the "Pallas and a Centaur" in the Uffizi, a political allegory dedicated to Lorenzo de' Medici, and the "Mars and Venus" in the National gallery, London. With these works may be grouped a lost cycle of frescoes painted in the villa of Lorenzo de' Medici at Spedaletto near Volterra by Botticelli, Ghirlandaio, Perugino and Filippino Lippi, and two allegorical frescoes from the Villa Lemmi now in the Louvre, generally thought to have been painted in 1486 for the marriage of Lorenzo Tornabuoni and Giovanna degli Albizzi but perhaps rather earlier in date.

The picture of Botticelli as a humanist artist may be completed with reference to 19 woodcuts which he designed for an edition of Dante's *Divine Comedy* with the commentary of Landino, printed at Florence by Lorenzo della Magna in 1481. It is possible that this work was paid for by Lorenzo di Pierfrancesco, and certain that he was responsible for commissioning a later series of 96 drawings illustrating the *Divine Comedy* (now distributed between the Staatsbibliothek, Berlin, and the Vatican library). In these drawings—Botticelli's supreme achievement as a draftsman—the imagery of the *Divine Comedy* is reinterpreted in Neoplatonic terms. Their execution seems to fall within the decade 1485–95. Before the commencement of this series, Botticelli designed the engraving of the "Triumph of Bacchus and Ariadne" (single example in the British museum, London). Concurrently with the latest of the drawings, he painted, for Antonio Segni, the "Calumny" (Uffizi), inspired by Lucian's description of a lost painting by Apelles.

In 1474 Botticelli visited Pisa, in connection with a proposed commission for frescoes in the Campo Santo, and in 1480 executed, on the choir screen of the Ognissanti, a fresco of "St. Augustine in His Study." A companion fresco of "St. Jerome in His Study" was painted at the same time by Ghirlandaio. The virile forms and ambitious space construction of the St. Augustine find a counterpart a year later in a fresco of the Annunciation painted for S. Martino alla Scala, which ranks with Botticelli's most inspired works.

With the experience of these frescoes behind him, Botticelli was summoned to Rome, in the summer of 1481, to undertake, in the company of Ghirlandaio and Cosimo Rosselli, the frescoed decoration of the Sistine chapel, and between this time and Oct. 1482 executed three frescoes of the "Purification of the Leper and the Temptation of Christ," the "Youth of Moses" and the "Destruction of the Sons of Korah." Though filled with incidental beauties, these crowded and conventional designs do not represent the painter's talent at its most felicitous.

Botticelli's development after his return to Florence may be charted in terms of a number of altarpieces. The first of these, a "Virgin and Child Enthroned With the Two SS. John," painted for S. Spirito in 1485, is in the Dahlem museum. This was followed by a larger and more ambitious altarpiece painted for S. Barnaba (Uffizi); one panel from the beautiful predella of this altarpiece, the "Vision of St. Augustine," has acquired universal popularity. From the years 1488–90 date the great altarpiece of the "Coronation of the Virgin" in the Uffizi (painted for S. Marco) and an Annunciation in the same gallery painted for the convent of Cestello. Several of Botticelli's best-known paintings of the Virgin and Child in half-length date from these same years. Among these are the "Virgin and Child With an Angel," in the Gardner museum, Boston, and the "Virgin and Child With Young St. John" in the Louvre, as well as two circular panels of the "Madonna of the Magnificat" and the "Madonna and Child With Six Angels," both in the Uffizi. All four paintings are remarkable for their intimate personal sentiment, and those in the Uffizi are at the same time some of the most sophisticated 15th-century examples of the employment of the tondo, or circular, form.

After about 1490 expressive line plays an increasingly important part in Botticelli's style. First apparent in the later Dante illustrations, and subsequently in the scenes from the legends of Virginia Romana and Lucretia (Accademia Carrara, Bergamo, and Gardner museum, Boston) and four scenes from the life of St. Zenobius (National gallery, London; Gemäldegalerie, Dresden; Metropolitan museum, New York), this recourse to visual distortion prepared the way for the late style which Botticelli developed under the inspiration of Girolamo Savonarola, after 1498. The painter's brother, Simone di Mariano, who returned to Florence in 1493 and lived with Botticelli in the Via Nuova, became an avowed follower of Savonarola. Botticelli himself seems to have been associated with the movement only after Savonarola's death in 1498. The influence of Savonarola's teachings and prophecies is directly reflected in two paintings. The first of these, an "Adoration of the Shepherds" in the National gallery, was painted in 1500–01 and contains a Greek inscription in which the period between 1498 and 1500 is identified with the second woe of the Apocalypse. The second, in the Fogg Art museum, Cambridge, Mass., represents the Crucifixion with the Angel of Justice flaying the Florentine marzocco and the Magdalen prostrate beneath the Cross. In addition, a number of Botticelli's late paintings reveal the oblique influence of Savonarola in heightened emotionalism and in expressionistic imagery. The two subjects which appealed particularly to the painter's mystical temper at this time were the suffering Christ (best version in the Accademia Carrara) and the Lamentation over the Dead Christ (best version in the Alte Pinakothek, Munich).

Botticelli died on May 17, 1510, and was buried in the Ognissanti, Florence.

Throughout his life Botticelli was also active as a portrait painter. Notable examples of his portraits exist in the National Gallery of Art, the National gallery, the Uffizi and the Accademia Carrara.

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BOTTLE-BRUSH PLANTS comprise two genera of Australian plants, known botanically as *Callistemon* and *Melaleuca*, belonging to the myrtle family (Myrtaceae; *q.v.*). They take their name from the resemblance of the head of flowers to a bottlebrush. Although known in greenhouse culture, they are commonly grown out-of-doors in parts of Florida and California for the beauty of their highly coloured stamens which vary from lemon to crimson. *M. leucadendra* is known as the cajeput or punk tree. Its bark is pale buff and peels off in many thin layers. It is durable and almost impervious to water. (J. M. Bl.)

BOTTLES. This article discusses bottles (defined as narrow-necked rigid or semirigid containers designed to hold liquids or semiliquids) and allied container forms, such as jars, tumblers, jugs, vials, ampoules, and carboys. The material most commonly used in making bottles and these other containers is glass, although plastics have become increasingly important.

History.—The earliest bottles were made from gourds, shells, or animal skins. Wine was transported and stored by the early Egyptians and Greeks in bottles formed by sewing up a goat's skin and leaving the projection of one leg and foot to serve as a vent. The Old Testament refers to the use of skin bottles for wine. Skins are still sometimes used in parts of western Asia to convey and store water. The shell of the bottle gourd is widely used for holding liquids, especially in Africa, where its shape and ornament are often imitated in vessels of pottery. In southern Turkey, crude long-spouted bottles are still carved from pine logs.

Glass.—The use of glass for making containers has been traced back to both the Egyptians and Syrians prior to 1500 B.C. The early Egyptian method consisted of winding strings of molten glass around a core of silica paste on a metal rod, or dipping the core into molten glass. When the glass hardened, the silica paste was dug from it. The blow pipe method, the first major improvement in the art of making glass containers, was developed shortly before the time of Christ. In this process, which is still used to produce special, high-value glass containers, the glass blower dips the end of a hollow tube into molten glass to collect a gob, and then blows and manipulates the gob to produce a finished object. Metal molds were introduced to speed up the production of mouth-blown glass containers. (*See* Glass Manufacture: *Glass Forming Processes: Hand Processes.*)

Developments in glass manufacturing that contributed importantly to the growth in the use of glass containers were the substitution of hydrocarbon fuels (first coal and later natural gas) for wood and the discovery of lead crystal. The use of hydrocarbon fuels contributed primarily to lowering the cost of glass, while the discovery of lead crystal greatly improved glass quality.

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

AFRICAN GOURD BOTTLES WITH CARVED WOODEN STOPPERS FROM KENYA

Still another innovation that reduced the cost of glass substantially was the development of the open hearth type of furnace as a replacement for the older pot-type, direct-fired furnace. In the open hearth furnace, gaseous fuel is used, and flames are played directly over the top of the melt.

But the most important development in the history of glass containers up to the early 1960s was the perfection of automatic machinery that manufactures containers continuously. The first automatic machine was commercially introduced in 1903 by Michael J. Owens, its inventor.

Plastics.—Rigid and semirigid plastic bottles, jars, jugs, carboys, and the like were of minor importance in the early 1960s compared with glass containers. The early growth of plastic bottles was stimulated by the use of low-density polyethylene, a flexible plastic material that permitted production of a bottle that could be squeezed to dispense the contents. High-density polyethylene, a more rigid but tough plastic, was developed in the late 1950s, and its development permitted the production of containers that have thinner walls and cost less than the older squeeze bottles.

Raw Materials and Composition.—*Glass.*—Container glass is made from three major raw materials: silica sand (SiO_2), soda ash (Na_2CO_3), and dolomitic lime ($CaO \cdot MgO$). Limes are introduced as raw limestone ($CaCO_3$) or dolomite ($CaCO_3 \cdot MgCO_3$). Dolomitic limestone tends to have a high iron content and, in Britain, limestone is usually used for colourless glass manufacture since high-grade supplies are plentiful. Magnesium oxide can then be added in the form of magnesite ($MgCO_3$). Feldspar is commonly added for its alumina, and borax may be included to supply boron oxide. Minor ingredients aid the melting of the batch or control the colour of the glass. Fused at high temperature (above 2,700° F.), the oxides derived from the raw materials mutually dissolve, making glass of the following range of composition:

SiO_2 (silica, or silicon dioxide)	68%–74%
Al_2O_3 (alumina, or aluminum oxide)	0.2%–5%
CaO (calcium oxide) and MgO (magnesium oxide)	8%–14%
Na_2O (soda or sodium oxide)	13%–16%
B_2O_3 (boron oxide)	0%–1.5%

Iron oxide (FeO) is always present in raw materials, and a green colour results from it unless the glass is decolourized with selenium; the selenium produces a red coloration that masks the green tint of the iron. The faint straw colour that would remain after the masking is covered by adding cobalt oxide—the glassmaker's "bluing." Arsenic trioxide (As_2O_3) is usually added to oxidize the ferrous iron to the ferric (Fe_2O_3) condition, in which its colour is a paler, more yellowish green. Colourless, or flint, glass cannot be produced if the glass contains more than 0.06% iron oxide.

Besides flint bottles, many coloured ones are made. Amber glass, which protects against the chemical action of light, is made by introducing carbon along with sulfur or a sulfate, thereby generating sulfides in the glass. In the U.S., the carbon is often added as powdered sea coal; in Britain graphite, coke, and powdered coal are commonly used. Iron oxide, in concentrations of 1% or more, makes a green colour that may be reinforced by chromium oxide. Chromium oxide by itself, in a concentration of one pound per ton of glass, produces emerald green. A rich blue results from adding a similar concentration of cobalt oxide.

Glass containers of all sorts must have sufficient resistance to the attack of water and solutions so that the liquids or semiliquids placed in the containers will not be chemically affected by traces of alkali extracted from the glass. Therefore, soda, which helps to melt the glass but also tends to make it soluble, is kept at a minimum. Lime and alumina increase resistance to attack. Bottles for medical serums and other sensitive pharmaceuticals are often made from borosilicate glass, in which boron oxide replaces most of the soda, and alumina is used in place of lime, with silica predominating. (*See* the article GLASS MANUFACTURE for details on batch mixing, furnaces, and melting and annealing operations.)

Plastics.—The important plastic materials for the manufacture of rigid and semirigid containers are the polyolefins (including both low- and high-density polyethylene), polystyrene, and polyvinyl chloride. These are all thermoplastic resins; that is, they soften on heating and can be readily formed. The important basic raw material for all of these plastics is petroleum, which yields hydrocarbons that are processed into plastics by several chemical transformations. In addition, chlorine is an important element in the manufacture of polyvinyl chloride. Because of the relatively low temperatures at which plastics soften, the operations for fabricating containers from these materials are considerably simpler than are those for making glass containers. The higher cost of plastic containers, however, is offset to some extent by their lighter weight; many more containers can be made from a pound of plastic than from a pound of glass.

Methods of Manufacture.—*Glass.*—The most common method for manufacturing virtually all glass containers and most plastic bottles (except plastic jars and vials) is blow molding. In this process, a parison that contains enough material to form the finished container is made in the rough shape of the finished container but much smaller. The parison is transferred to a blowing mold in which compressed air forces it out to its final dimensions.

In glass container manufacture, the parison is most commonly made by using compressed air in a gob feeding process. The older Owens process operated in much the same way except that the glass was drawn into the parison mold by vacuum from a molten pool.

The alternate process for manufacturing parison is by pressing. Again, gob-feeding is customary, but instead of using compressed air to form the parison in the mold, a plunger is used. The press and blow process is most useful for wide-mouthed containers. Pressing can be used alone—without subsequent blowing—for containers of simple shapes, such as plain jelly glasses.

Plastics.—In the blow molding of plastic bottles the most common method for manufacturing the parison is by extruding a tube, capturing the semimolten tube in the blow mold and forming the finish, and then blowing. The other method is to form a parison in an injection mold and then to transfer the parison to the blow mold in a manner similar to the method used in manufacturing glass containers. The extrusion blowing method is less expensive for large articles because the extruder can be operated continuously if it feeds a number of blow molds. The injection molding process is intermittent, but if the articles to be made are small, many can be produced in one cycle of the injection molding machine.

Container Characteristics.—*Glass.*—Glass containers offer chemical inertness, transparency, high rigidity and strength, long shelf life, and ease of opening and closing; another advantage is that they can be made in a wide variety of shapes.

Returnable glass containers are the least expensive liquid-tight containers available; but they have the disadvantage of having to be handled twice by retailers and distributors in each distribution cycle. As a result, in the U.S. there is considerable pressure to replace returnable glass containers with nonreturnable ones. Lighter-weight glass containers were competing in the early 1960s with returnable glass and metal cans. There was a dramatic reduction in the weight of glass containers after World War II. In some cases, weight was reduced by one-third to one-half with little or no sacrifice in strength.

The appeal of glass packages to consumers at the point of sale, which is an important factor in self-service merchandising, is high because of transparency, high gloss, and variety of shapes. Glass containers are convenient to use because they are easy to open and close and because their contents can be heated while still in the container. The fragility of glass containers has been and remains their principal disadvantage. Efforts are being made to reduce breakage by taking advantage of the inherently high strength of glass (of which only a small fraction was being used). While transparency is an advantage, it raises the problem of having to prevent absorption of ultraviolet rays by products sensitive to this type of radiation. The glass colours available for this use are limited, and the problem has been intensified by the development of lightweight, thin-walled glass containers.

Plastics.—Liquid-tight rigid and semirigid plastic containers are more expensive than glass. As pointed out earlier, raw materials cost far more for plastics than for glass, and there is no offsetting savings in the fabricating cost for plastic containers. The outstanding general advantage of plastic over glass is greater toughness. Toughness is particularly useful when the package is handled under conditions in which it might be dropped and broken, as are liquid household detergents and other cleaning products. Other features of plastic liquid-tight containers have more specialized appeal; for example, the squeeze-to-use feature. In general, plastic containers do not provide as good a barrier as glass to gain or loss of water vapour, gases, flavour, and odour, and when used in relatively heavy, rigid sections they do not have the transparency and gloss of glass. Since the common thermoplastic materials cannot be heated much higher than the boiling point of water, they are difficult to sterilize, cannot be hot-filled, and their contents cannot readily be cooked in the package. (P. B. BA.; X.)

BOTTLE TREE, the common name, in reference to the shape of the trunk, of various trees of the genus *Brachychiton,* belonging to the cacao or chocolate family (Sterculiaceae). Native to Australia, bottle trees are cultivated in southern California and Florida as ornamentals. The flame bottle tree (*B. acerifolium*) is grown especially for its display of brilliant red blossoms that appear during the brief period when the tree is leafless. *See* STERCULIACEAE.

BOTTOMRY (BOTTOMRY BOND), a maritime contract in the nature of a mortgage on a vessel, now almost obsolete, used to secure a loan by means of which the vessel is enabled to proceed upon its voyage. Repayment of the loan is conditional on the safe arrival of the vessel, both the security and the right to repayment being lost if the vessel is lost. A similar contract creating a security interest in cargo is called respondentia. *See* MARITIME LAW. (B. CE.)

BOTTROP, an industrial town on the northern edge of the Ruhr in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany, is 6 mi. (10 km.) W.N.W. of Essen. Pop. (1961) 111,997. Although first mentioned in the middle ages, it remained a small town until the latter part of the 19th century. The Catholic priory church of St. Cyriakus (1861–62) stands in the centre of the old part of the town on the site of the village church and round it the business district has grown up. St. Martin's (1883) is the chief Protestant church. North of the Altmarkt is the Rathaus (1916) built in neoclassic style with an imposing tower. A bell from the old church of St. Cyriakus (cast in 1425) stands in the Rathausplatz. The industrial part of the town is mainly in the south while to the north are the municipal park and Kollnischer Wald. The local coal mines, employing almost one-half of the industrial workers, produce large amounts of coal and coke. Manufactures include chemical by-products of coal, machinery and structural steel for buildings and bridges. Molding sand is mined and exported. In World War II it was captured by U.S. troops on March 30, 1945. (F. H. M. K.)

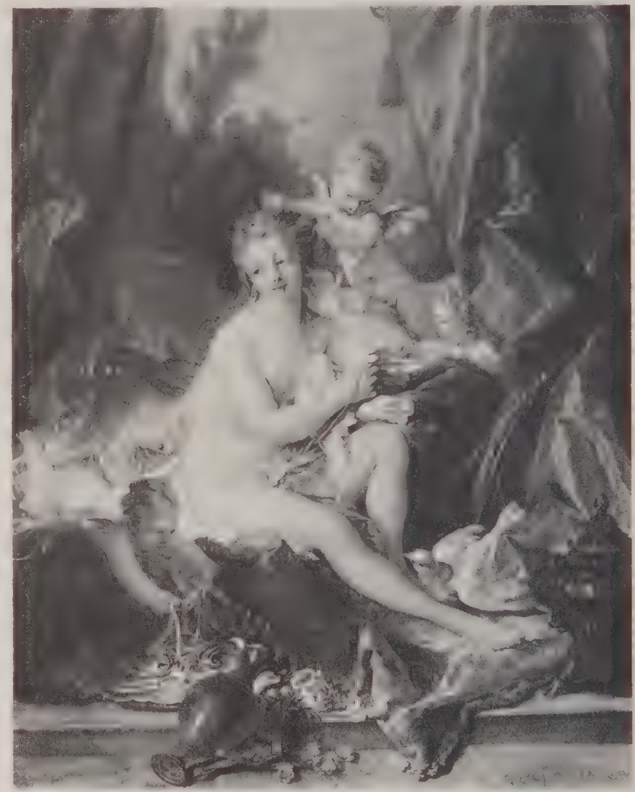
BOTULISM, a kind of food poisoning caused by toxins produced by the bacterium *Clostridium botulinum,* growing in improperly canned foods. The mortality rate is high, and treatment is unsatisfactory. *See* FOOD POISONING, BACTERIOLOGICAL.

BOUAKÉ, the capital of a district of the Republic of Ivory Coast, in West Africa, lies in a plain covered by a wooded savanna and broken by rocky hills. Pop. (1963 est.) 53,000. The town is a centre of the highly developed Baule (*q.v.*) people. It is divided by the Abidjan-Niger Railway, to the north of which are the residential quarters and to the south of which lie the administrative and commercial quarters. Bouaké is also an important junction of roads to Abidjan and Bobo-Dioulasso (in Upper Volta) and to the neighbouring republics of Ghana and Guinea. It is a market centre for an agricultural region (rice, yams, corn, coffee, cocoa), and has cotton and tobacco factories. Bouaké was formerly a slave market, and in 1896 a post was established there for the pacification of the neighbouring peoples, achieved by 1912. (J. D.)

BOUCHARDON, EDME (1698–1762), French sculptor and early precursor of neoclassicism, was born on May 29, 1698, at Chaumont, Haute-Marne, and died in Paris, on July 27, 1762. He was a pupil of Guillaume Coustou at Paris. The permanent classical bias of his art was settled during his stay in Rome (1723–33) where his copy of the Barberini "Sleeping Faun" created a sensation. In 1739 he was employed to execute the monumental fountain in the rue de Grenelle (completed 1745), a remarkably classical work for its date. These classicizing tendencies recommended him to the comte de Caylus, the propagandist of the reaction against the rococo style, and brought him the royal commission for the statue of "Amour Taillant son Arc dans la Massue d'Hercules" (Cupid Carving out his Bow from the Club of Hercules). This much discussed work, which took ten years to complete, achieved little success when exhibited at Versailles in 1750. His third major commission, that for the equestrian statue of Louis XV in the centre of the Place Louis XV at Paris, occupied the rest of his life. The statue was destroyed during the Revolution.

See A. Roserot, *Edme Bouchardon* (1910). (F. J. B. W.)

BOUCHER, FRANÇOIS (1703–1770), French painter, whose work has been called the most perfect expression of the rococo taste of 18th-century France, was born in Paris on Sept. 29, 1703. His father was an obscure painter. François was a pupil of François Lemoyne and worked for an engraver. His first important order was for engravings of 125 drawings by Antoine Watteau for M. de Julienne. In 1723 he won the Royal Academy's first prize, but went to Rome on his own. He spent three years there unrecognized. Back in Paris, he became a member of the Academy in 1734 and was elected to its various offices, including that of director in 1765. After doing illustrations for an edition of Molière's works, he worked for the Beauvais factory, drawing tapestry patterns of farmyard scenes and Chinese subjects.


COURTESY OF THE METROPOLITAN MUSEUM OF ART, BEQUEST OF WILLIAM K. VANDERBILT, 1920

"THE TOILET OF VENUS" BY FRANÇOIS BOUCHER, 1751. IN THE METROPOLITAN MUSEUM OF ART, NEW YORK CITY

Boucher's fame in Paris started with the reopening of the Salon in 1737. He painted allegories for the queen's chamber at Versailles. Mme de Pompadour had him paint pictures for Versailles, Marly and Bellevue. He gave her lessons in drawing and engraving. In 1753 he showed "The Sunrise" and "The Sunset," which Mme de Pompadour bought and which are now in the Wallace collection in London. Inspector of the Gobelins after Jean Baptiste Oudry's death, he produced for that factory the designs for the tapestries of the series entitled "Loves of the Gods." Boucher became Louis XV's first painter in 1763. Toward the end of his life, he was rich, but his talent began to fail and criticisms of his paintings and drawings began to be unfavourable (Grimm, Diderot). He died in Paris on May 30, 1770.

The sale of his art objects after his death brought a large sum. The Wallace collection in London and the Louvre contain the largest number of his works. A portrait of Mme de Pompadour is in the National gallery in Edinburgh, Scot.

See P. de Nolhac, *François Boucher premier peintre du Roi* (1925); M. Block, *François Boucher and the Beauvais Tapestries* (1933). (M. N. B.)

BOUCHER, JONATHAN (1738–1804), English clergyman who won fame as a royalist in America, was born near Wigton, Cumberland, on March 12, 1738. In 1759 he went to Virginia as a private tutor. After a visit to London in 1762 for his ordination, he became rector of Annapolis, and tutored Washington's stepson, thus becoming a family friend. His royalist views cost him his position: by 1775 he was conducting services with pistols on his pulpit cushion, and he was forced to return to England. He nevertheless dedicated to Washington *A View of the Causes and Consequences of the American Revolution* (1797), consisting of 13 of the eloquent sermons he had preached in America urging loyalty to England, and received a friendly acknowledgment.

Having obtained a pension and the living of Epsom, Surrey, Boucher devoted his leisure to writing and to philology. He contributed to W. Hutchinson's *History of the County of Cumberland,* two volumes (1794 *et seq.*) and compiled a "Glossary of Archaic and Provincial Words," intended to supplement Samuel Johnson's *Dictionary*. It was only published in part, but was later used for Noah Webster's *Dictionary*. He died at Epsom on April 27, 1804.

See *Letters of Jonathan Boucher to George Washington,* ed. by W. C. Ford (1899); *Notes and Queries,* 3rd series, vol. ix (1866) and 5th series, vol. ix (1878).

BOUCHER (DE CRÈVECOEUR) DE PERTHES, JACQUES (1788–1868), French antiquarian, who was largely responsible for establishing the existence of prehistoric man, was born on Sept. 10, 1788, at Rethel, Ardennes. By vocation he was a customs official, like his father, and in 1825 became director of the customhouse at Abbeville, near the mouth of the Somme river. There he began devoting his leisure to archaeology. In the course of his explorations in the Somme valley, he discovered hand-worked flints and other stone tools imbedded in ancient gravels laid down in the Pleistocene, or Ice Age, some of them *in situ* with the bones of extinct mammals. While not the earliest to find evidence of a Stone Age culture, Boucher de Perthes was the first to grasp its revolutionary significance, in an age when Archbishop Ussher's date of 4004 B.C. was widely accepted as the time of creation. In 1838 he presented tools in evidence before the scientific society at Abbeville, but met with disbelief; and his monograph *De l'industrie primitive* (1846) was ignored. In 1859—the year of publication of Darwin's *Origin of Species*—his conclusions were at last upheld by a group of eminent British scientists, including the geologists C. Lyell and J. Prestwich, who visited the excavated sites. His other archaeological studies included *De l'homme antédiluvien et ses oeuvres* (1860) and *Antiquités celtiques et antédiluviennes,* 3 vol. (1847–64). A man of broad interests, he also wrote books of fiction and travel, and works on social and economic questions that reflected liberal views far in advance of his time. He died on Aug. 5, 1868, at Abbeville.

See Lady Prestwich, "Recollections of M. Boucher de Perthes," in *Essays Descriptive and Biographical* (1901); and G. E. Daniel, *A Hundred Years of Archaeology* (1950).

BOUCHES-DU-RHÔNE, a *département* of southeastern France, at the mouth of the Rhône, was formed in 1790 from the western part of Provence (*q.v.*); it is bounded to the north beyond the Durance river by Vaucluse, east by Var, west across the Rhône by Gard, and it fronts the Mediterranean sea for about 120 mi. from the western part of the Rhône delta to the rocky coast beyond Marseilles and La Ciotat. Pop. (1962) 1,248,355. Area 1,974 sq.mi. The triangle of the Rhône delta below Arles, in the southwest of the *département,* is the district known as the Camargue (*q.v.*), a low-lying marshy tract, with extensive lagoons in the depressions between the embankments of past and present distributary channels. East of the main channel of the Rhône is the flat, boulder-strewn tract of the Crau, formed of coarse material spread out by an earlier Durance from the gap of Lamanon between the main tract of limestone hills and the Alpilles, a westward prong that extends toward the Rhône south of the lower Durance valley. The eastern part of the *département* consists of lowland basins of marls and other Tertiary rocks, set amid scarped limestone hills. They include that of the Etang de Berre, largely filled by a shallow sheet of water with a narrow channel connecting with the sea, the basin of Aix, and that of Marseilles-Aubagne. Cultivated land shows a very patchy distribution, interrupted by extensive areas of almost soilless limestone, carrying scrub and pinewoods, which provide turpentine.

The extension of irrigation (more than one-third of the cultivated land in the *département* is irrigated, mainly with water derived from the Durance river) allowed the reclamation of considerable areas, especially in the Crau and in the plain north of the Alpilles, for the cultivation of vegetables and fodder crops. In these areas, exposed to the blasts of the mistral, the delicate crops are grown on plots between rows of cypress shelter belts. In the Camargue rice cultivation has been developed. Elsewhere the traditional Mediterranean trilogy of wheat, vine and olive tends to be replaced by specialization upon vineyards, cultivated by smallholders organized in co-operative associations. The wine is not generally of high quality, but Cassis and Palette are well known. Among other fruits, the almond is widely grown, and used for confections which are a speciality of Aix-en-Provence and other places.

Although the ore of aluminum, bauxite, takes its name from the village of Les Baux on the southern edge of the Alpilles, where it was first exploited, the main area of production has shifted to the neighbouring *département* of Var. Behind Marseilles, in the basin of Aix, is a small lignite field round Fuveau and Gardanne, which supplies Marseilles with fuel for electricity generation. Brine evaporation is still carried on at places along the coast of the Rhône delta. The great port city of Marseilles dominates the commercial and industrial life of the *département.* Its industries are especially concerned with refining and processing imported products, such as vegetable oil, grain and sugar. From the mountain-framed lowland into which the old and 19th-century ports and the city are crowded, the port and industrial area were extended after World War II by the development of an *annexe* on the Etang de Berre. At its entrance, Lavera was equipped as a modern oil port, whence oil is piped to great refineries on the shores of the Etang at Shell-Berre and La Mède. An associated development of petrochemical industries was initiated. Mineral oil accounted in 1960 for the great bulk of the tonnage handled by the port of Marseilles, one of the great oil ports and refining centres of western Europe. In other parts of the *département* industry is of subsidiary importance, but rice milling at Arles, naval shipbuilding at La Ciotat, the manufacture of ceramics at Aubagne and cement at La Bédoule, and scattered brick and tile works and food industries may be mentioned.

The Etang de Berre is connected with Marseilles by the Rove canal, which tunnels through the Nerthe mountain. The main Paris-Lyons-Marseilles railway also approaches the city from the northwest by a long tunnel. Farther inland the *département* is traversed by the main road from the Rhône valley to the Riviera and Italy, along the line of the Roman *Via Aurelia.* Aix-en-Provence, first Roman base in Provence, and Salon lie along its line. The ancient Roman cities of Aix and Arles, rich in history and architecture, are important tourist centres, and the fortress ruins at Les Baux and the Camargue village of Saintes-Maries-de-la-Mer also are special attractions for tourists. Near Aix-en-Provence, the home of Cézanne, is the Mont Ste. Victoire, featured in many of his landscapes, and the western part of the *département* round Arles is depicted in many of the works of Van Gogh.

Marseilles is the capital of the *département,* divided into three *arrondissements* centred upon Marseilles, Aix-en-Provence, and Arles (*qq.v.*). The *arrondissement* of Marseilles forms the ecclesiastical province of Marseilles, the remainder of the *département* that of Aix. Aix also has the court of appeal and the older part of the University of Aix-Marseilles.

BOUCICAULT, DION (DIONYSIUS LARDNER BOURSIQUOT) (1822?–1890), Irish-U.S. playwright and actor, was born in Dublin on Dec. 26, 1822 or 1820. It is commonly assumed that he was the natural son of Dionysius Lardner, a boarder in his mother's house. In 1837 he began acting and in 1840 submitted his first play to Mme Vestris at Covent Garden; it was rejected. His second play, *London Assurance* (1841), which foreshadowed the modern social drama, was a huge success. Other early plays were *Old Heads and Young Hearts* (1844) and *The Corsican Brothers*

(1852). In 1853 Boucicault and his second wife, Agnes Robertson, arrived in New York city, where his plays and adaptations were long popular. His *The Poor of New York,* based on the panics of 1837 and 1857, had a long run at Wallack's theatre in 1857, and *The Octoroon* (1859) caused a sensation with its implied attack on slavery.

Boucicault and his actress-wife joined Laura Keene's theatre in 1860 and began a series of popular Irish plays—*The Colleen Bawn* (1860), *Arrah-na-Pogue* (1864), *The O'Dowd* (1873) and *The Shaughraun* (1874). After returning to London in 1862, he provided Joseph Jefferson with a successful adaptation of *Rip Van Winkle* (1865). In 1872 Boucicault returned to the U.S., where, except for a trip to Australia that resulted in his third marriage, he remained until his death, Sept. 18, 1890. At the time of his death he was a poorly paid teacher of acting in New York.

As both writer and actor, Boucicault raised the stage Irishman from caricature to character. His major contribution to the theatre, however, was his influence on United States drama. (S. W. H.)

BOUCICAUT, JEAN LE MEINGRE, Marshal (*c.* 1366–1421), French soldier distinguished in the wars against the Ottoman Turks and as an exponent of the ideals of chivalry, was the son of another Jean le Meingre (d. 1368) also known as Boucicaut and likewise a marshal of France. The younger Boucicaut had served in several campaigns, notably at Roosebeke (1382), and been made a marshal by Charles VI in 1391 before he joined the expedition to Hungary (1396). Taken prisoner by the Turks at Nicopolis (Nikopol on the Danube), he was ransomed and in 1399 appeared at Constantinople with 1,400 men and a good fleet to aid the Byzantine emperor against the Turks. He defeated a Turkish fleet at Gallipoli and arrived in the Golden Horn in time to prevent the capture of Galata. He held the Turks in check for a year and then returned to France to seek volunteers. He did not return to Turkey, however, and was sent instead to strengthen French dominion in Genoa. His administration was successful but involved him in a brief war with Venice. Genoa threw off the French yoke in 1409 while he was away. Taken prisoner at the battle of Agincourt (1415), he died in England. Boucicaut, who was very skilful in the tournament, founded the order of the *Dame blanche à l'écu vert,* a society whose object was to defend the wives and daughters of absent knights.

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BOUDIN, EUGÈNE LOUIS (1824–1898), French painter, who was pre-eminent as a painter of the moods of water, was born at Honfleur, the son of a sea pilot, on July 12, 1824. The father gave up the sea for a small stationer's shop in Le Havre. Troyon and Millet came to the shop and discovered the boy's talent for art, and Courbet and Alphonse Karr found their way there. Boudin went to Paris to study, and, after a short time, returned to his native place. He was a follower of Corot, and in his turn became the master of Monet.

The École St. Siméon, named after the farm which was its headquarters, dates from 1856. In this colony Boudin was a leader. The group included Millet, Courbet, Diaz, Harpignies, Jongkind, Isabey, Monet and others. Boudin presently moved to Trouville and then married and set up house in Le Havre. From 1875 onward he exhibited at the Salon but without attracting much notice until his "Corvette russe" was bought by the state for the Luxembourg gallery in 1888. In 1896 the "Rade de Villefranche" was bought for the same gallery, and Boudin, then over 70, received the Legion of Honour. He died at Deauville on Aug. 8, 1898.

Boudin's best work was in his small canvases. As the painter of tidal rivers he was outstanding, and Corot called him the "master of the sea." A large number of his sketches are at Le Havre.

BOUDINOT, ELIAS (1740–1821), U.S. lawyer and public official, was born in Philadelphia, Pa., on May 2, 1740. He practised law and became a member of the revolutionary party at the outbreak of the American Revolution, serving first as deputy in the New Jersey provincial assembly, and then as one of New Jersey's representatives in the continental congress. He was president of that body from Nov. 1782 to Oct. 1783. After the establishment of the national government he was for six years (1789–95) a member of the national house of representatives. He became director of the U.S. mint at Philadelphia in 1795, succeeding David Rittenhouse, and served for 10 years. He was the first president of the American Bible society, and in reply to Thomas Paine's *Age of Reason,* published the *Age of Revelation* (1790). He died at Burlington, N.J., on Oct. 24, 1821. (E. E. R.)

BOUÉ, AMI (1794–1881), Austrian geologist who was one of the pioneers in geological research, was born in Hamburg, Ger., on March 16, 1794. He received his early education there and in Geneva and Paris. In Edinburgh he came under the influence of Robert Jameson, whose teachings in geology and mineralogy inspired his future. Boué was thus led to make geological expeditions to various parts of Scotland and the Hebrides and in 1820 he issued his *Essai géologique sur l'Écosse,* in which the volcanic rocks in particular were carefully described. He settled for some years in Paris, being one of the founders of the Société Géologique de France in 1830 and its president in 1835. In 1841 he settled in Vienna and became naturalized as an Austrian. He died there on Nov. 21, 1881.

Boué published important papers on the geology of the Balkan states (1859–70), *Mémoires géologiques et paléontologiques* (1832) and *La Turquie d'Europe,* four volumes (1840).

BOUFFLERS, LOUIS FRANÇOIS, Duc de (1644–1711), marshal of France, distinguished in the last of the Dutch Wars, in the War of the Grand Alliance and in the War of the Spanish Succession, was born Jan. 10, 1644, of an old Picard family that held the marquisate of Boufflers in Ponthieu. As a guards officer he was at the first French landing in Algeria, at Djidjelli (1664). In 1669 he bought the colonelcy of the royal dragoons, a new arm much favoured by the king, Louis XIV, who noted the young colonel's exploits. After good service under Turenne and under François de Créquy on the German frontier, Boufflers was made colonel-general of dragoons (1679–92) and promoted lieutenant-general (1681). Wounded in the trenches at Mons in 1691, he was made colonel of the French Guards (1692–1704). With that high honour he was made marshal of France in 1693 and created duc de Boufflers in 1694.

In 1695, when he shared the army command in Flanders with the marshal duc de Villeroi, Boufflers was the soul of the defense of Namur, where 8,000 of his garrison perished before he surrendered. In 1702, in command of the main French army, he began with a sharp blow at the Dutch before Nijmegen but was then maneuvered out of the Rhine-Meuse area by Marlborough. In 1703 his cavalry raid on the Dutch near Antwerp checked their plan. He was appointed to command the royal bodyguard in 1704.

Boufflers had been governor of Lille since 1694, and in 1708, when Marlborough and Prince Eugène of Savoy were threatening it, he asked for leave to take up his post there. He did so just before the siege began (Aug. 1), and with 14,000 men he made another memorable defense. On Dec. 9 he marched out from the citadel with the full honours of war. The next year he volunteered to help the marshal duc de Villars, his junior, and in the battle of Malplaquet (*q.v.*) found himself in command when Villars was wounded; he led the household cavalry with great spirit, took the decision to retreat and kept the army in such control that he reported defiantly that they were ready to fight again. He died at Fontainebleau on Aug. 22, 1711. (I. D. E.)

BOUFFLERS, STANISLAS JEAN, Chevalier de (1738–1815), French man of letters, described as "the Voiture of his age," was born in Lorraine on May 31, 1738. His mother, Marie Catherine de Beauvau-Craon, marquise de Boufflers, was the mistress of the duke of Lorraine, Stanislaw Leszczynski (the dispossessed king of Poland), at whose court in Lunéville the boy was brought up. While studying theology at Saint-Sulpice in Paris, he wrote *Aline, reine de Golconde* (1761), the charming tale of a milkmaid, Aline, who after a series of improper adventures becomes queen of Golconda. This tale won immediate success in fashionable circles but led to his expulsion from Saint-Sulpice, whereupon he joined the Knights of Malta so as to combine qualification for ecclesiastical benefices in Lorraine with the freedom of a military career. For the next 24 years he was either campaigning in Europe (often with the Austrian armies) or establishing his reputation for wit in the Parisian salons, where in 1777 he fell in love with Éléonore de Jean de Manville, comtesse de Sabran. To restore his finances he served two terms (1786 and 1787) as governor of Senegal, where he showed interest in developing the country's resources but was reluctant to exploit the slave trade. Elected to the Académie Française in 1788, he was deputy for the nobility of Nancy in the states-general of 1789, but emigrated to Prussia in 1791. With the loss of his benefices his celibacy became pointless, and he married Mme de Sabran at Breslau in 1797. Returning to France in 1800, he supervised an edition of his complete works (1803). He died in Paris on Jan. 18, 1815.

There are editions of Boufflers's *Contes* and of his *Poésies diverses* by Octave Uzanne (1878 and 1886) and of his letters to Mme de Sabran by Paul Prat (1891).

See N. H. Webster, *The Chevalier de Boufflers* (1916).

BOUGAINVILLE, LOUIS ANTOINE DE (1729–1811), French navigator, commander on land and at sea, colonial organizer and explorer who, in his voyage of circumnavigation (1766–69), made important discoveries in the Pacific ocean, was born in Paris on Nov. 11, 1729. He showed an early aptitude for mathematics and published a treatise on integral calculus (1754–56). Having entered the army at the age of 24, he went to Canada in 1756 as aide-de-camp to the marquis de Montcalm and distinguished himself in the war against England. Bougainville then undertook to colonize the Falkland Islands for France at his own expense. He established his colony in Jan. 1764, but in Jan. 1765 Commodore John Byron planted an English colony in another part of the islands, and the French government agreed to cede the group to Spain in April 1767. Bougainville, commissioned by his government to make a voyage of discovery round the world, sailed in Dec. 1766 in the frigate "La Boudeuse" accompanied by a storeship. He traversed the Straits of Magellan and sailed northwest to the Tuamotus. He visited Tahiti, discovered in June 1767 by Capt. Samuel Wallis, and named it *La Nouvelle Cythère*. Sailing west he touched at Samoa (*Archipel des Navigateurs*) and the New Hebrides (*Les Grandes Cyclades*). He then took a westerly course toward New Holland, in waters not previously navigated by any European ship. On the fringes of the Great Barrier Reef he turned north without sighting Australia and passed through the Louisiade archipelago and the edge of the Solomon Islands to New Britain. Since his men were now suffering from scurvy and his ships needed a refit, he repaired to Buru in the Moluccas (Sept. 1768), and thence to Batavia. In March 1769 he arrived at St. Malo, having lost only seven men since leaving France.

On his return Bougainville was promoted *chef de vaisseau* (1770) and appointed secretary to the king (1772). In 1779–82, as *chef d'escadre,* he served in North America; and after the French defeat at the battle of the Saints, off Martinique (April 12, 1782), he was court-martialed and banished from court. He returned to the army, and after the peace he settled in Paris. He obtained the rank of vice-admiral in 1791; and in 1792, having escaped from the massacres of Paris, he retired to his estate in Normandy. He was chosen a member of the Institute at its formation, and became a member of the board of longitude. Napoleon I made him a senator, count of the empire and member of the Legion of Honour. He died in Paris on Aug. 31, 1811.

Bougainville was characterized by courage and resource in action, by urbanity in personal relationships and by a scientific cast of intelligence. His name was given to the largest of the Solomon Islands and to the strait between Malekula and Espíritu Santo islands of the New Hebrides group. The South American climbing plant *Bougainvillea,* often cultivated in greenhouses, is also named after him.

Bougainville's *Voyage autour du monde* (1771) was translated into English by J. R. Forster (1772). His personal papers were dispersed by sale in London in 1957. (R. A. Sn.)

BOUGAINVILLE, the largest of the Solomon Islands (*q.v.*), is situated near the northern end of the chain and, together with Buka, forms part of the Australian trust territory of New Guinea (*q.v.*). Measuring 127 mi. by 49 mi., Bougainville has a rugged and heavily forested mountainous core containing two active volcanoes, Mt. Balbi (8,502 ft.) and Mt. Bagana (5,730 ft.). On the east coast there is a narrow plain in the vicinity of Kieta, the chief settlement, and there are situated most of the coconut plantations that constitute the island's principal economic activity. The native population numbers about 40,000. The island was named for the French explorer, Louis Antoine de Bougainville (*q.v.*). (D. W. F.)

BOUGAINVILLEA, a genus containing a dozen or more South American shrubs, often woody climbers, belonging to the four-o'clock family (Nyctaginaceae). The leaves are simple, petioled, alternate, ovate to elliptic-lanceolate and commonly entire. The small and inconspicuous flowers are enclosed by showy mauve, magenta, purple or red corollalike bracts that constitute the decorative value of the plants. Formerly *Bougainvillea glabra* and *B. spectabilis,* with their varieties, constituted the forms chiefly known in cultivation in the United States, but *B. trolli,* with its several varieties, is now also widely grown. All the species are highly sensitive to frost and thus can be grown successfully outdoors only in regions that are essentially frost free. They may be grown in greenhouses, however, where the climate does not permit year-round outdoor culture.

The young stock, obtained from half-ripened or old wood, can be started in pots and grown in the field during summer. During early autumn the potted plants must be lifted and brought into the greenhouse. Under proper care these plants should bloom the following spring. In most of Florida, along the coast of the Gulf of Mexico and in southern California, bougainvillea is used extensively as a porch cover, on pergolas, arches and as hedge or fence plants. They may also be planted at the base of trees, up which they climb to make beautiful displays of colour. All species and varieties withstand drought extremely well and may be pruned heavily without risk of injury. (J. M. Bl.)

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PENDANT BRANCHLET OF BOUGAINVILLEA (B. GLABRA)

BOUGHTON, GEORGE HENRY (1833–1905), Anglo-U.S. painter, born on Dec. 4, 1833, near Norwich, Eng., was brought up in Albany, N.Y. After studying art in Paris during 1861–62, he settled in London and was much influenced by Frederick Walker. His pictures of early American colonial life and scenery were especially characteristic, and subject pictures such as "Weeding the Pavement" (Tate gallery, London) had a great success. Boughton executed many fine book illustrations, notably those for *Rip Van Winkle* (1893) and *Knickerbocker History* (1886). He became a royal academician in 1896, and died in London on Jan. 19, 1905. (D. L. Fr.)

BOUGHTON, RUTLAND (1878–1960), English composer of opera, whose work was influenced by the Wagnerian concept of the music drama, was born at Aylesbury, Buckinghamshire, Jan. 23, 1878. He studied at the Royal College of Music in 1900 but was otherwise self-taught. He had the idea of writing a series of works based on Arthurian legends, and of creating a festival theatre for their performance at Glastonbury. After a long struggle (1914–24) with inadequate resources he abandoned the attempt to establish the theatre, but had some success in London and elsewhere. His most popular work was the tuneful romantic opera, *The Immortal Hour* (1913), which had a run of 216 performances in London in 1922. Among his other successes were *Bethlehem* (1915), *Alkestis* (1922), *The Queen of Cornwall* (1924) and *The Lily Maid* (1934). After 1939 little was heard of his music, but this did not discourage him from composing, and between 1943 and 1946 he wrote two more Arthurian music dramas, *Galahad* and *Avalon*. Besides operas, he wrote choral works, symphonies, concertos and chamber music. He published a book on Bach (1907) and, with Reginald Buckley, his partner in the Glastonbury scheme, *The Music Drama of the Future* (1908). He died in London, Jan. 25, 1960. (Co. Ma.)

BOUGIE (Algeria): *see* Bejaïa.

BOUGUER, PIERRE (1698–1758), French scientist, took part with C. M. de la Condamine in an expedition to measure an arc of the meridian near the equator in Peru (1735–43) and used the results in a new determination of the figure of the earth (*see* Gravitation), a full account of this operation being given in 1749 in *La Figure de la terre*. Born at Croisic in lower Britanny on Feb. 16, 1698, he succeeded his father, Jean Bouguer, as regius professor of hydrography at Croisic and in 1730 became professor at Le Havre. As a hydrographer he wrote on ships, maneuvering and navigation. He might also be called a geodesist and a physicist. As a physicist he worked on problems connected with the passage of light through the atmosphere and on photometry. He constructed tables of atmospheric refraction based on his own theory and the adopted refraction on the horizon, and at 26° altitude. He made some of the earliest measurements in astronomical photometry and investigated the absorption of light in the atmosphere, the results of which inquiry he published in his *Essai d'optique sur la gradation de la lumière* (1729). In optics he constructed an early form of the instrument later called the heliometer. Bouguer died at Paris on Aug. 15, 1758. (J. Jn.)

BOUHOURS, DOMINIQUE (1628–1702), French grammarian and literary critic, notable as an extreme purist, was born in Paris on May 15, 1628. Having taken vows as a Jesuit in 1662, he was entrusted with the education of the sons of the duc de Longueville and subsequently with that of the marquis de Seignelay, Colbert's son. His first book (1668) was an attack on the Jansenists of Port-Royal. He began to advance his ideas on the French language in *Les Entretiens d'Ariste et d'Eugène* (1671), but this book, which also included another attack on Port-Royal, was banned by the government. Thereafter he developed his linguistic and literary doctrine in a series of works. In the name of purity of language he required such caution and circumspection in the choice of words and in sentence-building as would in practice make great writing no longer possible. This was made clear enough in the *Lettres . . . sur le sujet de la Princesse de Clèves* (1678; on Mme de La Fayette's masterpiece), which were written by J. B. du Trousset de Valincour but inspired by Bouhours. Bouhours had great influence in his time and was the teacher of the Jesuits who were later to edit the *Journal de Trévoux*. He died in Paris on May 27, 1702.

See A. Adam, *Histoire de la littérature française au XVII^e^ siècle*, vol. v (1956). (Ae. A.)

BOUILLON, a town in Belgium, province of Luxembourg, known for the ducal title connected with it. Bouillon in the 11th century was held by the counts of Ardennes, five of whom, between 1012 and 1069, were invested with the dukedom of Lower Lorraine by the German kings. As Bouillon was their principal stronghold, it became usual to designate these dukes, loosely, as dukes of Bouillon, though Bouillon itself was not a duchy. Godfrey the Hunchback (d. 1076) left Bouillon to his nephew Godfrey, who pledged it in 1096 to the bishop of Liège to raise funds for his crusade. Thereafter the bishops of Liège occasionally styled themselves dukes of Bouillon. In 1482, however, Guillaume de La Marck got Bouillon in pledge from Liège and installed his brother, Robert I (d. 1487), lord of Sedan, as chatelain. Robert II (d. 1536) had to restore Bouillon to Liège in 1521, but Robert IV (d. 1556), with French support, began to style himself duc de Bouillon in 1548 and actually got possession of the place in 1552. His son, Henri Robert de La Marck (d. 1574), had to restore Bouillon to Liège again in 1559, but he and his son Guillaume Robert (d. 1588), continued to style themselves dukes of Bouillon. Their heiress, Charlotte, brought the title to her husband, Henri de La Tour d'Auvergne (1555–1623), in 1591.

As sovereigns of Sedan, Henri and his successor, Frédéric Maurice (1605–52), were particularly formidable to the French government whenever they chose to conspire against it. Frédéric Maurice lost Sedan in 1642 when his role in the conspiracy of Cinq-Mars came to light, but during the Fronde the French government, in order to conciliate him, undertook to promote his claim to Bouillon as soon as practicable. Accordingly, French troops having taken the place (1676), his son Godefroy Maurice (1641–1721) was set up by Louis XIV as independent sovereign there (1678). The next dukes of Bouillon, in direct succession, were Emmanuel Théodose (1668–1730), Charles Godefroy (1706–71), Godefroy Charles Henri (1728–92) and Jacques Léopold (1746–1802). The last named—who was to lose Bouillon in 1794 when it declared itself a republic (it was annexed to France next year)—had always been sickly, so that his father had in 1786 recognized as eventual heir an English naval lieutenant, Philip D'Auvergne, a descendant of the medieval counts of Auvergne. On the defeat of Napoleonic France, D'Auvergne in Aug. 1814 set himself up as sovereign in Bouillon, but the victorious powers in Nov. 1815 gave the sovereignty, with Luxembourg, to the Netherlands. The ducal title was adjudged in 1816 to Charles Alain Gabriel de Rohan, duc de Montbazon (a great-grandson of Charles Godefroy), in whose family it remains. On the partition of Luxembourg in 1831, Bouillon became Belgian. Pop. (1961) 3,017. (J. G. R.-S.)

BOULANGER, GEORGES ERNEST JEAN MARIE (1837–1891), French general and minister whose political activities constituted a grave danger to the republican regime in the 1880s, was born at Rennes on April 29, 1837. He entered the army in 1856, served in Algeria, Italy and Cochin China (Indochina) and in the Franco-German War. He was made a brigadier general in 1880 on the recommendation of the duc d'Aumale (Henri d'Orléans), and his expressions of gratitude on this occasion were remembered against him in 1886, when, as minister for war, he erased the duke's name from the army list as part of the campaign against the princes of formerly sovereign dynasties residing in France.

Boulanger became director of infantry in 1882 and two years later was appointed to command the army in Tunisia, but was recalled because of differences of opinion with Pierre Paul Cambon, the political resident. Returning to Paris, he began to take part in politics under the aegis of Clemenceau and of the Radical party. In Jan. 1886 he entered Charles de Freycinet's government as minister for war.

By introducing reforms for the benefit of all ranks and by courting popularity openly, Boulanger came to be accepted by the people as the man destined to avenge France's defeat in the Franco-German War. He thus became a tool in the hands of the groups hostile to the existing republican dispensation. On Freycinet's defeat in Dec. 1886, Boulanger was retained at the ministry of war by the new prime minister, René Goblet, though Clemenceau by this time had withdrawn his patronage from the obviously too compromising general. On Goblet's retirement from office in May 1887, the Paris populace clamoured for their *"brav' général,"* but Maurice Rouvier, who had long been hostile to Boulanger, refused to include him in his government, and the general was sent to Clermont-Ferrand to command the XIII corps. A Boulangist "movement," however, was now in full swing. The Bonapartists (except the empress Eugénie) had attached themselves to the general, and the royalists were led to support him by the duchesse d'Uzès (Marie Anne Clémentine de Rochechouart-Mortemart), who contributed large sums to the general's political fund.

Boulanger was deprived of his command in 1888 for coming three times to Paris without leave and in disguise, and for visiting Prince Napoleon at Prangins in Switzerland. His name was removed from the army list, but almost immediately he was elected deputy for the Nord. In June 1888 his proposals for revising the constitution were rejected by the chamber, whereupon he resigned. An altercation with Charles Floquet led to a duel (July 13) in which the elderly prime minister inflicted a severe wound on the general. Neither this humiliation nor Boulanger's failure as an orator checked his followers' enthusiasm, and throughout 1888 his personality dominated French politics.

In Jan. 1889 Boulanger was returned for Paris by an overwhelming majority, and he became an open menace to the parliamentary constitution, which he sought to modify to suit his ambitions. But a new government under Pierre Tirard, with Ernest Constans as minister of the interior, decided to prosecute Boulanger, and within two months the chamber was requested to waive the general's parliamentary immunity. To his friends' astonishment, Boulanger fled from Paris on April 1, going first to Brussels and then to London. He was tried *in absentia* for treason by the senate as high court and condemned on Aug. 14, 1889, to deportation. In the elections of 1889 and 1890 his supporters received a setback, and public enthusiasm for his cause dwindled away. On Sept. 30, 1891, Boulanger committed suicide in Brussels at the cemetery of Ixelles, over the grave of his mistress, the vicomtesse de Bonnemain.

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BOULANGER, NADIA (1887–), French teacher of musical composition, among whose students have been many of the leading composers of the 20th century, was born in Paris on Sept. 16, 1887. Her family had been associated for two generations with the Paris Conservatory, in which her father, Ernest Boulanger—her own first instructor—was a teacher of singing. She received her formal training there (1897–1904), principally under Gabriel Fauré. Afterward she taught composition for a time at the conservatory and privately. She also published a few short works, and in 1908 won second place in the Prix de Rome competition with her cantata *Sirène*. She ceased composing, rating her works "useless," after the death in 1918 of her talented sister, Lili, also a composer.

In 1921 Miss Boulanger began her long association with the Conservatoire Américain, founded at Fontainebleu by Walter Damrosch after World War I for American musicians. She made a lecture-recital tour of the United States in 1937 and returned in 1938 for appearances as the first woman conductor of the Boston, New York Philharmonic, and Philadelphia orchestras; she had already (1937) become the first woman to conduct an entire program of the Royal Philharmonic of London. She spent the period of World War II in the U.S., mainly as a teacher at the Washington (D.C.) College of Music and the Peabody Conservatory, Baltimore. After returning to France she taught again at the Paris and American conservatories, becoming director of the latter—her special academic home—in 1949.

Miss Boulanger's pupils included the American and European composers Lennox Berkeley, Elliot Carter, Aaron Copland, David Diamond, Jean Francaix, Roy Harris, Darius Milhaud, Walter Piston, Roger Sessions, and Virgil Thomson. Her influence as a teacher was always personal rather than pedantic: she refused to write a textbook of theory. Her aim was to enlarge the student's aesthetic comprehensions while developing his individual gifts.

BOULDER, a city of Colorado, U.S., on Boulder creek, just east of the continental divide, 30 mi. N.W. of Denver, at an elevation of 5,354 ft.; the seat of Boulder county. (For comparative population figures *see* table in COLORADO: *Population.*) Protected by mountains from the winter winds, and cooled in summer by breezes from glaciers to the west, the average monthly mean temperature ranges from 32.5° F. (Jan.) to 73.6° F. (July); the sun shines almost every day.

The water supply comes from the Arapahoe glacier, which is owned by the city, thus making Boulder perhaps the only city in the nation with such a water supply. The Rocky Mountain National park of 410 sq.mi. is 40 mi. to the northwest and the Roosevelt National forest lies a few miles west. Boulder canyon and others in the vicinity have great scenic beauty, and the city owns 6,000 ac. of mountain park lands.

The first settlement there was made late in 1858, and placer gold was discovered nearby in 1859. The town was laid out in 1859; the first city charter was secured in 1871; and a city-manager form of government was adopted in 1917.

The city adjoins a rich agricultural area. Once supported by mines of coal, precious and rare metals, the city later attracted important industrial organizations. In addition to the large National Bureau of Standards plant (1954), space and research industries mushroomed in the area. For several years after 1900 most of the tungsten mined in the United States came from the Nederland region, 18 mi. W. of Boulder.

The University of Colorado, incorporated in 1861 and opened in 1877, is in Boulder, except for its medical school which is in Denver. The university buildings are constructed of native sandstone. The university has an annual enrollment of more than 15,000 students. (L. R. HA.)

BOULE, (PIERRE) MARCELLIN (1861–1942), French geologist, paleontologist and physical anthropologist, a specialist on fossil man, was born Jan. 1, 1861, at Montsalvy. Educated at Toulouse and Paris as a geologist, his interests broadened to include paleontology and, eventually, human paleontology. He became lecturer on geology at Paris and then assistant professor at Clermont-Ferrand. In 1892 he was appointed laboratory assistant at the French National Museum of Natural History, where he served as professor from 1902 to 1936. In that capacity he made extensive studies on human fossils from Europe, north Africa and Palestine, and he reconstructed the first complete Neanderthal skeleton (1908), from Chapelle-aux-Saints. His broad background enabled him to correlate geological and archaeological evidence in establishing a chronological sequence for remote eras.

He was president of the French Geological society; founder of the Institute of Human Paleontology and of the *Annales de Paléontologie;* and editor of *L'Anthropologie*. He received the Legion of Honour (commander) and many academic honours. He died July 4, 1942, at Montsalvy.

Boule's best-known work was *Les Hommes fossiles* (1921; 1952); his monograph, "L'Homme fossile de la Chapelle-aux-Saints," in *Annales de Paléontologie* (1911–13), remains a model of its kind. Among his many other works were *La plateau de Lanemezan* (1895); *Les volcans de la France centrale* (1900); and *Les Grottes de Grimaldi* (1906–19). (L. C. B.)

BOULE, in ancient Greece the council of a city or other body politic (as distinct from the general assembly, or ecclesia). Each Greek league or confederacy also had a council, sometimes called boule but more often called *synhedrion* (*see* ACHAEAN LEAGUE; BOEOTIA; GREECE: *History*). The name boule was more often used for the council of a democratic state, whereas gerousia was normally reserved to an aristocratic council, but there is no sharp distinction between the two terms. The councilors were respectively called *bouleutai* and *gerontes,* but other names were also used (*timouchoi* at Massalia, *probouloi* at Delphi, etc.). This article gives a general survey of the development of the institution of the boule; for further details on aristocratic councils *see* GEROUSIA.

Kings in archaic Greece, as elsewhere, were surrounded by a council of elders. A gerousia (according to one interpretation) is alluded to in Mycenaean documents. In Homer the elders, who ate on formal occasions with the king, also had judicial functions. It is not known how the kings chose their councilors. In Sparta, under the dual kingship, the 28 gerontes were elected by the people from among those over 60 years old; the Spartan gerontes led and controlled the deliberations of the assembly and had wide judicial powers, but the assembly was summoned by the kings or, later, by the ephors. In purely aristocratic states the council was supreme. At least in some cases it perpetuated itself by electing the magistrates of the city and co-opting former magistrates. According to one theory, the Areopagus (*q.v.*) in Athens before Solon (*q.v.*) worked on these principles. The individual councilors were appointed for life and were not accountable to the general assembly for their actions.

Transition to democracy was effected either by modifying the old councils or by replacing them with new ones or by opposing a new council to the old one. In Corinth (*q.v.*) after the fall of the tyrants at the end of the 6th century B.C. there seems to have been a council (perhaps yearly) of 80, of whom 8 functioned in turn as chairmen. In the 5th century Argos had an aristocratic council of 80 together with a more democratic council. In Athens in 594 B.C. Solon did not abolish the Areopagus, but (according to one view) transferred the elections to the assembly and created a new boule of 400 to guide the work of the assembly. The new boule was later (508 B.C.) connected by Cleisthenes (*q.v.*) with his new ten tribes and increased to 500 members. Coexistence of two councils was probably also to be found in Chios, at least from about 550 B.C., and Solon may have based his reform on Ionian models. A gerousia and a boule are found together in Hellenistic Cyrene and elsewhere.

The individual cities of the Boeotian league *c.* 395 B.C. had four councils; each of them took its turn in preparing the business to be put before the other three. One-fourth of the councilors acted as the real boule; the others had the function of a primary assembly. This type of organization must have inspired the Athenian project for the so-called "constitution of five thousand" in 411 (*see* THERAMENES). At Delphi, in the 4th century B.C., 30 yearly councilors were divided into two groups, each in charge for six months of the general conduct of affairs; another group of councilors (under the name of *prytaneis*) was in charge of finances throughout the year. There were also two secretaries, making a total of 40 members; councilors could be re-elected.

The Athenian boule, after the reforms of Cleisthenes, was elected by lot every year, except during the brief periods of oligarchic reaction in 411 and 404 B.C. Each tribe provided 50 councilors who were at least 30 years old; a certain number of councilors was allotted to each deme of the tribe in rough proportion to its size. The functions of the council were defined (and perhaps limited) by the oath for the members introduced in 501 B.C. A man chosen by lot was not obliged to serve. Since poorer citizens might be unwilling to serve, this explains why, especially in the 4th century B.C., men of property prevailed in the council, though property qualifications did not operate before 322 B.C. The councilors were paid (in the 4th century, 5 obols). They met (normally in the special building, *bouleuterion*) every day of the year except on feast or unpropitious days. The councilors belonging to each tribe functioned in turn as a general purposes committee for a tenth of the year; they summoned the others and prepared the agenda for the council. They were called *prytaneis* and were presided over by an *epistates*. One-third of the *prytaneis* sat in permanence in a building of their own, the tholos. The *epistates* would change every day, keep the seal of the state and the key to the treasury for the day; he was what might be called the one-day president of the Athenian republic. In the 5th century the *epistates* also presided over the assembly; in the 4th century the presidency of the assembly was left to a man chosen by lot from the councilors who were not *prytaneis*.

The most important task of the Athenian boule was to draft the deliberations for discussion and approval in the assembly. The draft (not necessarily a recommendation) was called *probouleuma*. The assembly could not discuss a topic unless the boule had passed a formal resolution. But any Athenian in the assembly could amend the *probouleuma* and make new proposals; he could also privately ask the boule to put an item on the agenda. There were moreover constitutional rules for the inclusion of certain routine items of business in the agenda for certain meetings of the ecclesia. The *probouleuma* regulated, but did not impede, the private initiative of any Athenian. The council was assisted by one and later by more than one secretary, provided by lot in turn from each tribe; after about 360 the secretary was no longer a member of the council. The boule could fine up to 500 drachmas or initiate a trial in the judicial courts. It controlled the farming of public revenues and it dealt with debtors to the state; it controlled the maintenance of the fleet and of the cavalry; judged the fitness of the magistrates-elect; it received foreign ambassadors and advised the strategoi in military matters. It could be given special powers by the assembly in an emergency. The boule, even after Ephialtes (*q.v.*), never totally replaced the Areopagus in political importance. The Areopagus recovered influence in Hellenistic and even more in Roman times when the Areopagus and the boule shared the government of the city, the boule being the minor partner. In the Hellenistic age property qualifications were intermittently required for the councilors, and their number was increased to 600 in 307 B.C., to 650 in 229, and again returned to 600 from 200 B.C. until the age of Hadrian, when the number of 500 was restored; later still the number went up to 750. The Athenian boule is still mentioned in sources of the 4th century A.D.

The Athenian system largely influenced the organization of the councils of other cities in the Hellenistic period but other types survived or were newly introduced. In Argos and Rhodes the council remained in office only six months and in Cyrene the members seem to have sat for two years, and the council to have been renewed by halves every year. Under the Roman emperors annual election gradually became purely formal and eventually disappeared. By the end of the 3rd century A.D. the councils were everywhere permanent bodies. Hereditary membership gradually replaced the recruitment of councilors by lot or election or selection by magistrates. The councils of the east became increasingly similar to the *curiae* of the western part of the empire (*see* CURIA).

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BOULEZ, PIERRE (1925–), French composer of serial music, and conductor. Born at Montbrison (Loire), on March 26, 1925, he studied with Olivier Messiaen at the Paris Conservatoire, and, from 1945 to 1946, with René Leibovitz. From 1948 he conducted an instrumental ensemble, Domaine Musicale, for Jean Louis Barrault's theatre, the Marigny; with the same ensemble, he also gave independent concerts, at which he introduced much contemporary music to the Paris public. By the 1960s Boulez had gained an international reputation, not only as a composer but also as a conductor of both the modern and classical repertory.

His works include: *Le Visage Nuptial* (1946–50), for two voices, women's chorus, and orchestra; *Sonatine* (1946), for flute and piano; *Le Marteau sans maître* (1951), for voice and six instruments; three sonatas for piano (1946, 1948, 1957); *Poésie pour pouvoir* (1958), for two orchestras, commissioned by the Donaueschingen Festival as a companion piece to K. Stockhausen's *Gruppen; Structures* (two books: I, 1952; II, 1961) for two pianos; *Figures, Doubles*, and *Prismes* (1964), for orchestra; *Eclat* (1965), for chamber orchestra (15 instruments); *Pli selon Pli* (1960), consisting of five works, *Don,* for large orchestra, three *Improvisations sur Mallarmé,* for voice and chamber ensemble, and *Tombeau,* for orchestra.

A dominant feature both of Boulez's music and of his conducting is his awareness of instrumental texture. This is apparent in the earliest of his compositions, which combine the influence of the 12-note composers with that of Messiaen and, through him, of certain oriental music. Boulez was also influenced by the work of the poets Mallarmé and René Char. In his *Sonatine*, the 12-note canons and imitations fly so fast that one is left merely with an impression of movement and texture. In *Structures*, book I, the actual series is simply taken from a work of Messiaen's; but Boulez elaborates it to a remarkable degree in strict permutations of pitch, duration, dynamics, and even attack (total serialization), and it is these densities and speed of movement that become the dominant feature, rather than the series itself. In *Le Marteau sans maître,* florid decorative textures flow into one another, voice and instruments rise and fall with the utmost apparent spontaneity; and these are punctuated by pairs of bongos, side drums, or gongs. In each movement of the work the instrumentation is varied, and a number of processes—hockets, imitations, etc.—are set in motion. Boulez's concern with the physical activity of singing or playing was taken, in *Pli selon Pli,* to the point where, at certain moments, there is no absolute pulse, and the performers must orient themselves by maintaining a constant awareness of the structure of the work.

See also MUSIC, 20TH-CENTURY.

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BOULLE (Boule; incorrectly Buhl), **ANDRÉ CHARLES** (1642–1732), French cabinetmaker, who gave his name to a fashion of inlaying, boulle or buhlwork, was born in Paris on Nov. 11, 1642. As a young man Boulle had studied drawing, painting and sculpture. He was employed for several years at Versailles, where he produced what was regarded as his most remarkable work: the flooring in "wood mosaic," the paneling and the marquetry in the private study (no longer existing) of the Grand Dauphin. Boulle received numerous commissions from the French royal family, princes, noblemen, and financiers in France and from foreign courts. He died in Paris on Feb. 29, 1732.

Boulle's style was continued successfully in France during the 18th century and also under Napoleon III. Such was its popularity that any piece with some copper inlay on a black or red ground came to be described as "buhl." (S. Gr.)

BOULLÉE, ÉTIENNE LOUIS (1728-1799), one of the great French architects of the Neoclassical period, was born in Paris on Feb. 12, 1728. His full importance for 20th-century architecture was widely rediscovered in the 1950s. He has been called both a megalomaniac and an autonomous architect but these statements fail to describe his personality and originality.

Boullée was fascinated by social problems, interested in town and regional planning, and more attracted to theoretical projects than to the construction of buildings. For these reasons his manuscripts and drawings, which he bequeathed to the nation and were left by his pupil Joseph Bénard to what is now the Bibliothèque Nationale, Paris, played an unusually large part in his work. His artistic achievements, transmitted by his numerous pupils, inspired the best in Napoleonic architecture. Among them A. T. Brongniart, J. F. Chalgrin, and J. N. L. Durand may be counted. Boullée never married, but seems not to have been lonely as he was constantly surrounded by friends and disciples.

An unambitious and conscientious man, he served the Academy of Architecture, of which he had been a member since 1762, until its dissolution. He retained his friends and influence, as shown by the fact that he was one of the judges of a sculpture competition in 1794 for a statue intended for the Pont-Neuf in Paris. He died in Paris on Feb. 6, 1799.

Boullée's executed buildings consisted mainly of a number of fashionable mansions, among them the Hôtel Brunoy, Paris, and the Calvary Chapel in the Church of St. Roch in Paris. His most important projects were of a grand and communal nature, such as a National Palace, a Communal Palace, and plans for rebuilding the Palace of Versailles, as well as the Bibliothèque Royale, the latter plan published in 1785. He also concentrated on designs for a cenotaph for Newton. The project of 1784, a sphere half-embedded in its base, best expresses Boullée's notion of austere and sublime form. His grandiose projects, however, were not necessarily utopian. Had the Revolutionary leaders been successful there is little doubt that they would have been willing and able to commission such monumental architecture. As Robespierre and others pointed out, the Revolution required large assembly halls as communal meeting places—the type of building that Boullée liked to design. Although opposed to Revolutionary terror, he nevertheless cherished ideals of reform and was a pioneer of functional architectural thought. (*See* Neoclassical Art and Architecture.)

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BOULOGNE (Boulogne-sur-Mer), in the *département* of Pas-de-Calais in northern France, is on the English channel at the mouth of the Liane, 125 km. (78 mi.) NNW of Amiens by road and 45 km. (28 mi.) SE of Folkestone by sea. Pop. (1962) 49,036. It stands upon hills skirting the east bank of the Liane, with the industrial quarter, Capécure, on the west bank. Haute Ville, the older part of the town, on the top of a hill, is a comparatively small oblong surrounded by 13th-century ramparts with boulevards outside. There are the law courts, château, and *hôtel de ville* (18th century), and a bell tower (13th and 17th centuries). At some distance to the northwest is the church of Notre-Dame (1827–66), a well-known place of pilgrimage, on an old site. The modern town—the much larger Basse Ville—stretches from the foot of the hill to the harbour. The public buildings include a museum of antiquities with a fine collection of Greek vases and Alaskan masks; galleries of painting and drawings; china and ceramics and natural history. The public library contains more than 120,000 volumes as well as valuable manuscripts, many richly illustrated. The Colonne de la Grande-Armée, begun in 1804 and completed under Louis-Philippe, commemorates Napoleon's projected invasion of England. The harbour is at the mouth of the Liane and is divided into two main parts, an outer, deep-water harbour and an inner port with docks for fishing, passenger and cargo boats, and wet and dry docks. Boulogne is the third French port for passenger traffic and the first for car ferry traffic to Folkestone and Dover. It is the chief fishing port of France, herring and mackerel being the most important catches. There are foundries, cement factories, ceramic works, fish curing and canning factories, shipbuilding and the manufacture of pens, pencils, ropes, fishing nets, canvas and shoes. Jute, manganese ore, coal, wine, fuels, timber, machinery, woven goods of silk and wool are imported, while ferromanganese, wines, brandy, woven goods, stone and cement are exported.

Boulogne is on the site of the Roman harbour of Gesoriacum, later called Bononia. It was destroyed by the Normans in 882, but rebuilt about 912. In the days of the Carolingian kings it was head of a countship, long in dispute between Flanders and Ponthieu. It belonged to the house of Ponthieu from 965 to 1234, and then to Brabant and Auvergne until seized by Philip the Good, duke of Burgundy, in 1419. In 1477 Louis XI of France reunited it to the crown. In 1544 Henry VIII of England took the town by siege but it was restored to France in 1550. From 1566 to the end of the 18th century it was the seat of a bishopric. During the Napoleonic Wars, from 1803 to 1805, Napoleon I assembled a large army there with the hope of invading England, but Nelson's navy bombarded the harbour and eventually Napoleon gave up the attempt at invasion. In World War I the first British forces landed there on Aug. 12, 1914, and the town and port were under British administration until 1918. In World War II Boulogne was occupied by German forces on May 25, 1940, and became a German submarine base. During the occupation it was made part of the German "Westwall." It was liberated by Canadian forces on Sept. 18, 1944. The war damage to the harbour was very severe but regular passenger cross-channel services were resumed in 1946. (He. H.; F. S.-Bo.)

BOULTER, HUGH (1672–1742), English archbishop of Armagh, the virtual ruler of Ireland at the height of the Protestant ascendancy, was born in London on Jan. 4, 1672. Educated at Christ Church, Oxford, he entered the church and rose rapidly under the patronage of the earl of Sunderland. In 1719 he was made chaplain to George I and then bishop of Bristol. In 1724 he reluctantly accepted his appointment as archbishop of Armagh and primate of all Ireland. He soon became the government's chief adviser in Ireland, and was 13 times a lord justice.

Boulter's policy in Ireland was based on the conviction that the English interest must be supreme. He used his control of patronage to secure the advancement of Englishmen to high ecclesiastical and political offices. He condemned policies which gave the discordant groups in Irish politics a common cause for opposition. Convinced of the danger of the enormous Roman Catholic majority, he made the penal laws more stringent (1728), prohibiting Catholics from voting and excluding them from the legal profession. He also promoted a scheme to found schools to bring up orphans and poor children as Protestants. Under his auspices the Incorporated society was founded in 1733 by royal charter, and chartered schools were built, but the militant Protestantism of the scheme doomed it to failure in Ireland.

Boulter's talents were above all administrative, and within the limitations of his English and Protestant outlook he ruled Ireland well. Aware of the disastrous economic situation he encouraged agricultural development, introducing a bill to prevent the wholesale conversion of arable land to pasture, and tried to reform the coinage, combating both English indifference and Irish opposition, led by Jonathan Swift. Despite his preoccupation with politics, he did much to reform the Irish (Anglican) Church, trying to prevent pluralism, dividing up unwieldy parishes, and encouraging the building of new churches. He augmented the benefices of the poorer clergy, and left the bulk of his estate to this cause. His generosity to the poor of Dublin earned him popularity, especially during the famine of 1739–40. Boulter remained primate until his death in Ireland on Sept. 27, 1742.

BOULTON, MATTHEW (1728–1809), English manufacturer, engineer and artist, an outstanding leader in industrial development who introduced James Watt's steam engine, was born on Sept. 3, 1728, at Birmingham. After managing his father's hardware business, in 1762 he built Soho manufactory, near Birmingham, and with John Fothergill produced gilt and silver buttons, buckles, Sheffield plate, etc. He founded the Birmingham assay office in 1773.

In 1768 Boulton made the acquaintance of James Watt. When John Roebuck, founder of Carron ironworks and owner of coal mines, became bankrupt, Boulton accepted Roebuck's share in Watt's first steam engine patent (1769) as repayment of a debt. In 1775 Boulton took Watt as partner in the steam engine business and obtained a 25-year extension of the patent. Assisted by William Murdock, they established the steam engine industry by initially erecting pumping engines on Cornish mines. Boulton foresaw great industrial demands for steam power and wrote, "People in London, Manchester and Birmingham are steam mill mad." He urged Watt to design the double-acting rotative engine, patented in 1782. The Watt engine (1788) for driving lapping machines at Boulton's factory is in the Science museum, London. In 1786 Boulton applied the steam engine to coining machinery and in 1790 he patented his coining press; he also supplied machinery to the royal mint. He became a fellow of the Royal society in 1785 and established a theatre in Birmingham in 1807.

By 1800, when Matthew Robinson Boulton and James Watt, Jr., took over their fathers' business, almost 500 steam engines had been installed in the British Isles and abroad. Boulton died on Aug. 17, 1809, at Birmingham.

See H. W. Dickinson, *Matthew Boulton* (1937). (Ar. S.)

BOUMÉDIENNE, HOUARI (real name Mohammed Boukharouba) (1925–), Algerian army officer, became president of the Algerian republic in July 1965 after his Revolutionary Council in the preceding month had seized power and imprisoned the former president, Ahmed ben Bella. He was born in 1925 at Guelma in the *département* of Bône (now Annaba). A student at universities in Tunis and Cairo (Al Azhar), where he specialized in Arabic studies, he became a schoolmaster in Egypt until 1955, when he joined the forces of the Algerian revolution. Under his adopted name Houari Boumedienne he fought in the western region and made rapid progress as a soldier, being appointed to the staff of the National Liberation Army and becoming its chief in March 1960. It was during this period, much of which was spent in Tunisia, that Colonel Boumédienne and his fellow officers studied the works and examples of Mao Tse-tung, Fidel Castro, and Ernesto Guevara. This political activity seems to have alarmed the Algerian provisional government, for in June 1962 an attempt was made to dismiss him. But his position in the army was assured and he lent his support to Ben Bella, leading his troops into Algiers on Sept. 9, 1962, and making it possible for Ben Bella to assume power in the weeks that followed. Boumédienne was made minister of defense and then became vice-premier in May 1963 and president in July 1965. His opposition to Ben Bella seemed to have been directed against his policies and his abuse of personal power. He pursued a policy of democratic centralism on coming to power, and in October 1966 he announced that 700 communes would elect councils of workers and militants. These elections were held on Feb. 5, 1967, when more than 70% of the population voted. A taciturn man, Boumédienne allowed some mystery about his ideology to remain. *See* also Algeria: *History*. (D. W. J. J.)

BOUNCING BET, the common soapwort (*Saponaria officinalis*), which has become very widely naturalized in waste grounds and along roadsides in the eastern United States.

BOUNDARIES, the indicated limits of an area. In ancient Greece and Rome and during the middle ages there were no fixed boundary lines between political communities. The limits of a state's jurisdiction were vague; there were border zones or marches but no fixed lines. A frontier was merely a place where a state had put a halt to its authority; it had no recognition in public international law. The need for fixed boundaries arose as the modern states of western Europe developed to take the place of the Holy Roman empire. Exact boundaries were not possible, however, until the sciences of geography and cartography could furnish data needed for delimitation and demarcation.

Delimitation.—Delimitation is normally a diplomatic procedure, except that where a boundary dispute has been submitted to an international court, it is done by arbitral or judicial bodies. Even when this is true, the authority of the tribunal may be traced back to a diplomatic agreement in the form of a treaty or a *compromis*, an agreement to abide by a decision.

Diplomatic delimitation of a boundary may be on a bilateral or multilateral basis. An illustration of bilateral delimitation is provided by the negotiations between Mexico and the United States in 1848, resulting in a definition in the treaty of Guadalupe Hidalgo of the mutual boundary between them. Increasingly, however, negotiations for the delimitation of boundaries have been on a multilateral basis because of the more general recognition that matters of this nature affect the relative power positions of many nations. After the Second Balkan War the boundaries of the Balkan states were defined in a conference held at London in which the large powers took part. In 1919 the Paris peace conference fixed the boundary lines of European states for the post-World War I period. Following World War II negotiations were on a multilateral basis, with the large powers dominating even more openly than in 1919; the Council of Foreign Ministers, designated to write preliminary drafts of the peace treaties, was unable to agree on some boundaries.

There are five main considerations taken into account in the process of delimitation—strategic, ethnic, economic, geographic and historic. The strategic conception is that a line shall be drawn in such a way that the security of some one or more nations will be strengthened. Ethnic considerations played an important part in the delimitation of boundaries after World War I. An effort was made to find lines that would separate national groups as effectively as possible. To do this, population statistics were consulted or plebiscites were prescribed. Following World War II less stress was given to ethnic facts and more to strategic.

In addition to strategic and ethnic considerations, negotiators take into account economic, geographic and historic facts, so that a line will be as sound as possible from these points of view. After 1919, however, these factors were given somewhat less weight than strategic and ethnic considerations.

Demarcation.—After the delimitation of a boundary has been completed, demarcation should follow. This is the process of applying the documentary definition of the boundary to the earth's surface, and setting up monuments and buoys at selected points along the line. As a rule this work is done by a commission especially selected for the purpose. The boundary between the United States and Canada is unusually well marked. Many boundaries, however, have not been marked at all.

When a boundary is located in a river, it is understood to be at the *thalweg*, the middle of the navigable channel, rather than at the middle of the river. At times this doctrine of the *thalweg* is applied to other water boundaries, such as lakes and straits. When the boundary is a mountain range, it is common to take the water divide as the line. *See* also Waters, Territorial; High Seas; Mare Clausum and Mare Liberum.

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BOUND BROOK, a borough of Somerset county, N.J., U.S., on the Raritan river, 34 mi. S.W. of New York city. With South Bound Brook and Middlesex it comprises an urban area. (For comparative population figures *see* table in New Jersey: *Population.*) The town is primarily residential with quiet tree-shaded streets and parks. Many residents commute to work in industrial enterprises located nearby.

In 1681 all the land now occupied by Bound Brook was transferred by deed from two Indian chiefs to Philip Carteret and six other men. Settlement soon followed, but the borough was not incorporated until 1891.

The area is rich in American Revolutionary history and several interesting colonial houses survive. The Staats homestead in South Bound Brook was the headquarters of Baron von Steuben during the Revolutionary War. Col. Philip Van Horne's house, known as Convivial hall because of the famed hospitality of the colonel and his five daughters, was occupied for a time by Lord Stirling and later by "Light-Horse Harry" Lee. George Washington's army twice camped on the hills behind the village, known as the heights of Middlebrook, and the site is kept as a historical monument. It is said that there Washington first (1777) unfurled the Stars and Stripes as the national flag. (W. L. Ca.)

BOUNDS, BEATING THE, an ancient custom, dating at least from Anglo-Saxon times, formerly observed in many English parishes and intended, at a time when maps were rare, to familiarize the members of a parish with the position of its boundaries. A procession of the parish priest, the churchwardens and the parochial officials headed a crowd of boys who, armed with sticks, beat the parish borderstones. Originally the boys themselves were often beaten, or bumped on the boundary stones to help them to remember. The object of taking boys was to ensure that witnesses to the boundaries should survive as long as possible. The procession took place on Ascension day or during the preceding Rogation (*q.v.*) days (sometimes called "ganging days" or "gang week" in the north of England from the "gang" or procession) and was always marked, in England, by a parish-ale or feast, which assured its popularity. Beating the bounds had a religious side in the practice which originated the term "rogation," as the accompanying clergy used to beseech (Lat., *rogare*) God's blessing on the parish lands for the ensuing harvest. Much of the religious ceremonial was prohibited in the course of the Reformation, but the injunctions of Elizabeth I provided that "at the time accustomed the curate and substantial men of the parish walk about their parishes as they were accustomed, and at their return to church make common prayer." The ceremony became increasingly secular, but was fairly widely observed until the end of the 19th century. It is not altogether extinct, being continued, for example, in the city of London at the Tower, and in the parish of St. Dunstan-in-the-East.

"BOUNTY," MUTINY OF THE (1789): *see* Bligh, William.

BOURASSA, HENRI (1868–1952), pioneer Canadian nationalist politician and journalist, was born at Montreal, Sept. 1, 1868. A grandson of Louis Joseph Papineau, leader of the democratic movement in Lower Canada from 1810 to 1837, he became mayor of Montebello (Labelle district) at the age of 22. He represented Labelle in the federal house of commons from 1896 to 1907 as a Liberal, but he gradually became an independent nationalist. He resigned in protest against Canadian support of the imperialist cause in the South African War, but was immediately re-elected. He was the first prominent politician to advocate that Canada should become a completely separate nation under the crown—an idea which became a reality before his death. Bourassa's opposition to the exploitation of Quebec, or of Canada, by U.S. business firms drew him into co-operation with the Conservatives in both provincial and federal politics. He opposed the Liberal government in Quebec as a member of the legislative assembly from 1908 to 1912.

One of Bourassa's most enduring accomplishments was the establishment in 1910 of a daily French language newspaper in Montreal, *Le Devoir.* In 1911 he campaigned vigorously against the naval policy of the Liberals, and in 1917 against military conscription, introduced by the Conservatives. In 1925, as an Independent, he was again elected to parliament for Labelle, which he represented until his indifference to local political patronage led to his defeat in 1935 by a Liberal party member.

Disillusioned with both major parties, Bourassa in 1944 advocated support for either the Bloc Populaire Canadien or the Co-operative Commonwealth Federation. His career was a combination of religious conservatism and social radicalism. He died Aug. 31, 1952, at Outremont, on the island of Montreal. (G. O. R.)

BOURBAKI, CHARLES DENIS SAUTER (1816–1897), French general who served with distinction in Algeria, the Crimea and Italy but was unsuccessful as a commander in chief during the Franco-German War. He was born at Pau on April 22, 1816, the son of a colonel who lost his life in the War of Greek Independence. After studying at the military school at La Flèche and at Saint Cyr (1834–36), Bourbaki joined the Zouaves in Algeria. He showed considerable valour in battle, notably at Sétif (1840), and in 1842 was promoted captain. After a brief period in 1845 as aide-de-camp to King Louis Philippe, he went back to Algeria to take charge of the *bureau arabe* at Blidah. In 1851 he was colonel of the zouaves. During the Crimean War he fought with great bravery in the battle of the Alma and was promoted brigadier-general. Wounded during the capturing of Sevastopol, he returned once more to Algeria, becoming a general of division in 1857.

Bourbaki took part in the campaign in Italy in 1859 and assumed command of the 2nd division at Grenoble in 1860. Appointed aide-de-camp to Napoleon III in 1869, he commanded the imperial guard in 1870 and was engaged in the fighting around Metz after the outbreak of the Franco-German War. Sent by Marshal A. F. Bazaine to England to negotiate with the empress Eugénie, he was afterward unable to return to Metz and offered his services to the provisional government at Tours. In Oct. 1870 he was put in command of the army of the north but was subsequently transferred to the army of the east. Having won a victory over the Germans at Villersexel (Jan. 9, 1871) he tried to break through the German lines and to raise the siege of Belfort, but after three days' fighting suffered a severe repulse before Héricourt. Without munitions, lacking sufficient food supplies and leading an exhausted army, Bourbaki was incapable of action. On Jan. 26 he attempted to commit suicide and was replaced by Gen. C. Clinchant.

After the war he commanded the XIV corps and was governor of Lyons. Placed on the reserve in 1881, he twice tried unsuccessfully to enter parliament. He died at Bayonne on Sept. 23, 1897.

See G. Felix, *Le Général Bourbaki* (1898). (L. G.)

"BOURBAKI, NICOLAS," the collective pseudonym of a group of French mathematicians who began in the late 1930s to write a treatise on mathematics as a whole. About 24 volumes had appeared by 1960. Bourbaki's work is characterized by rigid adherence to the axiomatic method, strictly logical arrangement, insistence on the utmost generality, and carefully chosen terminology which has often been at variance with prevailing usage. Much of Bourbaki's terminology has, however, been generally adopted, his point of view has been widely accepted, and his work has determined the direction of much mathematical research.

An example of the axiomatic method is furnished by the theory of groups (*q.v.*). The theorems of abstract group theory can be interpreted at will as theorems about groups of rotations, groups of numbers, groups of permutations of the roots of equations, etc. The development of a branch of mathematics from axioms is at least as old as Euclid, although the idea of detaching the axioms completely from any interpretation came much later. It had often been applied before Bourbaki, although never on so grand a scale.

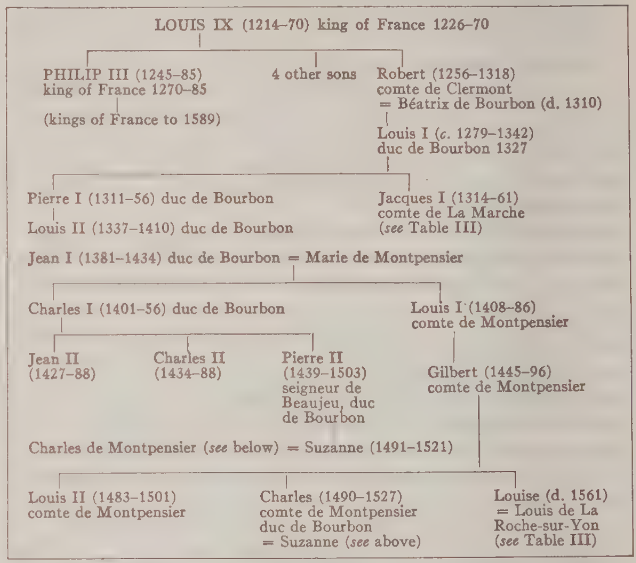
Another feature of Bourbaki's approach is his classification of mathematics. Instead of dividing mathematics into the traditional fields, Bourbaki divides it into parts characterized by their types of structure: for example, algebraic structure, such as the structure imposed on the real numbers by the operations of addition and multiplication; order, such as the structure imposed on the real numbers by the relation of inequality; and topology, such as the structure imposed on the real numbers by the concept of limit; *e.g.,* N. Bourbaki, *General Topology* (1966–67).

The parts of Bourbaki's treatise that had appeared by 1960 were supposed to constitute a portion of the first part of the whole, namely "the fundamental structures of analysis." They dealt with the theory of sets, algebra, general topology, functions of a real variable, linear topological spaces and integration.

The Bourbaki group has kept its exact membership secret. However, it is generally believed that among its original leaders were such well-known mathematicians as H. Cartan, C. Chevalley, J. Dieudonné and A. Weil; younger mathematicians such as J. Dixmier, R. Godement, J. L. Koszul, P. Samuel and J. P. Serre joined the group from time to time, while older members became inactive. The constant changes in membership have tended to preserve the youthful spirit that characterized the enterprise from its inception. (R. P. Bo.)

BOURBON, the name of one of the greatest formerly sovereign houses of Europe (Spanish BORBÓN; Italian BORBONE). To cite only their sovereign titles, Bourbon princes, in the period 1572–1931, were kings of Navarre, of France, of Spain, of Naples and Sicily (or of the Two Sicilies), of Etruria and of the French; and dukes of Parma and of Lucca. A branch of the house also inherited the pretension to the imperial throne of Brazil.

TABLE I.—*The Bourbon Descent from Louis IX: Ducs de Bourbon and Comtes de Montpensier*


LOUIS IX (1214–70) king of France 1226–70
PHILIP III (1245–85) king of France 1270–85
(kings of France to 1589)
4 other sons
Robert (1256–1318) comte de Clermont = Béatrix de Bourbon (d. 1310)
Louis I (c. 1279–1342) duc de Bourbon 1327
Pierre I (1311–56) duc de Bourbon
Louis II (1337–1410) duc de Bourbon
Jacques I (1314–61) comte de La Marche (see Table III)
Jean I (1381–1434) duc de Bourbon = Marie de Montpensier
Charles I (1401–56) duc de Bourbon
Louis I (1408–86) comte de Montpensier
Jean II (1427–88)
Charles II (1434–88)
Pierre II (1439–1503) seigneur de Beaujeu, duc de Bourbon
Gilbert (1445–96) comte de Montpensier
Charles de Montpensier (see below) = Suzanne (1491–1521)
Louis II (1483–1501) comte de Montpensier
Charles (1490–1527) comte de Montpensier duc de Bourbon = Suzanne (see above)
Louise (d. 1561) = Louis de La Roche-sur-Yon (see Table III)

The house of Bourbon, with its many branches, is itself a branch

TABLE II.—*The Bourbon Kings of France, with the House of Orléans to 1830*

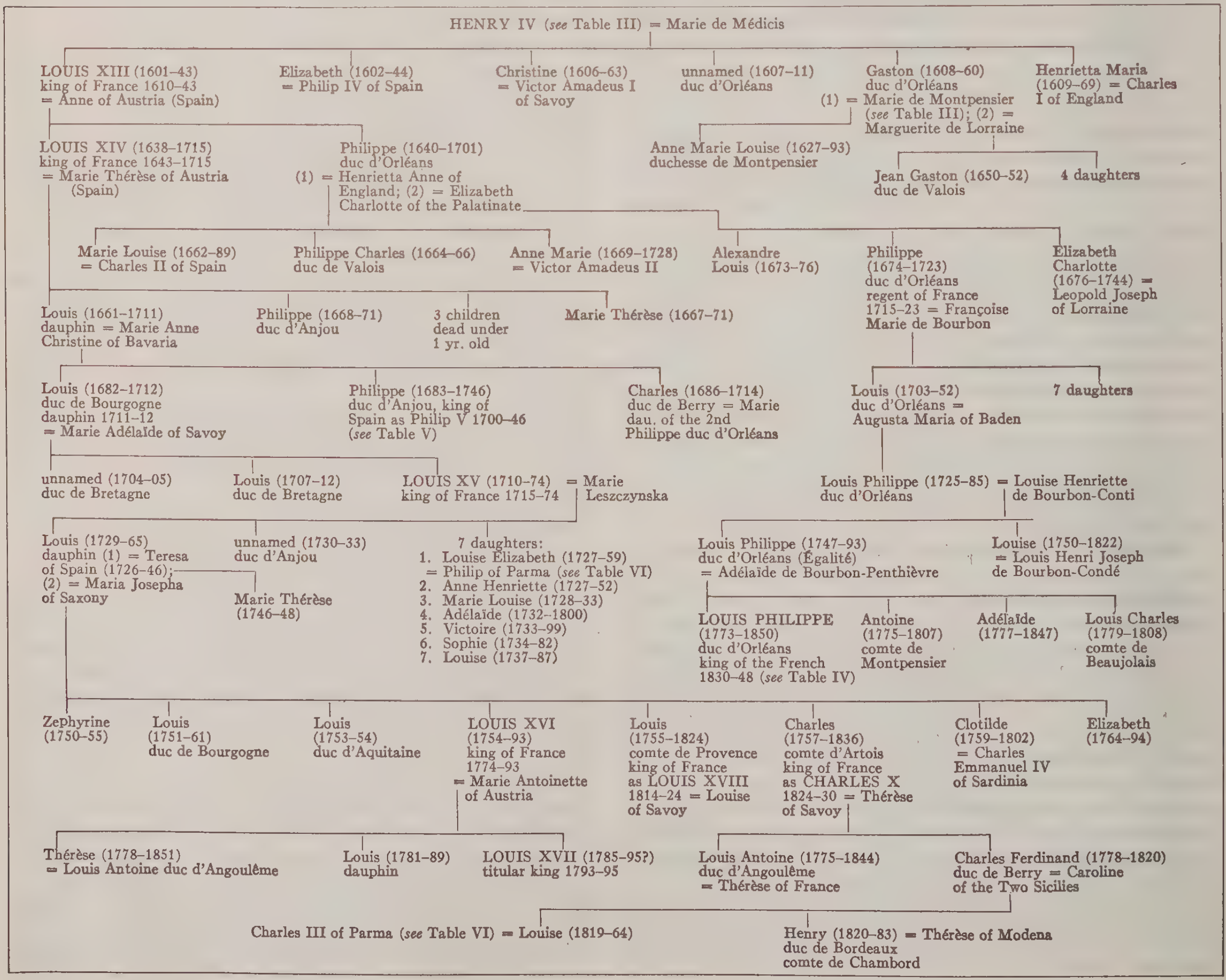
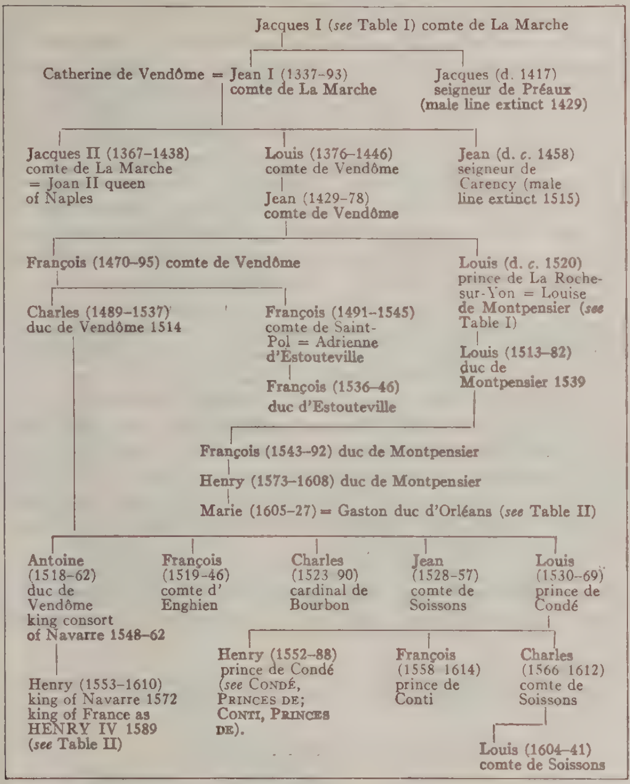

HENRY IV (see Table III) = Marie de Médicis
LOUIS XIII (1601–43) king of France 1610–43 = Anne of Austria (Spain)
Elizabeth (1602–44) = Philip IV of Spain
Christine (1606–63) = Victor Amadeus I of Savoy
unnamed (1607–11) duc d'Orléans
Gaston (1608–60) duc d'Orléans (1) = Marie de Montpensier (see Table III); (2) = Marguerite de Lorraine
Henrietta Maria (1609–69) = Charles I of England
LOUIS XIV (1638–1715) king of France 1643–1715 = Marie Thérèse of Austria (Spain)
Philippe (1640–1701) duc d'Orléans (1) = Henrietta Anne of England; (2) = Elizabeth Charlotte of the Palatinate
Anne Marie Louise (1627–93) duchesse de Montpensier
Jean Gaston (1650–52) duc de Valois
4 daughters
Marie Louise (1662–89) = Charles II of Spain
Philippe Charles (1664–66) duc de Valois
Anne Marie (1669–1728) = Victor Amadeus II
Alexandre Louis (1673–76)
Philippe (1674–1723) duc d'Orléans regent of France 1715–23 = Françoise Marie de Bourbon
Elizabeth Charlotte (1676–1744) = Leopold Joseph of Lorraine
Louis (1661–1711) dauphin = Marie Anne Christine of Bavaria
Philippe (1668–71) duc d'Anjou
3 children dead under 1 yr. old
Marie Thérèse (1667–71)
Louis (1682–1712) duc de Bourgogne dauphin 1711–12 = Marie Adélaïde of Savoy
Philippe (1683–1746) duc d'Anjou, king of Spain as Philip V 1700–46 (see Table V)
Charles (1686–1714) duc de Berry = Marie dau. of the 2nd Philippe duc d'Orléans
Louis (1703–52) duc d'Orléans = Augusta Maria of Baden
7 daughters
unnamed (1704–05) duc de Bretagne
Louis (1707–12) duc de Bretagne
LOUIS XV (1710–74) king of France 1715–74 = Marie Leszczynska
Louis Philippe (1725–85) duc d'Orléans = Louise Henriette de Bourbon-Conti
Louis (1729–65) dauphin (1) = Teresa of Spain (1726–46); (2) = Maria Josepha of Saxony
unnamed (1730–33) duc d'Anjou
Marie Thérèse (1746–48)
7 daughters:
1. Louise Élizabeth (1727–59) = Philip of Parma (see Table VI)
2. Anne Henriette (1727–52)
3. Marie Louise (1728–33)
4. Adélaïde (1732–1800)
5. Victoire (1733–99)
6. Sophie (1734–82)
7. Louise (1737–87)
Louis Philippe (1747–93) duc d'Orléans (Égalité) = Adélaïde de Bourbon-Penthièvre
Louise (1750–1822) = Louis Henri Joseph de Bourbon-Condé
LOUIS PHILIPPE (1773–1850) duc d'Orléans king of the French 1830–48 (see Table IV)
Antoine (1775–1807) comte de Montpensier
Adélaïde (1777–1847)
Louis Charles (1779–1808) comte de Beaujolais
Zephyrine (1750–55)
Louis (1751–61) duc de Bourgogne
Louis (1753–54) duc d'Aquitaine
LOUIS XVI (1754–93) king of France 1774–93 = Marie Antoinette of Austria
Louis (1755–1824) comte de Provence king of France as LOUIS XVIII 1814–24 = Louise of Savoy
Charles (1757–1836) comte d'Artois king of France as CHARLES X 1824–30 = Thérèse of Savoy
Clotilde (1759–1802) = Charles Emmanuel IV of Sardinia
Elizabeth (1764–94)
Thérèse (1778–1851) = Louis Antoine duc d'Angoulême
Louis (1781–89) dauphin
LOUIS XVII (1785–95?) titular king 1793–95
Louis Antoine (1775–1844) duc d'Angoulême = Thérèse of France
Charles Ferdinand (1778–1820) duc de Berry = Caroline of the Two Sicilies
Charles III of Parma (see Table VI) = Louise (1819–64)
Henry (1820–83) = Thérèse of Modena duc de Bordeaux comte de Chambord

Table III.—*The Branch of La Marche-Vendôme, to Henry IV, with the Second Line of Montpensier*


Jacques I (see Table I) comte de La Marche
Catherine de Vendôme = Jean I (1337–93) comte de La Marche
Jacques (d. 1417) seigneur de Préaux (male line extinct 1429)
Jacques II (1367–1438) comte de La Marche = Joan II queen of Naples
Louis (1376–1446) comte de Vendôme
Jean (1429–78) comte de Vendôme
Jean (d. c. 1458) seigneur de Carency (male line extinct 1515)
François (1470–95) comte de Vendôme
Louis (d. c. 1520) prince de La Roche-sur-Yon = Louise de Montpensier (see Table I)
Charles (1489–1537) duc de Vendôme 1514
François (1491–1545) comte de Saint-Pol = Adrienne d'Estouteville
François (1536–46) duc d'Estouteville
Louis (1513–82) duc de Montpensier 1539
François (1543–92) duc de Montpensier
Henry (1573–1608) duc de Montpensier
Marie (1605–27) = Gaston duc d'Orléans (see Table II)
Antoine (1518–62) duc de Vendôme king consort of Navarre 1548–62
François (1519–46) comte d' Enghien
Charles (1523 90) cardinal de Bourbon
Jean (1528–57) comte de Soissons
Louis (1530–69) prince de Condé
Henry (1553–1610) king of Navarre 1572 king of France as HENRY IV 1589 (see Table II)
Henry (1552–88) prince de Condé (see CONDÉ, PRINCES DE; CONTI, PRINCES DE).
François (1558 1614) prince de Conti
Charles (1566 1612) comte de Soissons
Louis (1604–41) comte de Soissons

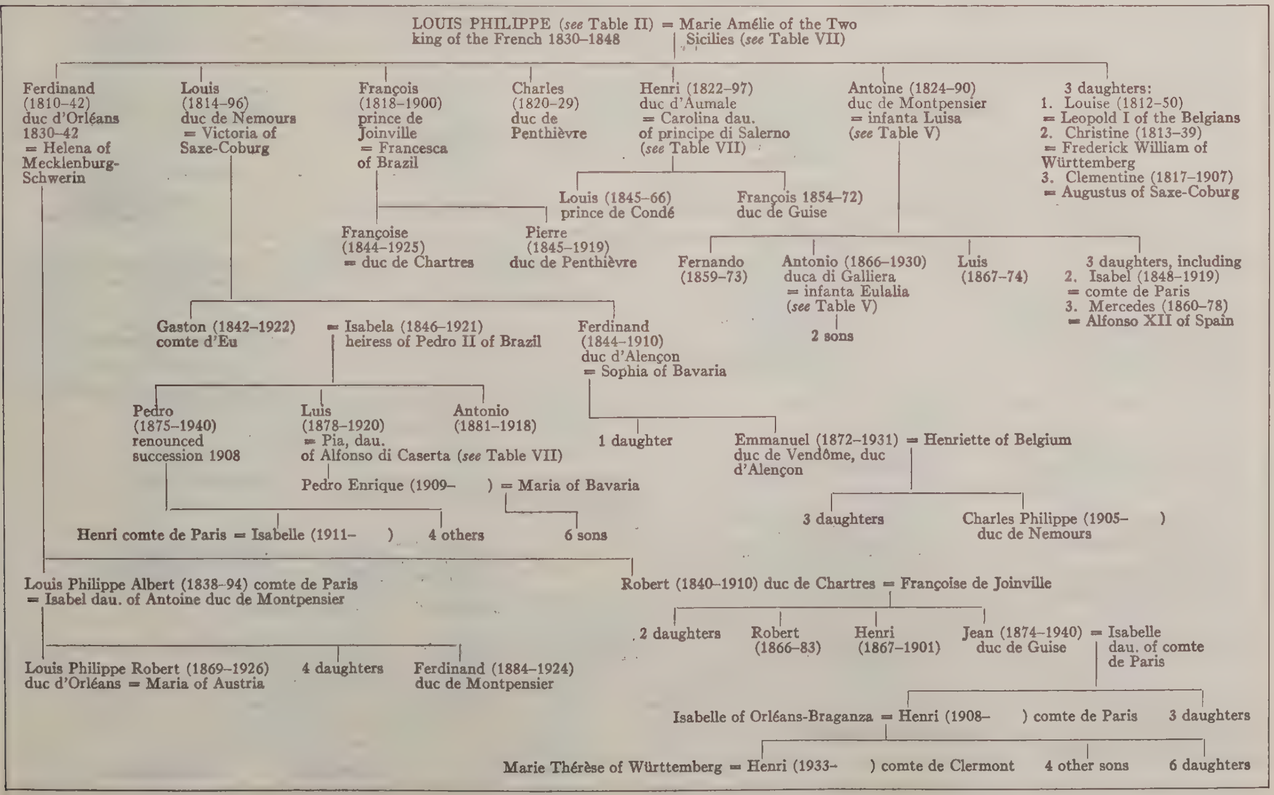
of the house of Capet (*q.v.*), since Louis IX of France, a Capetian of the direct line, is the ancestor of all the Bourbon princes through his son Robert, comte de Clermont, who married the heiress of the ancient lords of Bourbon (*see* Bourbonnais) and whose son Louis, likewise the ancestor of the whole house, was created duc de Bourbon in 1327 (*see* Table I). The senior male lines of the first duke's descendants, who had moreover acquired by marriage the countship of Montpensier, became extinct in 1527, so that the succession is through a junior line, that of La Marche-Vendôme (*see* Table III), from which all the sovereign branches of the house, as well as the princes de Condé and the princes de Conti (*qq.v.*) descend. After two Bourbons of this line had been kings consort (Jacques II, comte de La Marche, in Naples—a title not uncontested—and Antoine, duc de Vendôme, in Navarre), Henry de Bourbon, the head of the house, became not only king of Navarre (*see* Navarre, Kingdom of) in 1572 in succession to his mother but also king of France as Henry IV in 1589 as head of the whole house of Capet on the extinction of the male line of the Valois dynasty (*see* France: *History*). From Henry descend not only the two French branches but also the Spanish, Parmesan, Neapolitan-Sicilian and Brazilian.

The senior line of France runs in direct succession from Henry IV to Louis XVII and is then resumed in Louis XVIII, Charles X and the latter's grandson the comte de Chambord, who was pretender as "Henry V" (*see* Table II).

On the extinction of the senior male line of France in 1883, the headship of the house of Bourbon—and of that of Capet—passed to the Spanish line. The Bourbon Philip V's accession to the Spanish crowns in 1700 was based on his descent from two Habsburg infantas—daughters of Philip III and of Philip IV of Spain and wives respectively of Louis XIII and Louis XIV of France (*see* Table II)—and was sanctioned by the testament of the last Habsburg king of Spain, Charles II (*see* Spain: *History*; Spanish Succession, War of the).

Philip V, as a Capetian, introduced the Salic law of succession to the Spanish monarchy in 1713, but his great-grandson Ferdinand VII, who had no sons, revoked this in 1830 in favour of his elder daughter Isabella. His brother Don Carlos, who would have been his heir by Salic law, protested against this revocation,

Table IV.—*The House of Orléans from 1830*


LOUIS PHILIPPE (see Table II) = Marie Amélie of the Two Sicilies (see Table VII)
king of the French 1830–1848
Ferdinand (1810–42) duc d'Orléans 1830–42 = Helena of Mecklenburg-Schwerin
Louis (1814–96) duc de Nemours = Victoria of Saxe-Coburg
François (1818–1900) prince de Joinville = Francesca of Brazil
Charles (1820–29) duc de Penthièvre
Henri (1822–97) duc d'Aumale = Carolina dau. of principe di Salerno (see Table VII)
Antoine (1824–90) duc de Montpensier = infanta Luisa (see Table V)
3 daughters:
1. Louise (1812–50) = Leopold I of the Belgians
2. Christine (1813–39) = Frederick William of Württemberg
3. Clementine (1817–1907) = Augustus of Saxe-Coburg
Louis (1845–66) prince de Condé
François 1854–72) duc de Guise
Françoise (1844–1925) = duc de Chartres
Pierre (1845–1919) duc de Penthièvre
Fernando (1859–73)
Antonio (1866–1930) duca di Galliera = infanta Eulalia (see Table V)
2 sons
Luis (1867–74)
3 daughters, including
2. Isabel (1848–1919) = comte de Paris
3. Mercedes (1860–78) = Alfonso XII of Spain
Gaston (1842–1922) comte d'Eu = Isabela (1846–1921) heiress of Pedro II of Brazil
Ferdinand (1844–1910) duc d'Alençon = Sophia of Bavaria
Pedro (1875–1940) renounced succession 1908
Luis (1878–1920) = Pia, dau. of Alfonso di Caserta (see Table VII)
Antonio (1881–1918)
Pedro Enrique (1909–) = Maria of Bavaria
6 sons
1 daughter
Emmanuel (1872–1931) = Henriette of Belgium
duc de Vendôme, duc d'Alençon
3 daughters
Charles Philippe (1905–) duc de Nemours
Henri comte de Paris = Isabelle (1911–)
4 others
Louis Philippe Albert (1838–94) comte de Paris = Isabel dau. of Antoine duc de Montpensier
Robert (1840–1910) duc de Chartres = Françoise de Joinville
2 daughters
Robert (1866–83)
Henri (1867–1901)
Jean (1874–1940) duc de Guise = Isabelle dau. of comte de Paris
Louis Philippe Robert (1869–1926) duc d'Orléans = Maria of Austria
4 daughters
Ferdinand (1884–1924) duc de Montpensier
Isabelle of Orléans-Braganza = Henri (1908–) comte de Paris
3 daughters
Marie Thérèse of Württemberg = Henri (1933–) comte de Clermont
4 other sons
6 daughters

and on Ferdinand's death the first of the Carlist wars broke out (*see* CARLISM).

The extinction of the Carlist male line in 1936, however, combined with the fact that Isabella had in 1846 married the eldest son of the next brother of Ferdinand VII and of Don Carlos, made Isabella's descendant, the conde de Barcelona, both the head of the house of Bourbon and the rightful pretender to Spain according to Salic law. (*See* Table V.)

If all male descendants of Charles IV of Spain (other than those whose families have renounced their rights) became extinct, the headship of the house of Bourbon would pass to the Neapolitan-Sicilian branch, as descended from Charles III of Spain, who had conquered Naples and Sicily in 1734–35 and transferred them to his son Ferdinand on succeeding to Spain in 1759 (*see* Table V; Table VII; NAPLES, KINGDOM OF). If likewise the Neapolitan-Sicilian branch died out, the next heads of the house would be the pretenders to the duchy of Parma, descended from Charles III of Spain's brother Philip (*see* Table V; Table VI). Both Charles and Philip were entitled to Parma through their mother Isabella Farnese, heiress of the original dukes of Parma (*see* FARNESE). Charles in fact had been duke of Parma from 1731 to 1735 but had to renounce the duchy to secure general recognition as king of Naples and Sicily. Philip did not secure recognition as duke till 1748.

The junior branch of the house of Bourbon is that of Orléans, descended from Philippe, brother of Louis XIV of France (*see* Table II). Louis Philippe, duc d'Orléans, became *de facto* king of the French in 1830, as a result of the July revolution. If his descendants are now recognized as *de jure* pretenders to the crown of France, with priority over the claims of the Spanish, Neapolitan-Sicilian and Parmesan branches to it, this is because the non-Bourbon European powers, before consenting to recognize the Bourbon accession to Spain, had required that Philip V should renounce for himself and his descendants all rights to the French crown. Thus, with the Spanish branch and its Neapolitan-Sicilian and Parmesan subdivisions excluded, the house of Orléans could claim the French succession as by right after the death of the comte de Chambord in 1883. The claim of a junior branch of the line of Orléans to Brazil came about through the marriage of the comte d'Eu to Isabela, heiress of the last Brazilian emperor. The descendants of this marriage form the house of Orléans-Braganza or Bourbon-Brazil. (*See* Table IV.)

The political history of the house of Bourbon is part of the history of Europe and of the several states over which Bourbons reigned and need not be discussed here (*see* also biographical articles on members of the family). The dates on which the various sovereign branches were deposed, restored and deposed again can be seen in the tables. Dynastic co-operation was most effective in the 18th century, when the Bourbons of France and Spain allied themselves in the "Family compacts" (1733, 1743, 1761), least effective during the French Revolutionary and Napoleonic Wars and in the 19th century, despite the regularity of intermarriage of Bourbon with Bourbon.

In the accompanying tables (1) the names of sovereigns are mostly anglicized (*e.g.*, Philip instead of Felipe), but those of other persons are generally given in the original form, except

TABLE V.—*The Spanish Bourbons*

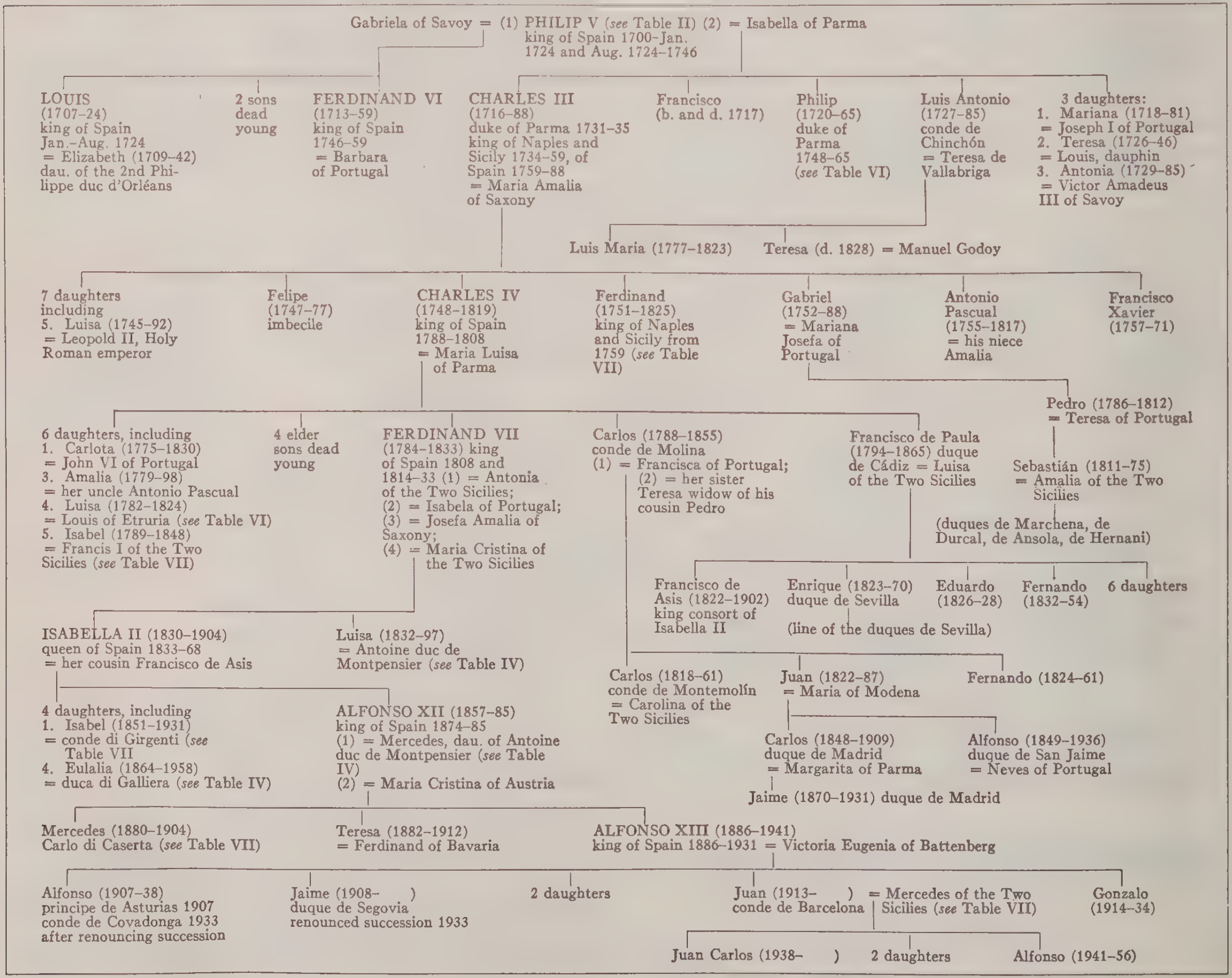

Gabriela of Savoy = (1) PHILIP V (*see* Table II) (2) = Isabella of Parma
king of Spain 1700–Jan. 1724 and Aug. 1724–1746
LOUIS (1707–24) king of Spain Jan.–Aug. 1724 = Elizabeth (1709–42) dau. of the 2nd Philippe duc d'Orléans
2 sons dead young
FERDINAND VI (1713–59) king of Spain 1746–59 = Barbara of Portugal
CHARLES III (1716–88) duke of Parma 1731–35 king of Naples and Sicily 1734–59, of Spain 1759–88 = Maria Amalia of Saxony
Francisco (b. and d. 1717)
Philip (1720–65) duke of Parma 1748–65 (*see* Table VI)
Luis Antonio (1727–85) conde de Chinchón = Teresa de Vallabriga
3 daughters:
1. Mariana (1718–81) = Joseph I of Portugal
2. Teresa (1726–46) = Louis, dauphin
3. Antonia (1729–85) = Victor Amadeus III of Savoy
Luis Maria (1777–1823)
Teresa (d. 1828) = Manuel Godoy
7 daughters including 5. Luisa (1745–92) = Leopold II, Holy Roman emperor
Felipe (1747–77) imbecile
CHARLES IV (1748–1819) king of Spain 1788–1808 = Maria Luisa of Parma
Ferdinand (1751–1825) king of Naples and Sicily from 1759 (*see* Table VII)
Gabriel (1752–88) = Mariana Josefa of Portugal
Antonio Pascual (1755–1817) = his niece Amalia
Francisco Xavier (1757–71)
Pedro (1786–1812) = Teresa of Portugal
6 daughters, including
1. Carlota (1775–1830) = John VI of Portugal
3. Amalia (1779–98) = her uncle Antonio Pascual
4. Luisa (1782–1824) = Louis of Etruria (*see* Table VI)
5. Isabel (1789–1848) = Francis I of the Two Sicilies (*see* Table VII)
4 elder sons dead young
FERDINAND VII (1784–1833) king of Spain 1808 and 1814–33 (1) = Antonia of the Two Sicilies; (2) = Isabela of Portugal; (3) = Josefa Amalia of Saxony; (4) = Maria Cristina of the Two Sicilies
Carlos (1788–1855) conde de Molina (1) = Francisca of Portugal; (2) = her sister Teresa widow of his cousin Pedro
Francisco de Paula (1794–1865) duque de Cádiz = Luisa of the Two Sicilies
Sebastián (1811–75) = Amalia of the Two Sicilies
(duques de Marchena, de Durcal, de Ansola, de Hernani)
Francisco de Asis (1822–1902) king consort of Isabella II
Enrique (1823–70) duque de Sevilla
(line of the duques de Sevilla)
Eduardo (1826–28)
Fernando (1832–54)
6 daughters
ISABELLA II (1830–1904) queen of Spain 1833–68 = her cousin Francisco de Asis
Luisa (1832–97) = Antoine duc de Montpensier (*see* Table IV)
Carlos (1818–61) conde de Montemolín = Carolina of the Two Sicilies
Juan (1822–87) = Maria of Modena
Fernando (1824–61)
4 daughters, including
1. Isabel (1851–1931) = conde di Girgenti (*see* Table VII
4. Eulalia (1864–1958) = duca di Galliera (*see* Table IV)
ALFONSO XII (1857–85) king of Spain 1874–85 (1) = Mercedes, dau. of Antoine duc de Montpensier (*see* Table IV) (2) = Maria Cristina of Austria
Carlos (1848–1909) duque de Madrid = Margarita of Parma
Alfonso (1849–1936) duque de San Jaime = Neves of Portugal
Jaime (1870–1931) duque de Madrid
Mercedes (1880–1904) Carlo di Caserta (*see* Table VII)
Teresa (1882–1912) = Ferdinand of Bavaria
ALFONSO XIII (1886–1941) king of Spain 1886–1931 = Victoria Eugenia of Battenberg
Alfonso (1907–38) principe de Asturias 1907 conde de Covadonga 1933 after renouncing succession
Jaime (1908–) duque de Segovia renounced succession 1933
2 daughters
Juan (1913–) conde de Barcelona = Mercedes of the Two Sicilies (*see* Table VII)
Gonzalo (1914–34)
Juan Carlos (1938–)
2 daughters
Alfonso (1941–56)

TABLE VI.—*The Bourbons of Parma*

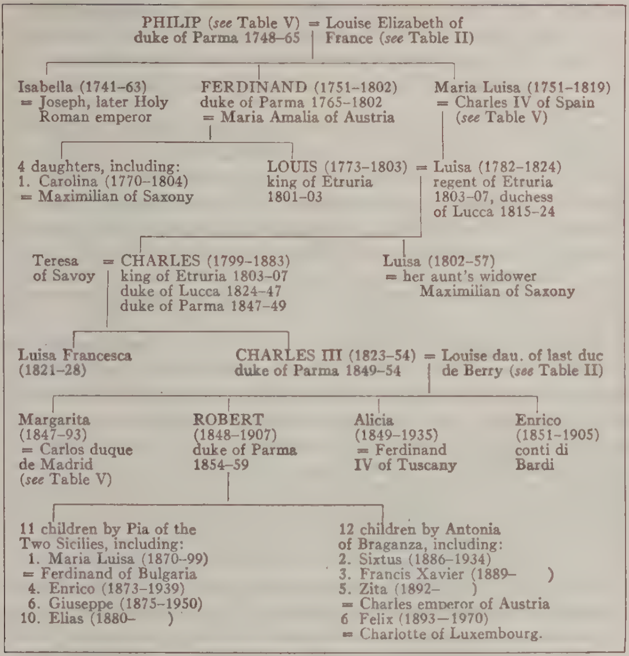
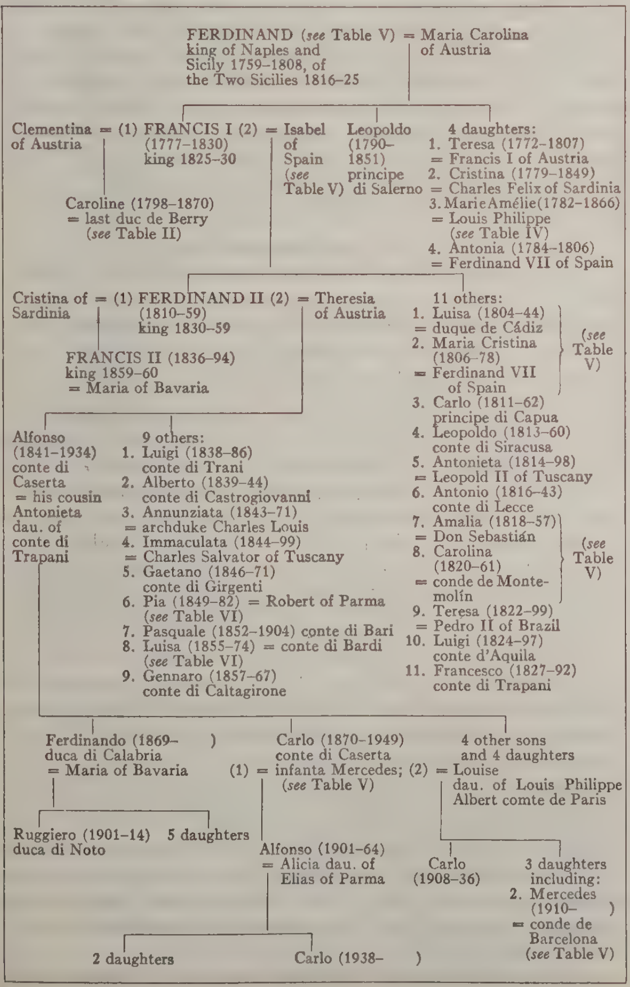

PHILIP (see Table V) duke of Parma 1748–65 = Louise Elizabeth of France (see Table II)
Isabella (1741–63) = Joseph, later Holy Roman emperor
FERDINAND (1751–1802) duke of Parma 1765–1802 = Maria Amalia of Austria
Maria Luisa (1751–1819) = Charles IV of Spain (see Table V)
4 daughters, including: 1. Carolina (1770–1804) = Maximilian of Saxony
LOUIS (1773–1803) king of Etruria 1801–03 = Luisa (1782–1824) regent of Etruria 1803–07, duchess of Lucca 1815–24
Teresa of Savoy = CHARLES (1799–1883) king of Etruria 1803–07 duke of Lucca 1824–47 duke of Parma 1847–49
Luisa (1802–57) = her aunt's widower Maximilian of Saxony
Luisa Francesca (1821–28)
CHARLES III (1823–54) duke of Parma 1849–54 = Louise dau. of last duc de Berry (see Table II)
Margarita (1847–93) = Carlos duque de Madrid (see Table V)
ROBERT (1848–1907) duke of Parma 1854–59
Alicia (1849–1935) = Ferdinand IV of Tuscany
Enrico (1851–1905) conti di Bardi
11 children by Pia of the Two Sicilies, including:
1. Maria Luisa (1870–99) = Ferdinand of Bulgaria
4. Enrico (1873–1939)
6. Giuseppe (1875–1950)
10. Elias (1880–)
12 children by Antonia of Braganza, including:
2. Sixtus (1886–1934)
3. Francis Xavier (1889–)
5. Zita (1892–) = Charles emperor of Austria
6 Felix (1893–1970) = Charlotte of Luxembourg.

TABLE VII.—*The Bourbons of the Two Sicilies*


FERDINAND (see Table V) king of Naples and Sicily 1759–1808, of the Two Sicilies 1816–25 = Maria Carolina of Austria
Clementina of Austria = (1) FRANCIS I (2) = Isabel of Spain (see Table V)
FRANCIS I (1777–1830) king 1825–30
Leopoldo (1790–1851) principe di Salerno
4 daughters:
1. Teresa (1772–1807) = Francis I of Austria
2. Cristina (1779–1849) = Charles Felix of Sardinia
3. Marie Amélie (1782–1866) = Louis Philippe (see Table IV)
4. Antonia (1784–1806) = Ferdinand VII of Spain
Caroline (1798–1870) = last duc de Berry (see Table II)
Cristina of Sardinia = (1) FERDINAND II (2) = Theresia of Austria
FERDINAND II (1810–59) king 1830–59
11 others:
1. Luisa (1804–44) = duque de Cádiz
2. Maria Cristina (1806–78) = Ferdinand VII of Spain
(see Table V)
3. Carlo (1811–62) principe di Capua
4. Leopoldo (1813–60) conte di Siracusa
5. Antonieta (1814–98) = Leopold II of Tuscany
6. Antonio (1816–43) conte di Lecce
7. Amalia (1818–57) = Don Sebastián
8. Carolina (1820–61) = conde de Montemolín
(see Table V)
9. Teresa (1822–99) = Pedro II of Brazil
10. Luigi (1824–97) conte d'Aquila
11. Francesco (1827–92) conte di Trapani
FRANCIS II (1836–94) king 1859–60 = Maria of Bavaria
Alfonso (1841–1934) conte di Caserta = his cousin Antonieta dau. of conte di Trapani
9 others:
1. Luigi (1838–86) conte di Trani
2. Alberto (1839–44) conte di Castrogiovanni
3. Annunziata (1843–71) = archduke Charles Louis
4. Immaculata (1844–99) = Charles Salvator of Tuscany
5. Gaetano (1846–71) conte di Girgenti
6. Pia (1849–82) = Robert of Parma (see Table VI)
7. Pasquale (1852–1904) conte di Bari
8. Luisa (1855–74) = conte di Bardi (see Table VI)
9. Gennaro (1857–67) conte di Caltagirone
Ferdinando (1869–) duca di Calabria = Maria of Bavaria
Carlo (1870–1949) conte di Caserta
(1) = infanta Mercedes; (see Table V)
(2) = Louise dau. of Louis Philippe Albert comte de Paris
4 other sons and 4 daughters
Ruggiero (1901–14) duca di Noto
5 daughters
Alfonso (1901–64) = Alicia dau. of Elias of Parma
Carlo (1908–36)
3 daughters including: 2. Mercedes (1910–) = conde de Barcelona (see Table V)
2 daughters
Carlo (1938–)

occasionally where princesses, having married into another country, are better known under that country's name (*e.g.,* Marie Amélie, queen of the French, instead of Maria Amalia); and (2) the first name Maria has in many cases been omitted from such compounds as Maria Amalia, Maria Antonia, Maria Luisa, Maria Teresa, Maria de las Mercedes, etc.

Something must finally be said about the bastard branches of Bourbon (not indicated in the tables). The oldest surviving one of these is that of Bourbon-Busset, descended from Louis de Bourbon (d. 1482), prince-bishop of Liège, another son of Charles I duc de Bourbon. Of the numerous bastards of Henry IV and Louis XIV, the most important were legitimated. The second Bourbon house of Vendôme begins with César (1594–1665), duc de Vendôme, Henry IV's eldest son by Gabrielle d'Estrées. Henry (1601–82), duc de Verneuil, was the son of Henry IV and the marquise de Verneuil. Of Louis XIV's five children by Louise de La Vallière, two were legitimated, namely Louis (1667–83), comte de Vermandois, and Marie Anne (1666–1739), known as Mademoiselle de Blois until her marriage with Louis Armand, prince de Conti.

The children of Louis XIV and the marquise de Montespan, all legitimated, were: Louis Auguste (1670–1736), duc du Maine, whose last direct heir died in 1775; Louis César (1672–83), abbé de Saint Germain-des-Près; Louis Alexandre (1678–1737), comte de Toulouse, whose son Louis Jean (1725–93), duc de Penthièvre, was the father of Louis Alexandre (d. 1767), prince de Lamballe, and of Louise Marie Adélaïde, mother of the future king Louis Philippe; Louise Françoise (1673–1743), called Mademoiselle de Nantes until her marriage with Louis III de Condé; Louise Marie (1676–81), Mademoiselle de Tours; and Françoise Marie (1677–1749), known as the second Mademoiselle de Blois until her marriage with Philippe, duc de Chartres, the future duc d'Orléans and regent.

See also references under "Bourbon" in the Index.

(J. G. R.-S.)

BOURBON, CHARLES, Duc de (1490–1527), constable of France, is often presented to the popular French historical imagination as the symbol of treason and ingratitude, though in fact his conduct was largely justified by the change in his king's treatment of him. Born at Montpensier on Feb. 17, 1490, the second son of Gilbert, comte de Montpensier, head of a junior branch of the house of Bourbon (*q.v.*), Charles benefited by a rapid succession of deaths: his father's (1496) was followed by his eldest brother's (1501); and finally, in 1503, his father's cousin Pierre II, duc de Bourbon, died leaving no male heir. Charles, who moreover proceeded to marry Pierre's daughter Suzanne, thus inherited the domains of the ducal line of Bourbon as well as those of Montpensier. At the age of 15, in 1505, he was one of the most powerful men in France.

Charles now started a brilliant military career. He was at the siege of Genoa in 1507 and took part in the battle of Agnadello in 1509. Appointed constable of France on the accession of Francis I, he contributed greatly to the victory at Marignano, which made his young king master of the Milanese. At 25, laden with honours by the king, Charles was governor of the Milanese in the king's name. He took effective measures to defend the province against the Holy Roman emperor Maximilian.

Then the constable began to lose the king's favour. Various explanations have been advanced for this change. The king's envy may indeed have been excited by the splendour of Charles's life at Moulins, capital of his duchy in the Bourbonnais, but above all it seems to have been the king's mother, Louise of Savoy, who worked against Charles. According to one story, Louise had been in love with the constable, but he had scorned her advances and rejected the proposal of marriage made by her after his wife's death (1521). It is certain in any case that Francis, who had neglected to pay his salary to the constable since his investiture, instituted proceedings in the *parlement* of Paris to recover the inheritance of the senior branch of the Bourbon family from him (1522–23). As the king's case was bad in law, the *parlement* suspended judgment but ordered the property to be sequestered, thus constituting the crown a trustee.

Thereupon Charles turned to negotiate with the emperor Charles V and with Henry VIII of England. At one time they even considered a partition of France, whereby the emperor would take Languedoc, Burgundy, Champagne and Picardy, the constable would add Provence and Dauphine to his own domains of Bourbonnais and Auvergne, and the king of England would have the rest of France, from Normandy to Guienne. Francis got wind of this simple project, but failed to stop Charles from escaping to the Franche-Comté. Passing into the emperor's service at the head of an army of German mercenaries, Charles then repelled a French attack on Italy (April 1524), invaded Provence and captured Toulon, but was halted before Marseilles (Aug.–Sept. 1524). Falling back on Lombardy, he fought in the battle of Pavia (Feb. 24, 1525), in which Francis was taken prisoner by Charles's soldiers. The treaty of Madrid (1526), whereby Francis recovered his liberty, guaranteed Charles's free return to France and the restitution of his possessions, but Francis did not keep his word.

To offset this disappointment, Charles V made the constable governor of the Milanese, the post that he had held ten years earlier as the representative of the king of France. Left without resources by the emperor for the upkeep of his army, the constable, in the spring of 1527 led his pillaging troops across central Italy to Rome. He was killed in the first assault on Rome (May 6, 1527), just before the capture and sack of the city.

Bibliography.—The life of the constable de Bourbon to 1521, by his secretary G. de Marillac, with the continuation of it by A. de Laval, is printed in *Panthéon littéraire*, ed. by A. Desrez (1836). *See* also the romanticized life by N. Baudot de Juilly, *Histoire secrette du connestable de Bourbon* (1696; new ed. 1947); and C. Hare, *Charles de Bourbon* (1924). (Ro. M.)

BOURBON, LOUIS HENRI DE BOURBON-CONDÉ, Duc de (1692–1740), French statesman, the first prime minister of Louis XV's reign, was born at Versailles on Aug. 18, 1692, the son of Louis de Bourbon-Condé (Monsieur le Duc). After the death of Louis XIV, he was placed by the regent, the duc d'Orléans, at the head of the regency council where he distinguished himself mainly by his opposition to the legitimized princes. In general he played little part in politics during Louis XV's minority, preferring to occupy himself in the speculation engendered by the financial system of John Law. In 1719, however, he met the marquise de Prie (Agnès Berthelot de Pléneuf), who soon became his acknowledged mistress and diverted to politics the energies he had been accustomed to dissipate in the chase. After the death of the duc d'Orléans on Dec. 2, 1723, Bourbon became first minister, but he remained completely under the influence of his mistress. The ministry was a disastrous one; increased taxation, repressive police measures and rigorous laws against the Protestants made the regime unpopular in France, while the ending of the betrothal of Louis XV to the infanta nearly led to war with Spain and was directly responsible for the Austro-Spanish *rapprochement* of 1725. In June 1726 a plot to secure the dismissal of A. H. de Fleury (*q.v.*) failed, and it was Bourbon himself who was dismissed. Exiled to Chantilly, he interested himself in chemistry and natural history until his death there on Jan. 27, 1740. (B. J. R.)

BOURBONNAIS, an old province of France, covering approximately the same area as the modern *département* of Allier. Bounded on the north by Nivernais and Berry, on the south by Auvergne, on the east by Burgundy and Forez and on the west by Berry, Bourbonnais included parts of lands held in pre-Roman times by certain Gallic tribes—the Arverni, the Aedui and the Bituriges Cubi—and later divided between Aquitania and Lugdunensis. The territory, a creation of the feudal period, was gradually carved out of neighbouring provinces by the sires or lords of Bourbon (the modern Bourbon-l'Archambault). These sires were descended from Aimon I (10th century), whose son or grandson Archambaud I or II (d. *c.* 1034) set up the dynasty of Archambaud. Archambaud IV (d. 1095) was succeeded by his brother Aimon II Vaire-Vache (d. 1110), whose great-granddaughter Mathilde I married Guy of Dampierre (d. 1216) as her second husband. Their descendants form the line of Archambaud-Dampierre: Archambaud VII the Great (d. 1242), his son Archambaud VIII (d. 1249) and the latter's two daughters, Mathilde II (d. 1262) and Agnès (d. 1287 or 1288). Agnès, by her first husband, Jean, second son of Hugh IV of Burgundy, had a daughter, Béatrix, who in 1276 married Robert, comte de Clermont, sixth son of Louis IX of France. Their son Louis, created duc de Bourbon in 1327, was the ancestor of the great sovereign dynasty of Bourbon.

Bourbonnais was confiscated by the French crown in 1527 on the death of the rebellious constable Charles, duc de Bourbon, and attached to the crown in 1531. In the 18th century different parts of Bourbonnais formed parts of five dioceses, those of Bourges, Clermont, Autun, Nevers and Limoges. The principal towns of Bourbonnais were Moulins (the capital), Gannat, Montluçon and Lapalisse. The province had a military government with headquarters at Moulins. For judicial purposes it came under the *parlement* of Paris.

BOURCHIER, THOMAS (*c.* 1412–1486), English cardinal and archbishop of Canterbury, was notable during the Wars of the Roses for his attempts to maintain peace and the stability of the church first by compromise and later by supporting whichever king was in power. He was a younger son of William Bourchier, made count of Eu (1419) for his services to Henry V, and of Anne, heiress of Thomas of Woodstock, duke of Gloucester, the youngest son of Edward III. Thomas Bourchier went to Oxford university in about 1425 and was chancellor of the university from 1434 to 1437. While bishop of Worcester (1435–43) and of Ely (1443–54), he was often at court and was frequently in demand as a confidant and arbitrator. His avoidance of political faction made his election as archbishop of Canterbury (1454) acceptable to all parties during the tense months (1453–54) of Henry VI's insanity. Chancellor from 1455–56, he organized the temporary pacification of 1458 and the abortive compromise settlement (Oct. 1460) of Richard duke of York's claim to the throne. He supported Edward IV unswervingly throughout his reign and was repaid by numerous grants, the king obtaining for him a cardinal's hat (1467). After Edward's death he accepted the usurpation of Richard III, and it was probably in naive good faith that he persuaded Elizabeth Woodville to give up her second son, Richard, duke of York, to join his brother, Edward V, in the tower of London. Bourchier crowned Richard III in July 1483 and his supplanter, Henry VII in Oct. 1485. He died at Knole, Kent, on March 30, 1486.

See *Registrum Thome Bourgchier Cantuariensis archiepiscopi,* ed. by F. R. H. Du Boulay (1957) for the most recent appraisal and bibliography. (A. R. M.)

BOURDALOUE, LOUIS (1632–1704), French Jesuit, held by many to have been the greatest of the 17th-century court preachers who in those days filled a public role comparable with that of the modern newspaper, was born at Bourges on Aug. 20, 1632. He became a Jesuit in 1648 and very soon manifested his gift for oratory. After preaching in the provinces, he was sent to Paris in 1669 where he preached in the church of Saint Louis. He soon earned the title of "king of preachers and preacher of kings." Bourdaloue disliked the custom of flattering funeral orations for the great, but the one he preached on the great Condé was so effective that it changed the life of the prince's son and successor, Henri Jules, who called it "the finest and most Christian panegyric that has ever been pronounced." Bourdaloue has been compared with the greatest orators of all ages. Louis XIV preferred Bourdaloue on an old theme to anyone else on a new one.

He was inevitably contrasted with J. B. Bossuet, though their styles and matter were very different. Bourdaloue always wrote out his sermons, which were careful logical expositions with much psychological insight into human nature. He never flattered his congregations, but his beautiful voice, speaking easily and rapidly, kept them spellbound. Bossuet, whose sermons depended to some extent on the stimulus of the occasion, has been called a lyrical preacher in contrast with Bourdaloue's more carefully prepared dialectical expositions. Yet Bossuet reads better today than Bourdaloue, who owed much to the beauty of his voice and the saintliness and attraction of his personality. Bourdaloue died in Paris on May 13, 1704.

See E. Griselle, *Bourdaloue, histoire critique de sa prédication,* 3 vol.

(1901–06); F. Castets, *Bourdaloue* (1904). (M. de la B.)

BOURDELLE, ÉMILE ANTOINE (1861–1929), French sculptor and painter, in whose works the heroic energy and exaggerated, rippling surfaces of Rodin mingled with the flat, decorative simplifications of Greek archaic and Romanesque art, was born in Montauban, Oct. 30, 1861. He studied at the École des Beaux-Arts in Toulouse, then went to Paris in 1885. After studying with Jean Alexandre Falguière, J. B. Carpeaux and A. J. Dalou, he entered the studio of Auguste Rodin, who was to remain one of the chief influences of his artistic life. The masterpiece of his early period was the monument of the "Defenders of 1870–71," (1893–1902). In 1900 he created a crucial work, the "Head of Apollo," whose majestic dignity and broad planes recalled Greek early classic works. In 1910 he achieved his first triumph in the salon with "Heracles the Archer," which again owed much to archaic art, although the pose is far more sinuous and the musculature more exaggerated. In this year he also created a Moses-like "Head of Rodin," as well as busts of Rembrandt and Ingres (1910–12). In 1912 he executed reliefs for the Théâtre des Champs Élysées in a compact, planar style. The subject was "Apollo and His Thought," accompanied by dancing muses. The year 1914 marked the creation of another masterpiece, the "Dying Centaur," which represented for him the defeat of paganism. His "Monument to Alvéar" (1923), in Buenos Aires, consisted of the equestrian subject flanked by four allegorical figures. Among his most satisfying works were his small studies, such as "Apples" (1917) or "Self-Portrait" (1908). He died in Paris on Oct. 1, 1929. (L. W. N.)

BOURDON GAUGE: *see* Pressure Gauge.

BOURG (Bourg-en-Bresse), capital of the *département* of Ain, eastern France, and formerly capital of the province of Bresse, is situated on the Reyssouze, a tributary of the Saône, in flat country to the west of the Jura mountains, 61 km. (38 mi.) N.N.E. of Lyons by road and about 70 km. (43 mi.) W. of Geneva, Switz. Pop. (1962) 28,813. The church of Brou, on the boulevard named after it in the southeast of the town, is a remarkable late Gothic monument (1506–32). Marguerite of Bourbon, wife of Philip of Savoy, made a vow to rebuild Brou priory, but died before she was able to fulfill it, and her daughter-in-law, Marguerite of Austria, built the church and monastery in memory of her husband Philibert le Beau of Savoy. The three mausoleums ornamented with the marble effigies of the two Marguerites and Philibert, the rood loft, the oak stalls, the stained glass and the reredos in the Lady chapel are masterpieces of the style. The Ain museum is housed in the buildings of the former priory, which has three cloisters. Notre Dame church was built in different periods, but mainly in the 16th century (nave, choir and stalls). There are some old houses of the 16th and 18th centuries. Bourg is a road and rail junction, standing at the crossing of the road from Paris to the Riviera by the Route Napoléon over the Alps with that from Bordeaux to Geneva and on the main line from Paris to Turin. There is considerable tourist trade and the town has iron and cable works, furniture factories and trade in grain, cattle and Bresse poultry. Neolithic remains have been found. Bourg has had a market since the 11th century and in 1250 the inhabitants were granted a charter of franchise. In 1272 the district of Bresse passed to Savoy by marriage. In 1601 it was annexed to France. In World War II when it was occupied by the Germans from Nov. 1942 until Sept. 1944, it was a centre of the Resistance movement. (Am. M.)

BOURGAULT-DUCOUDRAY, LOUIS ALBERT (1840–1910), French composer and musicologist who influenced his contemporaries by his researches on folk music. Born at Nantes, Feb. 2, 1840, he studied at the Paris Conservatoire, where he won the Prix de Rome (1862), and where (1878–1908) he was professor of the history of music. He wrote operas, symphonic works and chamber music, but his fame rests on his *Trente mélodies populaires de Grèce et d'Orient* (1876), *Trente mélodies populaires de Basse Bretagne* (1885) and *Quatorze mélodies Celtiques* (1909), which fostered a new approach to folk music in France by giving it in its original modal setting. He thus anticipated 20th-century music, being one of those who provided Debussy with the evocative archaism that through him became an essential element in modern musical style. He died at Vernouillet (Seine-et-Oise), July 4, 1910. (F. E. G.)

BOURGEOIS, LÉON VICTOR AUGUSTE (1851–1925), French statesman and ardent promotor of the League of Nations, winner of the Nobel peace prize in 1920, was born in Paris on May 29, 1851. Having studied law, he entered the civil service in 1876 and in 1887 rose to the position of prefect of police for the Seine *département*. He began his political career next year when he defeated Gen. Georges Boulanger in the Marne *département*, for which he then became deputy. He was a member of several governments from 1888 onward and prime minister from Nov. 1, 1895, to April 21, 1896. He fell from power in the constitutional struggle over the senate's right to veto budgetary supply. Minister of foreign affairs in Ferdinand Sarrien's government from March 14 to Oct. 19, 1906, he was responsible for French policy at closing stages of the Algeciras conference. Having already distinguished himself at the peace conference at The Hague in 1899, he was nominated a member of the permanent court of arbitration there in 1907. He was minister of foreign affairs in Alexandre Ribot's two-day government in June 1914. Thereafter he was minister without portfolio until he became minister of labour in Aristide Briand's government (1916–17). He had been elected to the senate in 1905 and was its president from 1920 to 1923.

Bourgeois had been one of the first to suggest a league of nations and so was appointed by the French government as its representative in the special committee of the Paris peace conference that prepared the covenant of the League of Nations. On the League's being constituted, he became France's principal representative, both in the council and in the assembly, until 1923, when approaching blindness forced him into retirement. In 1920 he was awarded the Nobel peace prize. He died at the château d'Oger, near Épernay, on Sept. 29, 1925. His publications include: *La Politique de la prévoyance sociale,* two volumes (1914–19), *Le Traité de 1919 et la Société des Nations* (1920) and *L'Oeuvre de la Société des Nations* (1920–23).

See M. Hamburger, *Hommes politiques: Léon Bourgeois* (1932).

BOURGEOISIE, a French term that referred originally to the inhabitants of walled towns in the middle ages. Such townspeople made their living by practicing the medieval arts and crafts. They occupied an intermediate position in the economic and social scale between the landlords and the peasantry in the open country. With the introduction of mechanical power into urban industry and the growth of the factory system the medieval handicraftsmen began to divide into two classes—employers and employees—and the growth of a new kind of class consciousness tended to restrict the idea of bourgeois to the employers. Thus arose a more modern system of economic and social classification which emphasized the distinction between bourgeois (or capitalist) and proletariat (*q.v.*). This distinction became politically important in the first part of the 19th century in the course of the reaction against the undiscriminating democratic idealism that flourished during the French Revolution.

Later, Marxist communists built a pretentious system of social and political philosophy on this distinction between *bourgeoisie* and proletariat. That the attempt to create a comprehensive philosophy of history and politics on this narrow basis was excessively unrealistic is demonstrated by the subsequent struggles between different schools of socialism and communism. Karl Marx's early collaborator, Friedrich Engels, made the first breach in the Marxist system when he admitted the importance of evolution as well as revolution in the development of human society. The successors of Marx and Engels, from Karl Kautsky and Lenin to Joseph Stalin and Nikita Khrushchev, were forced to make increasing concessions to the stubborn facts of modern industrial and political life. The original simplicity of the Marxist scheme of social classification yielded to a growing recognition of the baffling complexity of modern society and politics.

In the most advanced capitalistic countries there is a strong tendency to revert to one of the oldest schemes of social and political classification. Aristotle's system of politics emphasized the distinctions among three classes—upper, middle and lower—and stressed the importance of the middle classes in a well-ordered state. But in contemporary politics these major classes are highly complex, and there is no part of them which can be identified as the *bourgeoisie*. The word itself retains its practical utility chiefly in discussions of art and manners. In Great Britain and the United States *bourgeoisie* had nearly disappeared from the vocabulary of political writers and politicians by mid-20th century.

(A. N. H.)

BOURGES, a city of central France, capital of the *département* of Cher, is situated almost in the exact middle of the country, 196 km. (122 mi.) S.S.E. of Paris by road. Pop. (1962) 55,526. Bourges is built on a plateau in marshy country crossed by several streams, tributaries of the Cher. The medieval town with its winding streets was enclosed by fortifications, traces of which remain. The modern town with its industries extends to the north, east and west. The summit of the hill on which Bourges is built is crowned by the cathedral which dominates the city. Dedicated to St. Etienne, it is one of the most beautiful Gothic cathedrals in France. It was begun at the end of the 12th century and completed in 50 years, but some additions were made later. It has five magnificent doorways flanked by two asymmetrical towers: the Tour de Beurre on the north (Renaissance) and the Tour Sourde (13th century). The interior has five aisles—the inner aisles are remarkably high—and no transepts, and contains, among many works of art, exquisite stained glass windows of the 12th to the 17th century, those of the 13th century being particularly beautiful. Beneath the choir there is a splendid 12th-century crypt and traces of the 9th-century Carolingian church. The palace of Jacques Coeur (*q.v.*), the Hôtel Lallemant, the palace of John, duke of Berry (*q.v.*), and the magistrate's court were built in the 15th and 16th centuries using the Gallo-Roman fortifications. The Cujas house, built in 1515, is the Berry museum. The Ursuline convent (17th century) is used as the law courts. Two gardens, those of the town hall and Près-Fichaux, set off these fine buildings of the capital of the former province of Berry (*q.v.*).

Bourges is a centre of the aircraft industry and manufactures tires, spirits, biscuits and clothes. It is also the capital of a rich agricultural district famous for its corn, sheep, beef and wines. The old Berry canal is no longer used, the commercial traffic going by road and rail. The archbishop of Bourges bears the title of *Primat des Aquitaines, Métropolite et Patriarche*. The ancient Avaricum, capital of the Bituriges, Bourges was conquered in 52 B.C. by Julius Caesar despite the brave defense by Vercingetorix. Caesar noted in his commentaries that it was almost the most beautiful place in Gaul. St. Ursin brought Christianity to Bourges in the 3rd century. The city was destroyed many times after the end of the Roman occupation. Charlemagne unified Berry and made Bourges the capital of Aquitaine. Charles VII stayed there from 1422 to 1437 during the Hundred Years' War and Joan of Arc spent the winter of 1429–30 in the city. In 1438 the Pragmatic Sanction (*q.v.*) was signed at Bourges. Louis XI, in 1463, endowed his birthplace with a university which became famous for its teaching of Roman law, especially by Jacques Cujas (*q.v.*), but it has long ceased to exist. In this town John Calvin was converted to the ideas of Martin Luther. In World War II Bourges was occupied by the Germans from June 1940 to Aug. 1944.

(S. Po.)

BOURGET, PAUL CHARLES JOSEPH (1852–1935), French Catholic and conservative writer whose voluminous output included novels, short stories, plays, poetry, criticism and travel books, was born in Amiens on Sept. 2, 1852. The son of an eminent mathematician, Bourget studied at the Lycée Louis-le-Grand, the École des hautes études and the Sorbonne. He found medical studies too much for his sensitive nerves but passed his *licence-ès-lettres* brilliantly and embarked on a literary career in imitation of Balzac's heroes.

He began as a poet: *La Vie inquiète* (1875), *Édel* (1878) and *Les Aveux* (1882), reflecting varied influences, are sincere but uninspired. Now forgotten, these poems were then admired: some were set to music by Debussy. Encouraged by Taine, whose thought deeply influenced him, Bourget turned to criticism and published *Essais de psychologie contemporaine* (1883) and *Nouveaux Essais* (1886), brilliant analyses of the sources of contemporary pessimism. He also contributed many articles to the liberal republican dailies *Le Parlement* and *Le Journal des débats* (1880–86), only a few of which, including impressions of travel in Britain and Ireland, were collected (*Études et portraits,* two volumes, 1889). Meanwhile he published psychological novels: *L'Irréparable* (1884), *Cruelle énigme* (1885), *Un Crime d'amour* (1886), *André Cornélis* and *Mensonges* (both 1887). Set in fashionable society and written in reaction against Zola's naturalism, they are based on a no less deterministic psychological theory derived from Taine. But in *Le Disciple* (1889), his most important novel, Bourget broke with Taine by showing how determinism undermines morality and may lead to crime.

A period of uncertainty followed. Bourget married (1890), traveled in Italy (*Sensations d'Italie,* 1891) and in the United States (*Outre-mer,* 2 vol., 1895), and published further psychological novels: *La Terre promise* (1892), *Cosmopolis* (1892), *Une Idylle tragique* (1896). He was elected to the Académie française in 1894 and was a prominent *antidreyfusard.*

In 1901, Bourget was converted to Roman Catholicism and thereafter wrote primarily in support of the church and the monarchy. *L'Étape* (1902), *Un Divorce* (1904), *L'Émigré* (1907), *Le Démon de midi* (1914), etc., although called by Bourget *romans à idees* are really *romans à thèse* and have fallen into merited disfavour, like his political plays *La Barricade* (1910) and *Le Tribun* (1911). His short stories and *nouvelles* are still worth reading however: they include *Pastels* (1889), *Complications sentimentales* (1898), *Drames de famille* (1900), *Le Justicier* (1919) and *De Petits faits vrais* (1930). Bourget was always an excellent critic: *Pages de critique et de doctrine,* two volumes (1912), *Quelques témoignages,* two volumes (1928) and *Au service de l'ordre* (1929) contain much valuable writing. He died on Dec. 25, 1935, in Paris. A man of great personal integrity, Bourget was generous to young writers. Like his more gifted friend Henry James, he was devoted to his art and deeply interested in its technique. But his dogmatism was disastrous for his creative writing.

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(L. J. Au.)

BOURGUIBA, HABIB (1903–), first president of the Tunisian Republic, was born at Al Munastir, near Susah, on Aug. 3, 1903. Educated first in the Sadiqiya College at Tunis, he later took a law degree and a diploma in political science at Paris. Soon after his return to Tunis he founded (1930) and edited a nationalist newspaper in French. In 1934, when the more active members of the Destour, or nationalist, Party seceded and founded the Neo-Destour Party, he became first secretary-general of the new body, which was banned by the French authorities the same year. A period of forced residence during 1934–36, first at Bordj le Boeuf on the edge of the Sahara, later on the island of Djerba, was ended by the liberal policy of the Popular Front government in France. In 1938, however, Bourguiba was again arrested, and proceedings in the court of cassation in Paris were still pending at the outbreak of World War II. On May 27, 1940, he was transferred to the part of France subsequently held by the Vichy government. Freed by the Germans in 1942, he was sent by them to Rome. There he resisted efforts to secure from him a declaration of support for Axis aims. Allowed back into Tunisia in 1943, he made approaches to the Free French, which were ignored, and in 1945 escaped in disguise to Egypt. During the next six years he traveled extensively in the Middle East, the Far East, Europe, and the U.S. to publicize the Tunisian cause. Back in Tunisia in 1952 he was again imprisoned. His release in 1954 enabled him to direct the Tunisian delegation from behind the scenes during the negotiations for the internal autonomy promised by the French premier, Pierre Mendès-France. Two days before the actual signing of the conventions establishing Tunisian autonomy he made a triumphal reentry into Tunisia (June 1, 1955), but he was unwilling to become premier until full independence was recognized (March 1956). In 1957 Bourguiba was elected president. He was reelected in 1959, 1964, and again in 1969, having run unopposed. In internal matters Bourguiba favoured social reform; in foreign affairs he showed a preference for association with the West. He was against violent solutions, preferring to attain his aims by diplomacy. He played an important part as intermediary in the closing stages of the Algerian War. In 1965 his proposals for Arab-Israeli reconciliation were strongly criticized in Arab countries and resulted in a conflict with the United Arab Republic which continued in 1966. *See* also TUNISIA: *Independence*. (N. BA.; X.)

BOURIGNON, ANTOINETTE (1616–1680), Flemish religious enthusiast, who believed herself to be the "woman clothed with the sun" (Rev. xii), was born at Lille on Jan. 13, 1616. She began life a Catholic, but took to self-imposed retirement, penance, and mortification. Later she tried convent life and the management of an orphanage; both were failures because of her distrust of human nature and her harsh, autocratic disposition. She soon became convinced that she was directly illuminated by God for the reforming of things temporal and spiritual, and accordingly began to attack every form of religious organization.

She attracted many followers in the Netherlands and France, and especially in Scotland, where her doctrines were denounced by the Presbyterian general assemblies of 1701, 1709, and 1710. She died at Friesland on Oct. 30, 1680. Her works, which exhibit a curious medley of opinions, were collected by her disciple, Pierre Poiret (1679), who also published her life (1679).

See A. van der Linde, *Antoinette Bourignon, das Licht der Welt* (1895); A. R. Macewen, *Antoinette Bourignon, Quietist* (1910).

BOURMONT, LOUIS AUGUSTE VICTOR, COMTE DE GHAISNES DE (1773–1846), French soldier and politician and marshal of France, entered the Gardes Françaises in 1788 but fled the country during the Revolution (1792) and served in the émigré army of the prince de Condé in the campaigns of 1792 and 1793, subsequently serving as chief of staff to the royalist leader M. P. A. Scépeaux, in the civil war in lower Anjou (1794–96). Bourmont was excepted from the amnesty of April 1796 and fled into Switzerland. Soon afterward, having been made a *maréchal de camp* by Louis XVIII, he headed a fresh insurrection, which after some preliminary successes collapsed (1799–1800). He then made his submission to Bonaparte, married, and lived in Paris. His thinly veiled royalism, however, caused his arrest a few months later, and he was imprisoned, finally escaping to Portugal in 1804. Three years later the French Army under Gen. Andoche Junot invaded Portugal, and Bourmont was made chief of staff of a division. He returned to France with Junot after the Convention of Sintra, and was promptly rearrested. On Junot's demand he was soon released and was commissioned as an officer on the staff of the viceroy of Italy, Prince Eugène (Beauharnais), whom he accompanied in the Moscow campaign. He was taken prisoner in the retreat, but escaped and rejoined the French Army. His conspicuous courage at the battle of Lützen in 1813 led Napoleon to promote him general of brigade, and in 1814 his splendid defense of Nogent earned him the rank of general of division.

At the first Restoration Bourmont was naturally employed by the Bourbons, to whose service he had devoted his life, but he rejoined Napoleon on his return from Elba. On the eve of the campaign of 1815, and at the urgent request of Étienne, comte Gérard, he was given a divisional command in the army of the north. On the first day of the Waterloo campaign Bourmont went over to the enemy. It is not probable that he gave information of French movements to the allies, but the best that can be said in his defense is that his old friends and comrades, the royalists of Anjou, were again in insurrection and that he felt he must lead them. He made no attempt to defend his conduct, and was the accuser at Marshal Ney's trial. A year later he was given command of a division of the royal guard, and in 1823 he held an important position in the army which, under the command of the duc d'Angoulême, invaded Spain. He commanded the whole army in Spain for a time in 1824, became minister of war in 1829, and in 1830 was placed in command of the Algiers expedition. He directed the landing of the French and the capture of Algiers and was rewarded by being created marshal. But the revolution of 1830 ended his command, and, refusing to take the oath to Louis Philippe, he was forced to resign. In 1832 Bourmont took part in the rising of the duchesse de Berry, and on its failure retired to Portugal. There—as always on the side of absolutism—he commanded the army of Dom Miguel during the civil war of 1833–34, and after the victory of the constitutional party he retired to Rome. At the amnesty of 1840 he returned to France. He died at the château of Bourmont on Oct. 27, 1846.

BOURNE, FRANCIS (1861–1935), English cardinal, archbishop of Westminster, who, although lacking the personal magnetism of his predecessors, was a strong leader of Roman Catholics, pursuing policies he considered right for church and state, often in face of adverse criticism. He was born at Clapham, London, on March 23, 1861, and was educated at Ushaw college, St. Edmund's college, Ware, St. Sulpice in Paris, and Louvain university. (His book *Ecclesiastical Training* [1926] shows admiration for St. Sulpice and its methods.) After ordination in 1884, he worked at Blackheath, Mortlake and West Grinstead, before his appointment in 1889 as rector of St. John's seminary, Wonersh. In 1895 he became a monsignor and in 1896 coadjutor-bishop of Southwark. He was made archbishop of Westminster in 1903 and came into prominence in 1908 when the Blessed Sacrament procession he had planned through the streets during the Eucharistic congress was banned for fear of disturbances; he countered this by having the benediction given from the loggia of the cathedral. He became a cardinal in 1911, and from then on his influence grew, his patriotism finding full scope during the war. He championed the rights of the Arabs in Palestine, upheld Catholic claims in education, condemned violence in Ireland, denounced the general strike, reproved the modernists and was lukewarm toward the Malines conversations inaugurated by Désiré, Cardinal Mercier (*q.v.*) and Lord Halifax. He took the liveliest interest in university education, preferring Catholics to attend the national universities rather than to attempt to set up one of their own, and likewise favoured their joining existing political parties instead of forming a Catholic party. He opened many new parishes and favoured splitting up dioceses, if this made for greater progress. Cardinal Bourne died on Jan. 1, 1935.

See T. Hooley, *A Seminary in the Making* (1927); E. J. Oldmeadow, *Francis, Cardinal Bourne*, 2 vol. (1940–44). (J. W. DU.)

BOURNE, in physical geography, a variation of the term *burn* applied to small streams in Scotland, is the term applied to the intermittent streams that are common features of the chalk and limestone country of south England. Drainage there is slow, and after the land becomes saturated (as it does during the winter season) a heavy rain causes streams to develop where at other times they do not occur. These are the winter bournes that appear as place names in the Salisbury Plains, Winterbourne Gunning being an example.

Bourne in the sense of boundary is a different word; the first use of it in English is in Lord Berners' translation of Froissart's *Chronicles* (1523). The word was used several times by Shakespeare, and the figurative meaning of limit or goal of a traveler comes from the well-known passage from *Hamlet* (1602), "the undiscovered country, from whose bourne no traveler returns."

BOURNEMOUTH, a parliamentary and county borough, and seaside resort, in the county of Hampshire, Eng., 105 mi. S.W. of London by road. Pop. (1968 est.) 151,460. Area 17.9 sq.mi.

The present centre of the town occupies the valley of the Bourne, a little stream which goes past the pavilion rockery. The sandy beach of Poole bay is here backed by considerable sandstone cliffs scored with deep picturesque dells or chines. The town is of modern and remarkably rapid growth, though the site was occupied from prehistoric times. It is said that there was no house on the site when the Dorset squire Lewis Tregonwell, the founder of Bournemouth, paid a visit in 1810 before building a summer residence there. By 1841 Bournemouth consisted of 26 buildings including a church, a hotel, a boarding house and a library; the sheltered position and mild climate were beginning to attract attention. In 1851 the population was only 695, and in

1858 the only barber came from Christchurch twice weekly. A wooden pier was constructed in 1861 and, ten years after the railway came in 1870, a second pier was built. When the town was incorporated in 1890 the population had risen to 37,000. Suburbs rapidly extended inland and along the shore in both directions, much building having taken place after 1918 (when it became a parliamentary borough); *e.g.*, at Pokesdown, Southbourne, Westbourne, Branksome Park and Canford Cliffs. The heath vegetation and pines which flourish in the sandy soil were largely replaced by houses, but the municipality checked further destruction by protecting existing trees and planting new ones. Hengistbury Head, a prehistoric site and the southern arm of Christchurch (*q.v.*) harbour, was added to the borough in 1932. Many new parishes were formed and churches built. The boundaries of the borough now include Boscombe, Pokesdown, Southbourne, Kinson and Holdenhurst. Bournemouth, with Christchurch, sends two members to parliament.

There are six miles of sandy bathing beach and five miles of promenade including Undercliff drive. There are more than 1,400 ac. of public parks and pleasure gardens within the borough. Notable buildings include the pavilion (1929), the municipal college and central library (opened 1913), the winter gardens (originally built in 1876) which were opened as a new concert hall in 1947 and are the headquarters of the Bournemouth Symphony orchestra (established 1893), and the Russell Cotes art gallery and museum. There are also four theatres. Bournemouth is mainly a residential and resort town and has few industries apart from catering throughout the year for visitors and conferences. Its position halfway along the south coast of England, on the Hampshire-Dorset border, makes it a good centre for visits to Winchester, the New Forest, Salisbury, Wilton, Stonehenge, Shaftesbury, Cranborne, Yeovil, Dorchester and Lulworth cove.

Mary Shelley and her father and mother, William Godwin and Mary Wollstonecraft, are buried in the graveyard of St. Peter's church which also commemorates John Keble, an inhabitant of Bournemouth. Robert Louis Stevenson also lived in the town from 1884 to 1887.

BOURNONITE, a mineral sulfosalt containing antimony, lead and copper, of interest as an example of twinning and for the beautiful cross- and wheel-shaped crystallizations it affords. The crystals are orthorhombic and are generally tabular in habit. Usually the crystals are twinned on a face of the prism; the twinned individuals are nearly at a right angle, giving cruciform groups, and when often repeated the grouping has the appearance of a cogwheel. The mineral was first described from Cornwall in 1804 by the French mineralogist, comte de Bournon, after whom it was named. Because of its unusual appearance, it also has been known as wheel ore (Ger. *Rädelerz.*) It is opaque and has a brilliant metallic lustre with a lead-gray colour. The hardness is 2.5 and the specific gravity 5.8. The formula is $PbCuSbS_3$.
(Cl. F.)

BOURNONVILLE, AUGUST (1805–1879), Danish dancer and choreographer, who directed the Royal Danish Ballet for nearly 50 years, was born in Copenhagen on Aug. 21, 1805. He studied under his father, Antoine Bournonville, before going to Paris for further training under Auguste Vestris and Pierre Gardel.

After appearances at the Paris Opéra and in London, Bournonville returned to Copenhagen in 1829. The following year he became virtual dictator of Danish ballet. In 1836 he staged his own version of *La Sylphide*, a ballet by Filippo Taglioni, with his pupil and protegée, Lucile Grahn, in the title role. *Le Toreador*, produced in 1840, had a Spanish theme, and *Napoli*, given in 1842, was based on his impressions of a trip to Italy. His *Konservatoriet* (1849) is the only surviving ballet to show classical dance exercises as practiced in the classroom in the early 19th century.

A strong dancer with excellent elevation, and an accomplished mime, he emphasized these qualities in his ballets. His influence on Danish style, technique and choreography has been deep and long-lasting. Many of his ballets, such as *Napoli, La Ventana, Kermesse i Brügge, Et Folkesagn, Konservatoriet* and *La Sylphide* have remained in the repertoire for more than a century.

From 1861 to 1864 Bournonville directed the Swedish Royal Opera, at Stockholm. He staged several of his works in Vienna in 1855–56. His international fame, however, has derived chiefly from increasing recognition of his choreographic genius as exemplified in revivals by the Royal Danish Ballet for tours and festivals, since 1950. He died on Nov. 30, 1879. (Ln. Me.)

BOURRÉE, a French name for a dance common in Auvergne and in Biscay in Spain; also a term for a musical composition or a dance movement in a suite, somewhat akin to the gavotte, in quick time with two beats to the bar.

BOURRIENNE, LOUIS ANTOINE FAUVELET DE (1769–1834), French diplomat, remembered for his voluminous *Mémoires*, which give an interesting, if not very trustworthy, view of the Napoleonic age. He was born at Sens on July 9, 1769, and educated at the military school of Brienne, where, he asserts in his memoirs, he was the friend of Napoleon Bonaparte. Returning from a diplomatic post at Stuttgart in 1794, he found his name on the list of political émigrés, but it was eventually removed through Napoleon's influence. He was called to Italy by the victorious general at the time of the long negotiations with Austria (May–October 1797), and his knowledge of law and diplomacy was of some service in the drafting of the Treaty of Campo Formio. In the following year Bourrienne accompanied Napoleon to Egypt as his private secretary, and his memoirs contain a vivid account of the expedition. He also accompanied Napoleon on the return voyage to Fréjus. In the spring of 1805 he was sent as French envoy to Hamburg to carry out the measures of the commercial war with England, but he secretly relaxed the rules for those merchants who gave him favours. After amassing a fortune, he was recalled to France in disgrace in 1813. In 1814 he embraced the royal cause, and during the Hundred Days accompanied Louis XVIII to Ghent. He died at Caen on Feb. 7, 1834.

The *Mémoires* were published in ten volumes in 1829–31, and were frequently republished and translated thereafter. The best English edition, by Col. R. W. Phipps, appeared in 1893.

BOURSAULT, EDME (1638–1701), French man of letters, active in the literary world of mid-17th-century Paris, was born at Mussy L'Évêque, now Mussy-sur-Seine (Aube), in Oct. 1638. He composed light verse which appeared in the collection *Délices de la poésie galante* of 1663, engaged in journalism (editing a sequel to Jean Loret's gazette in 1665) and wrote plays, some of them polemic. He replied to Boileau's first *Satires* with a *Satire des satires*, written in 1666 and published in 1669. This was later recast as a play, the public performance of which seems to have been prevented by Boileau. One of his plays, *Le Médecin volant* (1661), used Molière's material and another, *Le Portrait du peintre* (1663), attacked *L'École des femmes*, provoking Molière to reply in *L'Impromptu de Versailles*. Other plays performed included *Le Mort vivant* (1662), *Les Nicandres ou les menteurs qui ne mentent point* (1664) and *Les Amours de Germanicus* (1673), one of the last plays to be acted at the Marais theatre. Boursault died in Paris on Sept. 15, 1701.

See H. Carrington Lancaster, *A History of French Dramatic Literature in the Seventeenth Century, part III. The Period of Molière, 1652–1672*, 2 vol. (1936); A. Adam, *Histoire de la littérature française au XVII^{e} siècle*, vol. 3 (1952). (W. G. Me.)

BOURSE: *see* Stock Exchange.

BOURSSE, ESAIAS (1630–1673), Dutch painter, whose interiors with figures were painted with great precision and with exquisite quality of colour, was born in Amsterdam. He was a follower of Pieter de Hooch. His paintings are exceedingly rare; many of them pass under the names of Vermeer van Delft and Pieter de Hooch. Two of the paintings ascribed to the latter (one bears the false signature) at the Rijksmuseum in Amsterdam are now recognized as being the work of Boursse. The Wallace collection in London has his masterpiece, an interior with a woman and a child in a cradle, reflecting something of the feeling of Rembrandt, by whom he was influenced. Other important examples are at the Rijksmuseum and at Aix-la-Chapelle. "Boy Blowing Soap Bubbles" is in the Berlin museum.

BOUSSAC, MARCEL (1889–), French textile manufacturer, industrialist, race-horse breeder and owner, was born at

Châteauroux on April 17, 1889. The second son of Louis Boussac, draper and clothing manufacturer, he took over the family business at the age of 18. The great cotton industry that was to grow out of this relatively small beginning was built on two main factors: the organizing ability and business memory of its promoter and the principle of self-sufficiency in business (the Boussac organization, for example, became its own bankers and insurance brokers). While still at Châteauroux, his first master move was a merciless war on the "black look" in France; its result was the introduction for the first time of colour into the clothes of the ordinary French family. In 1910, with the equivalent of £20,000 patrimony, he set up business in Paris in the traditional textile quarter of the city; no. 21, Rue Poissonnière, was later to become the nerve centre of the immense business organization known as Les Établissements Boussac. To prove his theory of "democratic luxury" he created, between World Wars I and II, the Toile d'Avion chain of stores in Paris. In the world of *haute couture* he launched the House of Dior in 1947. Boussac also manufactured domestic electrical equipment and acquired the Paris daily paper *L'Aurore*. Horse breeding and racing, his hobby, brought him world-wide fame on the turf. (P. W. He.)

BOUSSINGAULT, JEAN BAPTISTE (1802–1887), French chemist and pioneer in agricultural research, was born in Paris and spent his early manhood in South America. On his return to France he held the chair of chemistry at Lyons, and then the chair of agricultural and analytical chemistry in Paris. His most important work, which was translated into other European languages, was *Agronomie, chimie agricole, et physiologie* (1860–74; 2nd. ed., 1884). His writings included papers on the quantity of nitrogen in different foods, the amount of gluten in different wheats, investigations on the question of whether plants can assimilate free nitrogen from the atmosphere (which he answered in the negative), the respiration of plants, the function of their leaves, the action and value of manures, and similar subjects.

BOUSTROPHEDON, a term descriptive of a peculiar form of writing common among the early Greeks. The direction of writing was alternately right to left and left to right in horizontal lines, or, conversely, left to right and right to left. It was a transition between the earlier right to left writing and the later left to right style. The term was derived from two Greek words meaning "ox," and "to turn," from the resemblance of the writing to the winding course taken by oxen in plowing. There is a variety, known as serpentine boustrophedon, in which the posture of the letters is inverted as well as the direction, with the result, in some letters, of canceling out the change of direction.

See J. Whatmough, *Prae-Italic Dialects*, pp. 222, 523 (1933). (J. Wh.)

BOUTENS, PIETER CORNELIS (1870–1943), one of the most outstanding of Dutch poets in a sublime and elevated style, a mystic and a classical scholar, was born at Middelburg on Feb. 20, 1870. He studied classical languages at Utrecht and established himself at The Hague as a private tutor and man of letters. His early poems were influenced by the aesthetic view of life and of "art for art's sake" held by the school of Dutch poets writing after 1885. Later, however, largely through his study of Plato, his own art developed in the direction of philosophical mysticism. In his collected volumes *Praeludiën* (1902), *Stemmen* (1907), *Carmina* (1912) and many others, he portrays in beautiful and symbolic language the eternal desire of the soul. His mastery of metrical forms and subtle intuition made him an ideal translator of Homer, Aeschylus, Sophocles, Plato, Goethe, Rossetti, Wilde and others. He also adapted the Persian poems by Omar Khayyam. Because of his participation in literary organizations Boutens was greatly esteemed and internationally known during his lifetime. He died at The Hague on March 14, 1943.

See D. A. M. Binnendijk, *Een protest tegen den tijd* (1945); H. J. C. Grierson, *Two Dutch Poets* (1936) which gives a short account of Boutens' work, and translations of some poems. (Gd. W. Hs.)

BOUTERWEK, FRIEDRICH (1766–1828), German philosopher and literary critic, was born at Oker, in Lower Saxony, on April 15, 1766. He studied law at Göttingen but became a disciple of Kant in 1790 and published *Aphorismen, den Freunden der Vernunftkritik nach kantischer Lehre vorgelegt* in 1793. Later, however, he abandoned the Kantian position, being dissatisfied with its formalism, and inclined to the views of F. H. Jacobi (*see* Jacobi's letters to him; Göttingen, 1868). Bouterwek became extraordinary professor of philosophy at Göttingen in 1797 and ordinary professor in 1802. He died at Göttingen on Aug. 9, 1828.

His chief works are *Ideen zu einer allgemeinen Apodiktik*, two volumes (1799); and *Geschichte der Poesie und Beredsamkeit seit dem Ende des 13. Jahrhunderts*, 12 volumes (1801–19), notable for its treatment of Spanish literature. Other works were *Aesthetik*, 2 parts (1806); *Lehrbuch der philosophischen Vorkenntnisse* (1810); *Lehrbuch der philosophischen Wissenschaften* (1813); novels, including *Graf Donamar*, three volumes (1791–93); and poetical compositions.

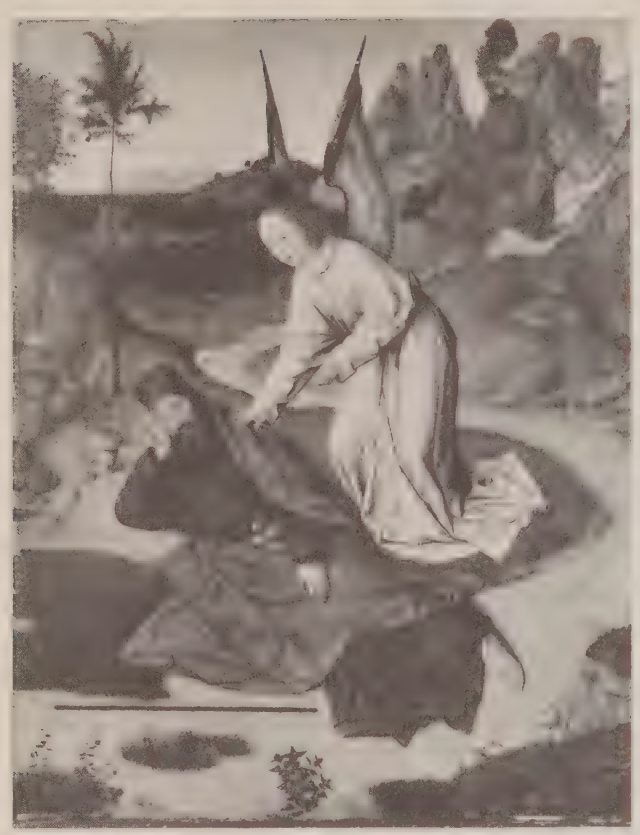
See G. Struck, *F. Bouterwek* (1919).

BOUTHILLIER (Le Bouthilier), a French family, originally from Angoumois, that rose to prominence in the 17th century with the four sons of the advocate Denis Bouthillier (d. 1622), who were childhood friends of Armand Jean du Plessis, the future cardinal de Richelieu. These sons were: Claude (*see* below); Denis, whose son Armand Jean, abbé de Rancé (*q.v.*), was the founder of Trappist monasticism; Sébastien, bishop of Aire from 1622 to 1625; and Victor, bishop of Tours from 1640 to 1670.

Claude Bouthillier (1581–1652) was one of Richelieu's principal adjutants. Secretary of state from 1628, he became superintendent of the finances jointly with Claude de Bullion in 1632 and sole superintendent in 1640. In this capacity he canceled a large class of exemptions from the *taille*, but he used his influence on several occasions to help individuals in disgrace or misfortune. He was especially valuable as a mediator between Richelieu and members of the royal family, as Richelieu could not always rely even on Louis XIII's support. Richelieu made him an executor of his will, and in Louis XIII's will he was nominated a member of the regency council. When this will was annulled, he resigned the superintendence (June 1643). He died in Paris on March 13, 1652.

Léon Bouthillier (1608–52), comte de Chavigny, was Claude's son. Designated secretary of state in 1632, he was in 1635 also made chancellor in the household of Gaston, duc d'Orléans, to watch over his conduct. Nominated, with his father, to the regency council in Louis XIII's will, he bitterly resented Jules Mazarin's monopoly of Anne of Austria's favour when she became sole regent and he was deprived of his secretaryship of state. Governor of the château of Vincennes, he was arrested there in Sept. 1648 as dangerous to the government, but the *parlement* of Paris took up his case as an example of arbitrary arrest and he was released in October. In the Fronde (*q.v.*) he was one of the prince de Condé's advisers against Mazarin, and in April 1651, during Condé's predominance, Anne made a show of taking Chavigny as prime minister. By July, however, he no longer dared to present himself at her council. As Condé's fortunes declined, Chavigny made secret overtures to Mazarin. Condé, hearing of these during the Fronde's last days in Paris, furiously reproached Chavigny, who, shocked and chagrined, fell ill and died (on Oct. 11, 1652). (J. G. R.-S.)

BOUTS, DIERICK (Dirk, Dieric, Thierry; last name sometimes given erroneously as Stuerbout) (*c.* 1400–1475), painter of the early Netherlandish school, was born at Haarlem where he was probably active for a number of years before going to Louvain in 1445(?). As some of the early works show the influence of Rogier van der Weyden, he may have worked at Brussels before settling in Louvain. From 1457 his name appears almost every year in the archives of Louvain up to his death in that city on May 6, 1475. Two authentic works of this master are known, both painted toward the end of his life. One was ordered by the Confraternity of the Holy Sacrament for the church of St. Peter at Louvain in 1464. The picture is a triptych whose wings are divided into two smaller panels, one above the other. The central panel represents the "Last Supper," and the artist seems to have introduced his own portrait and that of his sons in the background. On the wings are shown four scenes from the Old Testament foreshadowing the Holy Sacrament; *i.e.*, the "Feast of



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"ELIJAH IN THE DESERT" FROM THE WINGS OF THE TRIPTYCH OF THE "LAST SUPPER" BY DIERICK BOUTS, 1464–67. AT THE CHURCH OF ST. PETER, LOUVAIN, BELG.

the Passover," "Elijah in the Desert," the "Gathering of Manna," and "Abraham and Melchisedek." The other authentic work is a series of four huge panels, which the artist undertook for the town hall at Louvain. He only completed one of these and died before the completion of the second. These two pictures are now in the Brussels gallery. They represent an episode from the legend of the emperor Otto III.

These works reveal a master of harmonious colour schemes, a landscape painter who placed his figures in three-dimensional spaces, correctly constructed according to the rules of perspective. He observed nature closely and his drawing as a portraitist was precise and full of character. His rendering of human anatomy was primitive and his compositions were somewhat angular, lacking the grace which his contemporary Rogier van der Weyden gave to his pictures. Probably Bouts's earliest extant painting is the little altarpiece at Madrid representing the "Annunciation," the "Visitation," the "Nativity" and the "Epiphany." Then comes the large triptych in the cathedral at Granada representing the "Descent from the Cross," the "Crucifixion" and the "Resurrection," a copy of which is in the Colegio del Patriarca at Valencia. Other early works are: the "Entombment" (on canvas) in the National gallery, London, and the "Pietà" in the Louvre, Paris. The following works were probably painted after the move to Louvain: "Moses and the Burning Bush" in the Johnson collection at Philadelphia; the "Virgin Enthroned between St. Peter and St. Paul" in the National gallery; the triptych in Munich, known by the name of "The Pearl of Brabant," representing the "Adoration of the Magi," "John the Baptist" and "St. Christopher"; a pair of panels, probably the wings of a triptych of the "Last Judgment," both at Lille, representing respectively Paradise and Hell; and the triptych of the "Martyrdom of St. Erasmus" at St. Peter's, Louvain. Of several versions of the half-length figure of the "Madonna Holding the Child," the one in the National gallery is among the finest. Of portraits the most notable is in the National gallery, dated 1462, and believed by some to be a self-portrait. The Altman collection in the Metropolitan museum, New York, and the Friedsom collection in the same museum, also contain a portrait.

After his death his two sons, Albert and Dierick, carried on his tradition in Louvain.

Bibliography.—A. Wauters, *Notre première école de peinture, Thierri Bouts ou de Harlem et ses fils* (1863); E. Van Even, *L'Ancienne école de peinture de Louvain* (1870); A. Goffin, *Thiéry Bouts* (1907); M. J. Friedländer, *Die altniederländische Malerei*, vol. iii, *Dierick Bouts und Joos van Gent* (1925); L. Baldass, "Die Entwicklung des Dirk Bouts," *Jahrbuch Kunsthist. Samml.* (1932); W. Schöne, *Dieric Bouts und seine Schule* (1938). (J. Fe.)

BOUTS-RIMÉS, "rhymed line-endings," is the name given in European literatures to the making of a verse with a modicum of sense in it from given end-rhymes in a given order. *Bouts-rimés* are said to have been invented by the minor French writer Dulot in the 17th century. Alexander Dumas (*père*) invited French poets and versifiers to try their skill with given sets of rhymes and he published 150 of the results in 1865. Dante Gabriel Rossetti and William Rossetti improved their ingenuity and rhyming facility by filling in verses from *bouts-rimés*, and the former is said to have been able to produce a "sonnet" in from five to eight minutes. (J. W. T.)

BOUTWELL, GEORGE SEWALL (1818–1905), U.S. statesman, was born in Brookline, Mass., on Jan. 28, 1818. He was reared on a farm but at an early age entered upon a mercantile career at Groton, Mass. There he studied law but was not admitted to the bar until 1862. He served as a Democratic leader in the lower house of the state legislature in 1842–44 and again in 1847–50. With the help of "Free-Soil" votes he was elected governor of Massachusetts in 1851 and 1852. The passage of the Kansas-Nebraska act in 1854 finally alienated him completely from the Democratic party; thereupon he became one of the founders of the new Republican party in the state. He played an influential role in the Republican national convention of 1860, and two years later, after passage of the war tax measures, he was appointed the first commissioner of internal revenue by President Lincoln. He was a member of the national house of representatives from 1863 to 1869, and in 1867 acted as one of the radical Republican managers of President Johnson's impeachment trial. He served as secretary of the treasury in President Grant's cabinet in 1869–73 and as U.S. senator from Massachusetts in 1873–77. Under an appointment by President Hayes he prepared the second edition of the *United States Revised Statutes* (1878). As a vigorous opponent of the acquisition of the Philippine Islands by the United States, he became president of the Anti-Imperialistic league and a presidential elector on the Democratic ticket in 1900. He died at Groton, Mass., on Feb. 27, 1905. He published various volumes, including *The Constitution of the United States at the End of the First Century* (1895) and *Reminiscences of Sixty Years in Public Affairs* (1902). (N. A. G.)

BOUVARDIA, a genus of 30 species of handsome, evergreen, greenhouse shrubs, belonging to the family Rubiaceae, mostly natives of tropical America. The flowers are in terminal, many-flowered, flat clusters; the corollas are tubular, with a spreading four-lobed limb. The cultivated kinds are mostly of hybrid origin; the first was crossed at Parsons nursery, Brighton, Sussex, about 1857. Since then many different horticultural forms have originated, some of them fragrant and once very popular florist's flowers. In the United States *B. humboldtii*, a beautiful fragrant white-flowered shrub from Mexico, is widely grown for the florist trade, as is the red-flowered *B. ternifolia*. Usually forced for winter bloom, they need a warm greenhouse and rich soil. (N. Tr.)

BOUVIER, JOHN (1787–1851), U.S. jurist, was born in France in 1787. In 1802 his family emigrated to the United States, settling in Philadelphia. Bouvier became a citizen of the United States in 1812 and was admitted to the bar in 1818. He is best known for his able legal writings. His *Law Dictionary Adapted to the Constitution and Laws of the United States of America and of the Several States of the American Union* (1839, revised and brought up to date by Francis Rawle, under the title of *Bouvier's*

Law Dictionary, 1897), has always been a standard, later editions of which were issued in 1916, 1926 and 1934. He died in Philadelphia on Nov. 18, 1851.

BOUVINES, BATTLE OF, a decisive victory won at Bouvines, a village in Flanders south of Lille and west of Tournai, on July 27, 1214, by the French under King Philip II Augustus over the forces of the coalition formed against him. This coalition, grouped round the emperor Otto IV and King John of England (who was desirous of reconquering the French provinces that he had lost to Philip), comprised several French vassals displeased by Philip's policy, particularly Raynald (Renaud), count of Dammartin and of Boulogne, and Ferdinand, count of Flanders.

The plan of campaign had been minutely designed by the coalition. In the south, after landing at La Rochelle, John was to stir Aquitaine and Anjou to revolt and then to march against Paris. Meanwhile, from the north, the imperial army, reinforced with Flemish militia, a contingent of English mercenaries and the troops of Raynald and Ferdinand, likewise would march on Paris.

The first part of this plan collapsed when John was defeated at La Roche-aux-Moines early in July 1214. Thereafter Philip had greater freedom of action and resolved to take the offensive.

Otto, who had failed to synchronize his invasion of France with John's in the spring, was entrenched at Valenciennes. Philip, instead of moving straight at Otto through Douai, moved round to the northward of him through Lille and Tournai. But on reaching Tournai, Philip realized that Otto, aware of his movement, had made his troops march on to Mortagne at the junction of the Scarpe and the Scheldt, a fortified place, quite unassailable. Philip then moved again toward Lille. The imperial forces attacked the rear of the French when the vanguard had just crossed the Marcq at the bridge of Bouvines. Both armies then secured their positions on the highest part of the plateau. The left wing of the imperial army was composed of Ferdinand's Flemish troops, its centre of Germans under Otto's command, and its right wing of Raynald's knights and the English mercenaries under William Longsword, earl of Salisbury. On the French side, the king was in the centre, supported by his picked cavalry, with Guillaume de Barres; on his left his brother Robert commanded, on his right the military churchman Guérin, bishop of Senlis.

It was on the French right that the attack was launched, and the Flemish corps was completely disorganized after three hours. In the centre, however, the French *milices des communes,* weary of their march and of being drawn up in battle array, were encircled by the imperial infantry and knights. Philip himself was unhorsed, but was eventually extricated from serious danger. Guillaume de Barres, getting round the German cavalry, reached the emperor, who fled from the field. Lastly, on the left of the French, Raynald held out fiercely against the attack until he was captured. The French king's victory was then complete: Raynald and Ferdinand were his prisoners and the fugitive Otto was no longer able to resist the claims of his rival, Frederick II, to the empire. The battle marks the acme of the reign of Philip Augustus.

See C. Oman, *History of the Art of War in the Middle Ages,* vol. i (1924); F. Lot, *L'Art militaire et les armées au moyen âge en Europe et dans le Proche Orient,* vol. i (1946). (M. Pac.)

BOVET, DANIEL (1907–), naturalized Italian pharmacologist, was awarded the Nobel prize for physiology and medicine in 1957 for his production of a synthetic form of curare (the substance used by South American Indians to poison the tips of their arrows), which proved of great use in inducing muscular relaxation in surgical operations. Born in Neuchâtel, Switz., of French parents on March 23, 1907, Bovet studied in Geneva, and, from 1932, at the Pasteur institute in Paris where he became head of the laboratory for therapeutical chemistry in 1937. In 1947 he was appointed head of the pharmacological section of the Istituto Superiore di Sanita in Rome.

Bovet was responsible for a series of discoveries in chemical pharmacology which led to important advances in medical practice. By his work on sulfanilamide (1935–37), on aryloxyethylamine derivatives, and on anilino-ethyl-diethylamine he opened the way to the discovery of the important antihistamine drugs, of which mepyramine (1944) was his own outstanding achievement. In 1947 his investigations into synthetic substitutes for tubocurarine led to his discovery of gallamine triethiodide, and in 1949 he produced suxamethonium iodide, a useful short-acting drug. These discoveries had a revolutionary effect on anesthetic practice.

BOVIANUM, the name of two ancient Italian towns.

Bovianum Undecimanorum (modern Boiano, 11 mi. S.W. of Campobasso in the *regione* of Abruzzi e Molise) was the chief city of the Pentri Samnites, on the road from Beneventum to Corfinium. Remains survive both of the lower Roman town and of the upper Samnite city, where there are walls of the type of masonry known as Cyclopean. Both the Roman and the modern town lie on the plain. Bovianum was captured by Rome about 311 B.C. during the second Samnite War (328–304) and was temporarily the capital of the Italians in the Social War (90–89 B.C.), after which Sulla reduced it to a village. In the 1st century A.D. it became a colony for the veterans of the 11th legion (Undecima), whom Vespasian settled there; hence its name Undecimanorum.

Bovianum Vetus (near the modern Pietrabbondante, 5 mi. S. of Agnone and 19 mi. N.W. of Campobasso), the chief town of the Caraceni Samnites, was conquered by Rome in 298 B.C.

BOVIDAE, a family of the mammalian order Artiodactyla comprising cattle, sheep, goats, antelopes and other even-toed hoofed ruminants with hollow unbranched horns. Horns, always present in males and commonly in females, consist of a horny sheath covering a bony core that is a fixed part of the skull. Unlike the antlers of deer, the horns of Bovidae are never shed. Bovids are essentially grazing animals, but many are browsers as well. The family originated between 20,000,000 and 25,000,000 years ago in Europe or northern Asia and spread over most of the northern hemisphere during the Pleistocene. Africa now is headquarters of the family. Asia is also well-stocked with Bovidae. Few forms survived in Europe and a few, the bison, musk ox, mountain sheep and mountain goat, moved into North America.

See Artiodactyl and also the separate articles on the various members of the Bovidae. *See* also references under "Bovidae" in the Index.

BOVILLAE (near the modern Frattocchie, 12 mi. S.E. of Rome in the Italian *regione* of Lazio) was an ancient town of Latium and a station on the Via Appia. It was a colony of Alba Longa and one of the 30 cities of the Latin league. After the destruction of Alba Longa about 600 B.C., the religious cults associated with the Latin league were transferred, according to tradition, to Bovillae, including the cult of Vesta and that of the *gens Julia* or family of Julius. In inscriptions found at Bovillae, moreover, "Alban Vestal virgins" are mentioned, and in imperial inscriptions the inhabitants of Bovillae are called *Albani Longani Bovillenses.* The cult of the *gens Julia* made Bovillae important when the family rose to power under Julius Caesar. In A.D. 16 the shrine of the family worship was dedicated anew and yearly games in the circus were instituted. Bovillae was the scene of the murder of P. Clodius Pulcher by Milo in 52 B.C.; Clodius had a villa above the town, to the left of the Via Appia. Remains of buildings of the imperial period—the circus, a small theatre and edifices probably connected with the post-station—still may be seen southwest of the Via Appia.

BOW AND ARROW. The bow is one of the oldest of all projectile weapons and exists in great variety, some nations, especially in Asia, having evolved special forms with great skill and ingenuity. Bows could be made of one material, generally a stave of wood (self bow), or of more than one piece of the same material joined together (built bow), or of several materials, such as wood, horn and sinew glued together (composite bow).

Self bows are thicker in the middle (called the handle) where held by the bowman's hand and taper toward the tips, which are notched to hold the string looped over them. The arrow is fitted to the string by its head which has a "nock" (notch) and is then drawn back, bending the bow until a maximum tension is produced, whereupon it is released. Arrow heads of great antiquity have been found in many countries where specimens of bows have not survived: many possible arrow heads of knapped flint, roughly shaped, have been found dating from Paleolithic times, and others, finely finished, from Neolithic times.

The bow is mentioned several times by Homer, and in the Old Testament Ahab met his death when a man "drew his bow at a venture, and struck the king of Israel between the joints of his harness." Ramses II, pharaoh of Egypt, and Ashurbanipal, king of Assyria, are represented on stone carvings as shooting their bows from chariots. The Romans were not great archers.

In Europe the bow usually took the form of the self bow and was at first short, being drawn to the chest only. Very few English bows have survived but a few were recovered from the wreck of the "Mary Rose" sunk in 1545. A bow dug up on the site of Berkhamsted castle, Hertfordshire, and now in the British museum, London, almost certainly dates from the dauphin of France's siege of 1216.

It is to Wales that the origin of the English longbow is usually accredited. The longbow was as tall as a man and the arrow about half that length, the famous cloth-yard shaft. The bow was held with outstretched arm and the arrow drawn back to the bowman's ear. An English archer could shoot six aimed shots a minute and his effective range was about 200 yd., though an arrow could go twice as far in the right hands. Yew trees were planted with official encouragement and the making and sale of bows was strictly supervised. The best bows were made of yew, but they were also made of witch hazel, hickory, ash and elm. The arrows were feathered (fledged) as a rule with goose feathers, though peacock feathers were sometimes used for gayness. In England the bow was superseded by firearms during the 16th century.

In Europe the crossbow (*q.v.*) was preferred to the longbow; its use did not require the same physique or training and its range was greater. The crossbow consisted of a short bow mounted horizontally on a stock or tiller, leveled to the shoulder when aiming. It was more powerful than the longbow, but slower to load. In its simplest form the crossbow had a bow of wood and was drawn (spanned) by muscular tension, the bowman placing his foot in a stirrup fixed to the middle of the bow and drawing the string upward by hand. The crossbow with composite bow was much stronger and more effective. Made of layers of horn and wood glued together and covered with parchment, it was bent mechanically by a goat's foot lever or by a rack and is traditionally the bow used by William Tell. Crossbows are often richly decorated and were much used for shooting game. The windlass crossbow was the largest and most complicated and was more often used in siege warfare than in the field. It is still used for target shooting.

The prod or stonebow, a light crossbow which shot small bullets from a pocket in the centre of the string, was used solely for hunting and was still being made in Lancashire as late as the middle of the 19th century. A less important variety was the slurbow, where the shaft is guided within a barrel set along the tiller with slits along the sides for the string. The Saracens of Spain devised a very small crossbow of steel which could be concealed in the user's sleeve and was sometimes spanned by means of a screw in the base of the stock. In contrast certain countries developed very large bows; the archer lay on his back holding the bow horizontally and placing both feet in the middle.

Composite bows were used throughout Asia, the basic materials being horn and sinew, as the right kind of wood was not available in sufficient quantity. The Turks made some of the best bows ever fashioned: short and with the curve of the bow reversed, they shot light arrows very great distances and some specimens are signed and dated. The Japanese built bows are also of a high class, some of them being very long, even to the height of 8 ft., but they also made small bows of horn or whalebone. The Japanese examples of good quality are sometimes signed by the maker. The accessories to the bow, such as the bow case and quiver, are often elaborately decorated.

The natives of the Andaman Islands in the Bay of Bengal produced very large and broad bows. The bow in Africa was generally small, partly because it was not used as a rule in open country. The Eskimos used composite bows of wood and bone backed by sinew, very similar to the Asian bow. Bows were also used by natives of Melanesia and Polynesia, but normally not by Australian aborigines. The North American Indians used bows before they were introduced to firearms, their bows being either self bows or of wood backed by sinew.

The bowstring varies in material and in the way in which it is fastened to the bow. The English longbow usually had one of linen or hemp. Eastern bows were often strung with silk, spun or unspun, or mohair. Dwellers in warm, well-forested parts use a strip of rattan or bamboo, or a worked string of some vegetable fibre, but animal sinew or a strip of hide is widespread, especially with the Asiatic bow. Rattan or bamboo strings, being intractable, are often attached indirectly to the stave by a separate flexible loop, but with other bowstrings direct attachment is more common, the string being threaded through a hole in the bow, secured by a firm lashing, or looped over the ends and stopped from slipping by a shoulder, notch or other projection.

Arrows were governed by the bows from which they were shot: the English longbow had a wooden arrow; in Melanesia and elsewhere the pointed heads of the cane arrows were dipped in poison; the crossbow bolt or quarrel was much shorter than that of the longbow and was flighted with strips of leather or light wood rather than feathers. An arrow may be made all in one piece, a wooden stick with one end pointed and hardened in the fire, or it may be composed of two pieces, a shaft of reed, cane or light wood with a heavier sharpened foreshaft. More commonly a separate head of stone, bone, shell, metal, etc., is fixed to the shaft or foreshaft. The head may be tanged or socketed and fixed by lashings or cementing or both; the head can be made loose so that it stays in the wound when the shaft is extracted. Feathers or bits of leaf, leather or fur are added to light arrows to steady the flight, but arrows with heavy foreshafts are occasionally unfeathered. The steel points of arrows show a great variety of design, some being broad and flat with large barbs and others being crescent-shaped for the decapitation of birds. The head of the crossbow quarrel is usually small, solidly made and of polygonal section.

The arrow may be loosed in various ways. The easiest release is by holding the butt end of the arrow between the index finger and thumb and pulling the bowstring back with it. In the secondary release the arrow is still held by the index finger and thumb, but the other fingers help in pulling the string. In the so-called Mediterranean release the thumb takes no part; the nocked arrow is fitted to the string, which is drawn by the fingers. This is the loose of modern archers, as well as some of the most primitive peoples, the Vedda and the Eskimo, and it occurs in a modified form in the Andaman Islands. The Mongolian release is the opposite. Here the fingers are idle (save for steadying the arrow) and the thumb alone, protected by a ring or glove, does the work. This is universal in Asia and parts of Africa, and some of the oriental drawing-rings of ivory, jade and precious stones are of great beauty.

See ARCHERY. *See* also references under "Bow and Arrow" in the Index.

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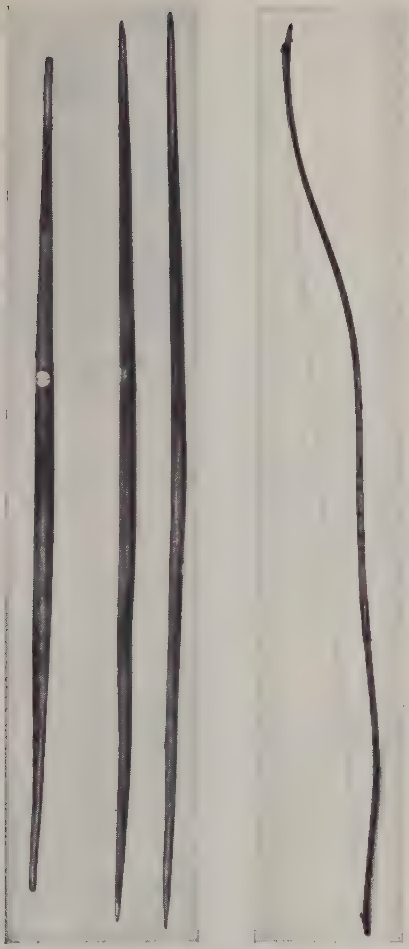
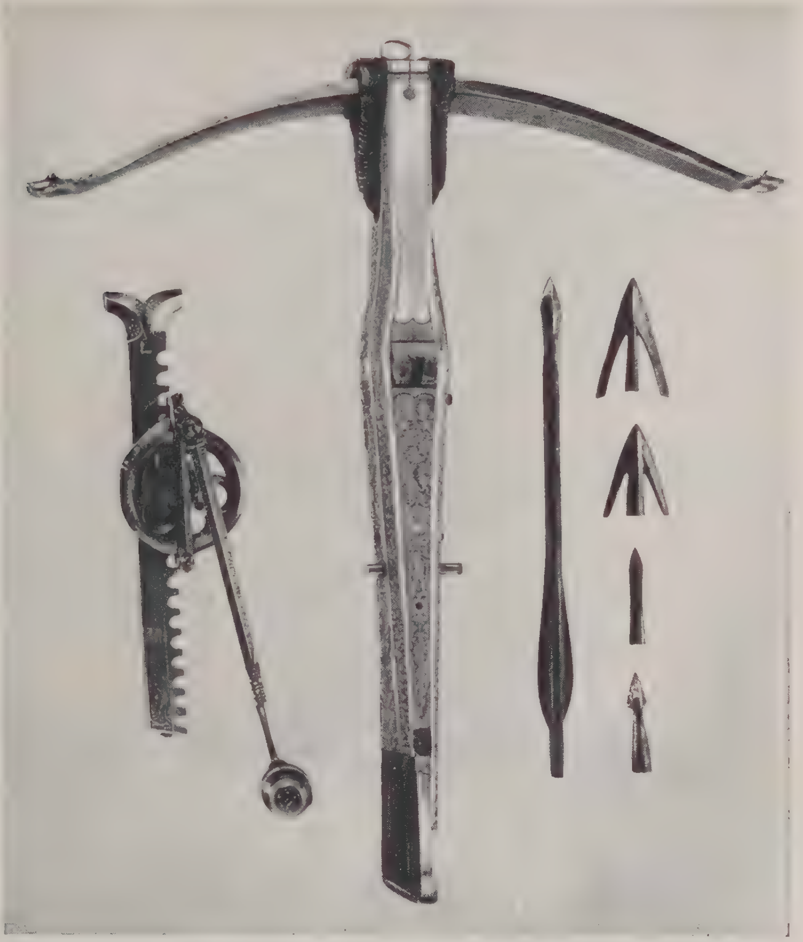
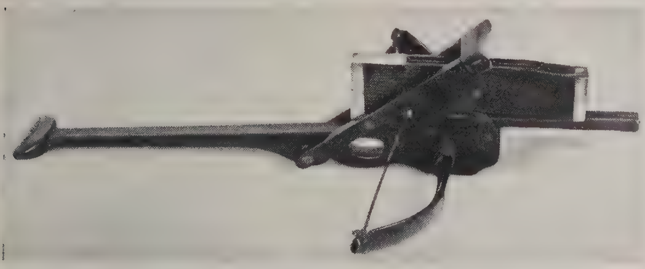
BOWDICH, THOMAS EDWARD (1791–1824), English traveler and author who prepared the way for the opening-up and annexation of the Gold Coast in Africa, was born at Bristol on June 20, 1791. In 1814 he became a writer for the African Company of Merchants, stationed in the Gold Coast at Cape Coast. In 1817 he went to Kumasi as the scientific member of a mission to Ashanti where he conducted negotiations so successfully that the way was prepared for the commercial opening-up of the interior. His *Mission from Cape Coast Castle to Ashantee* (1819, reissued in 1873), the earliest account of Ashanti by a European,



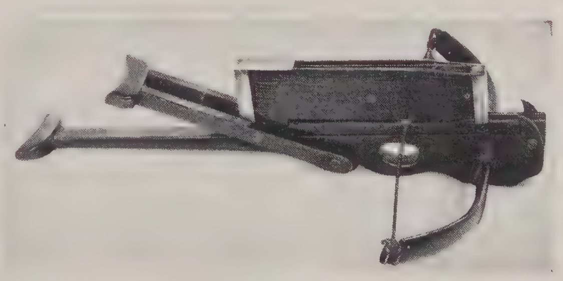
Left to right, English yew bow stave; two English bow staves recovered from the wreck of the "Mary Rose," sunk in 1545; Japanese bow, strung



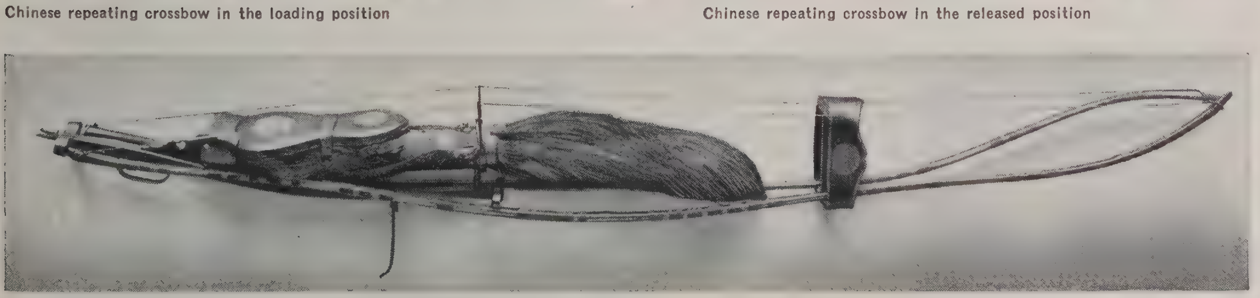
Sporting crossbow decorated with the arms of the Duke of Bavaria; German, 16th century; *left,* rack for winding crossbow; *centre right,* crossbow quarrel, or bolt, fledged with leather; *top right,* two arrowheads; *bottom right,* two heads of quarrels



Chinese repeating crossbow in the loading position



Chinese repeating crossbow in the released position

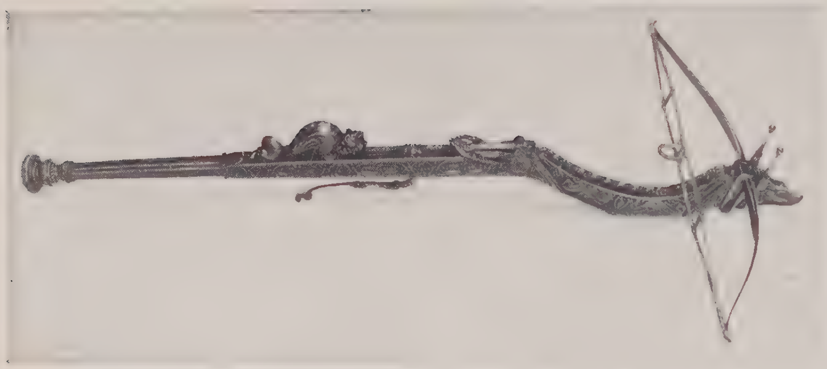


Utsubo, or enclosed quiver, of wickerwork covered with hair, with carrying rack and a pair of bows; Japanese, 18th century, Victoria and Albert museum

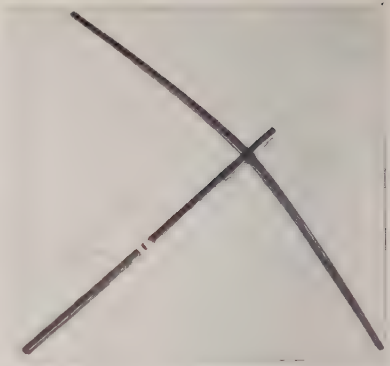
BOWS AND ARROWS FROM ENGLAND, GERMANY AND ASIA

BY COURTESY OF (ALL EXCEPT BOTTOM) MINISTRY OF WORKS (TOWER OF LONDON, ARMOURIES), CROWN COPYRIGHT RESERVED, (BOTTOM) VICTORIA AND ALBERT MUSEUM

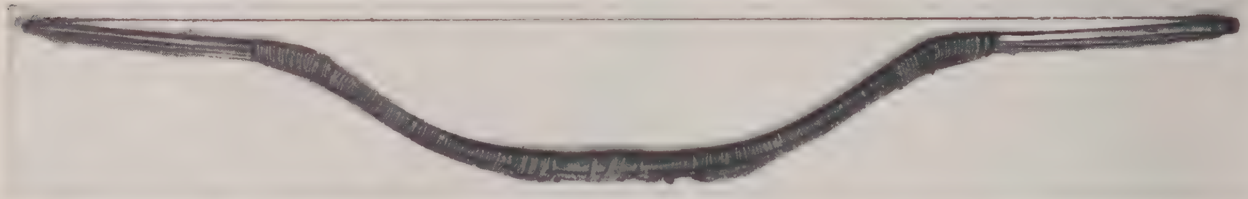
BOW AND ARROW



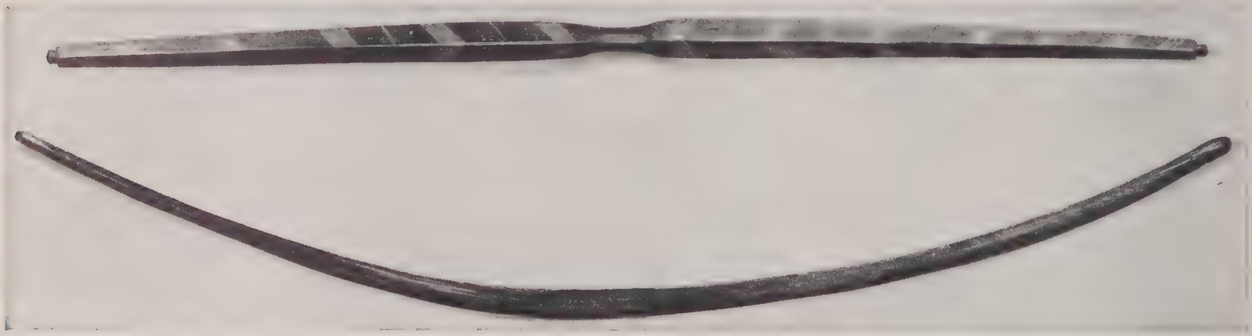
Prod or stonebow, a light crossbow which shot small bullets, with carved stock of yew; belonging to Wratislas von Bernstein, German, *c.* 1580. In the Wallace collection



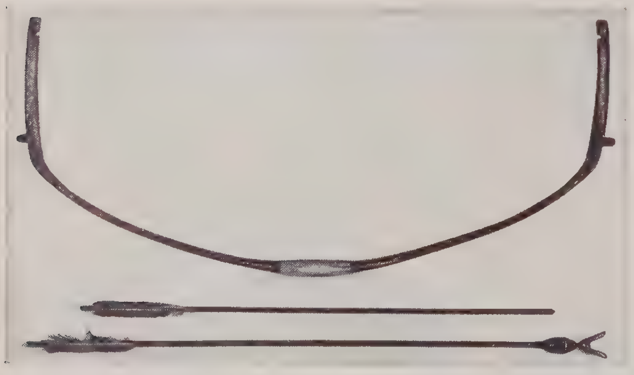
West African wooden crossbow



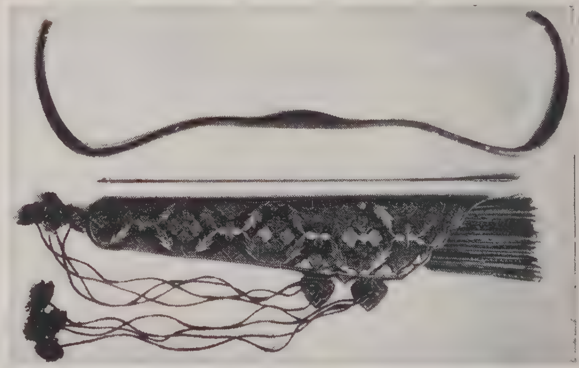
Eskimo composite bow with wood bow reinforced with plaited sinew



Top, American Indian self bow, northwest coast of the U.S.; *bottom,* primitive wood self bow, central India



Chinese composite bow with (centre) target arrow and (bottom) forked whistling arrow



Indian composite bow with arrows and embroidered quiver

BOWS AND ARROWS OF THE WORLD

BY COURTESY OF (ALL EXCEPT TOP LEFT) MINISTRY OF WORKS (TOWER OF LONDON, ARMOURIES), CROWN COPYRIGHT RESERVED; PHOTOGRAPH, (TOP LEFT) REPRODUCED BY PERMISSION OF THE TRUSTEES OF THE WALLACE COLLECTION

gave fascinating details of the kingdom of Ashanti at the height of its splendour. He gave his collections of African works of art, insects and reptiles to the British museum. On his return Bowdich publicly attacked the management of the Africa committee and was in considerable measure responsible for the British government's decision to abolish the company and take over the administration of the Gold Coast in 1821. Between 1820 and 1822 Bowdich lived and studied in Paris, where he mixed freely with Georges Cuvier, Alexander von Humboldt and other scholars. He left Paris to undertake a trigonometrical survey of the Gambia, but soon after his arrival he was taken ill, and died of fever at Bathurst on Jan. 10, 1824.

Bowdich published several papers, including an *Essay on the Geography of North-Western Africa* (1821) and an *Essay on the Superstitions, Customs, and Arts Common to the Ancient Egyptians, Assyrians, and Ashanties* (1821). (R. W. Sl.)

BOWDITCH, NATHANIEL (1773–1838), American mathematician and astronomer whose works on navigation are among the most useful ever written, was born at Salem, Mass., on March 26, 1773. He made four long voyages (1795–99) and, being an excellent navigator, commanded a vessel (1802), instructing his crews in lunar and other observations. He edited J. H. Moore's *The Practical Navigator* and in 1802 published the *New American Practical Navigator*, based on Moore's work, which was adopted by the U.S. navy department and went through numerous editions. Bowditch also undertook a translation of P. S. Laplace's *Mécanique céleste.* He later refused professorships at several universities and died at Boston on March 16, 1838.

BOWDLER, THOMAS (1754–1825), English "purifier" of Shakespeare for family reading, was born at Ashley, near Bath, on July 11, 1754. After years spent in medicine, travel, philanthropic work and some study of the education of children, in 1818 he produced *The Family Shakespeare.* The Shakespeare, which went through four editions before 1824, omitted "those words and expressions . . . which cannot with propriety be read aloud in a family" because of their indecency or impiety. Attacked by the *British Critic* (1822), Bowdler argued that words exciting "an impression of obscenity" were not to be spoken, written or printed; and if printed they "ought to be erased." An expurgation of Gibbon's *History* (1825), earlier selections from the Old Testament (1822) and his promotion of the Proclamation society against impiety and vice show the same bias. The word "bowdlerize" was first used in print in 1836 and has become a term of abuse. It is questionable, however, whether Bowdler did as much harm as the "adaptors" of Shakespeare (then still staged) or even the generally accepted Lamb's *Tales.* He died at Rhyddings, south Wales, Feb. 24, 1825. His dates are worth stressing, for he is often thought to be typically Victorian. (G. A. O.)

BOWDOIN, JAMES (1726–1790), political leader of Massachusetts during the era of the American Revolution. He was born in Boston of French Huguenot descent on Aug. 7, 1726, and graduated from Harvard in 1745. A merchant by profession, he also had a distinguished career as a public official. He was a member of the Massachusetts general court (1753–56) and of the council (1757–74, 1776–77). He was delegate to the first continental congress in 1774, president of the constitutional convention of Massachusetts, 1779–80, member of the state convention to ratify the federal convention, 1788, and governor of Massachusetts, 1785–87. During the revolutionary crisis, he boldly spoke out for American independence and worked closely with such popular leaders as Samuel Adams (*q.v.*) and James Otis (*q.v.*). He published important papers stressing the economic advantages to be enjoyed by a free America. In the critical post-Revolutionary period, he was a stabilizing force in Massachusetts political life. As governor, he took prompt action to suppress Shays' rebellion.

A man of wide cultural interests, Bowdoin was a prominent scientist whose specialties were physics and astronomy. He wrote numerous scientific articles (including one on electricity in collaboration with Benjamin Franklin) and corresponded with many notable American and English scientists. He was a founder of the American Academy of Arts and Sciences (1780) and served as its first president. He was a member of several other learned societies, including the famous Royal Society of London, and the recipient of honorary degrees from Harvard and the University of Edinburgh. He died in Boston on Nov. 6, 1790. Bowdoin college in Maine was named in his honour. (L. L. Tu.)

BOWEN, CHARLES SYNGE CHRISTOPHER BOWEN, 1st Baron (1835–1894), a great English appeal judge, was born on Jan. 1, 1835, at Woolaston, Gloucestershire, the son of a clergyman. From Rugby he went to Oxford and became a fellow of Balliol in 1857. He was called to the bar at Lincoln's Inn in 1861. Soon after he had begun to make his mark he was briefed against the claimant in the famous "Tichborne case," both in the civil and criminal trials. Bowen's services to his leader, Sir John (afterward Lord) Coleridge, in the former helped to procure for him the appointment of junior counsel to the treasury when Sir John was attorney general. In 1879 his acceptance of a judgeship in the queen's bench division gave him leisure. His subtle intellect and gentle irony were wasted upon common juries; but when, in 1882, he was raised to the court of appeal he was more at home. In Aug. 1893, Bowen was made a lord of appeal. But his health had broken down; he never sat to hear appeals, and he gave but one vote as a peer; his last public service was to preside over the commission which sat in Oct. 1893 to inquire into the Featherstone riots. He died on April 10, 1894.

Lord Bowen's judicial reputation rests upon the decisions delivered by him in the court of appeal, which are remarkable for their lucid interpretation of legal principles as applied to the facts and business of life and the advice given to the house of lords. He made translations of Virgil's *Eclogues*, and of the *Aeneid*, books i–vi, and his pamphlet, *The Alabama Claim and Arbitration Considered from a Legal Point of View,* showed that even in a legal discourse he was still a lover of style.

See Sir Henry Stewart Cunningham, *Lord Bowen* (1897).

BOWEN, NORMAN LEVI (1887–1956), U.S. geologist, was one of the great pioneers in experimental petrology, particularly in the field of phase equilibrium studies on silicate systems. Born in Kingston, Ontario, on June 21, 1887, he was educated at Queen's university, Kingston, and the Massachusetts Institute of Technology, Cambridge. He joined the Geophysical laboratory of the Carnegie institution of Washington, D.C., in 1912, serving in a research capacity until he retired in 1952, except for his occupancy of the chair of mineralogy at Queen's university, 1919–20, and of the chair of petrology at The University of Chicago, 1937–47. His memoir *The Evolution of the Igneous Rocks* (1928), with its emphasis on a physicochemical approach to problems of petrogenesis, came to exert a profound influence on petrologic thought in the ensuing decades. He initiated on his return to Washington in 1947 a program of study on silicate systems with volatiles, particularly water. These researches contributed greatly to the understanding of the origin of granite and to problems of metamorphism, to which subject his earlier work at Chicago on the progressive metamorphism of siliceous limestones and dolomites had made a great advance. He died in Washington on Sept. 11, 1956. (C. E. T.)

BOWER, FREDERICK ORPEN (1855–1948), English botanist, known for his research and publications on the Pteridophyta, particularly the ferns, was born at Ripon, Yorkshire, on Nov. 4, 1855. He was educated at Repton and at Trinity college, Cambridge, and later at the universities of Würzburg and Strasbourg. In 1882 he became lecturer in botany at the Royal (now Imperial) College of Science, London, where he was associated with Thomas Huxley. In 1885 Bower was appointed regius professor of botany at the University of Glasgow, a post he held until his retirement in 1925. Bower was one of the principal exponents of the "antithetic" or "interpolation theory" of alternation in the life cycles of Pteridophyta. His principal works include *The Origin of a Land Flora* (1908); *The Ferns,* 3 vol. (1923–28); *Size and Form in Plants* (1930); and *Primitive Land Plants* (1935). His many distinctions included the Linnaean medal (1909) and the Royal medal and Darwin medal of the Royal society (of which he was a fellow). Bower was president of the Royal Society of Edinburgh (1919–24) and of the British association (1930). He died on April 11, 1948. (J. Wn.)

BOWER, WALTER (1385–1449), Scottish chronicler and abbot of Inchcolm, in the Firth of Forth, author of the *Scotichronicon,* the first connected attempt at a history of Scotland, which expanded and continued the work of John of Fordun (*q.v.*), was born at Haddington. Bower probably entered religion at St. Andrews, and may earlier have taken degrees in theology at Paris. He was provided to his abbacy in 1417 and thereafter is frequently named in papal and royal records, as an unsuccessful claimant of the abbacy of Holyrood (1420), as an opponent of peace with England (1432) and as present in parliament and acting as its auditor. His care for the records of his abbey is responsible for their partial preservation. The *Scotichronicon* was undertaken at the instigation of his patron, Sir David Stewart of Rosyth, in 1441, and finished in 1447, the last date mentioned in it. Even when he leaves fabulous history, Bower is not entirely reliable, but without his 16 books (of which five and part of the sixth at least are the work of Fordun, with Bower's alterations and interpolations) the history of Scotland in the 13th and 14th centuries would lack many familiar landmarks. He is known to have used Andrew Wyntoun (*q.v.*), as well as Fordun. First printed by T. Hearne (1722), and then by W. Goodall (1759), from late 15th-century manuscripts, it exists in a number of copies. The manuscript at Corpus Christi college, Cambridge, appears to be the author's manuscript. The work must still be used in the edition by Walter Goodall misleadingly titled *Johannis de Fordun Scotichronicon cum Supplementis et continuatione Walteri Boweri* (1759). (A. A. M. D.)

BOWERBANK, JAMES SCOTT (1797–1877), English naturalist and paleontologist, whose studies on the history of sponges are especially noteworthy, was born in Bishopsgate, London. Until 1847 he was an active partner in the family business (a distillery) but kept his interest in natural science. About 1836 he and six others founded "The London Clay club." His *A History of the Fossil Fruits and Seeds of the London Clay* appeared in 1840. Bowerbank was the originator of the Palaeontographical society. His great work, *Monograph of the British Spongiadae* (1864–82), was nearly complete at his death, March 8, 1877.

BOWERBIRD, the name applied to birds of the family Ptilonorhynchidae, containing about 17 species like stout thrushes, 8 to 14 in. long. Although the females are usually dull, the males often sport brilliant plumage approaching that of their close relatives, the birds of paradise (*q.v.*), though without decorative plumes. Ten species occur in New Guinea, others in eastern Australia. In jungle or brush they construct courtship bowers or "runs" of sticks, decorating floor or entrance with small bones, shells and brightly coloured berries, flowers or feathers. Both sexes use bowers as a playground, and males fight, display or "dance" for the females.

The satin bowerbird (*Ptilonorhynchus violaceus*), abundant in the wooded mountains of southeastern Queensland, eastern New South Wales and Victoria, builds a walled corridor usually facing north and south though often hidden in the jungle. The "blue" males—lustrous bluish or purplish black—prefer lavish decorations of blue bits of glass or blue flowers, the greenish females and young males prefer green to decorate the bower entrance. Two blotched eggs are laid in a bulky nest 6 to 40 ft. up in bush or tree that may be some distance away from the bower.

The regent bowerbird (*Sericulus chrysocephalus*) is the most brilliantly plumaged bird in Australia, gorgeous in black and orange-yellow. Common in the McPherson ranges, Queensland, it rarely constructs a bower. Some species build no bower at all; one surfaces a bare spot with leaves to form a "circus ring." The gardener bowerbird (*Amblyornis inornatus*) of New Guinea builds a roofed bower, three feet wide, of orchid stems near the foot of a small tree, and covers the floor and entrance with moss, ornamented with fresh flowers and berries, which are replaced by fresh ones as they fade. *See* also COURTSHIP OF ANIMALS; BIRD. (G. F. Ss.)

BOWFIN, a fresh-water fish (*Amia calva*) of North America, also known as grindle, mudfish or dogfish; it is the only living representative of its family, the Amiidae, which dates back to the Cretaceous period (beginning about 130,000,000 years ago). The bowfin is a voracious fish found in sluggish waters from the Great Lakes southward to the Gulf of Mexico. Because it may eat large numbers of game fish it is sometimes considered a pest.

The elongate bowfin is mottled green coloured and has a long dorsal fin and strong conical teeth. The female reaches a length of 30 inches; the male is smaller and is distinguished by a black spot circled with orange on the tail. (C. HU.)

BOWIE, JAMES (1796–1836), hero of the Texas revolution, was born in Logan county, Ky., in 1796. The family moved to Missouri in 1800 and to Rapides parish, La., in 1802. At the age of 18, James left home, cleared land and sawed the timber into lumber for current income. He later sold the land and engaged in the slave trade with two of his brothers, John and Rezin. James and Rezin later bought and improved a sugar plantation, Arcadia, on Bayou La Fourche and introduced steam power for grinding cane. Rezin was elected to the Louisiana legislature and James spent much time in New Orleans society where he learned French and Spanish and had his portrait painted. About 1826 the two brothers speculated in Spanish land grants in Arkansas. James is said to have killed a man in a duel and then to have gone to Texas in 1828. He is also reputed to have been the inventor of the Bowie hunting knife. At Bexar (San Antonio), Bowie became friendly with the vice-governor, Don Juan Martin de Veramendi. He obtained citizenship papers and about 15 eleven-league grants of land, and married the Veramendis' daughter, Ursula, in 1831. The restrictive law of April 6, 1830, helped interest Bowie in the early Texas revolutionary movement. He took part in several battles and then with volunteers joined Col. William B. Travis in the Alamo (*q.v.*), disputing leadership with him. But he fell ill and was found dead on his cot after the Alamo fell (March 6, 1836). (T. P. MA.)

BOWKER, RICHARD ROGERS (1848–1933), U.S. editor and publisher, is known for his development of professional library standards. Born in Salem, Mass., on Sept. 4, 1848, he graduated from the College of the City of New York, became literary editor of the *New York Evening Mail* and later of the *New York Tribune* and founded the R. R. Bowker company, which specializes in the publication of bibliographical materials. He was instrumental with Frederick Leypoldt and Melvil Dewey in organizing the American Library association in 1876 and in founding the *Library Journal,* which he edited for more than 50 years; he also edited or published the *Annual Library Index,* the *American Catalog* and *Publishers' Weekly.* A champion of authors' rights, he was an authority on copyright and wrote two books on copyright history, literature and law. He organized the earliest list of state documents and other important bibliographies and wrote books on business, politics, education, religion and economics.

A proponent of civil service reform, Bowker drafted the first national civil service reform plank. He also helped to form the Independent Republican, or "Mugwump," movement in 1879. He died Nov. 12, 1933, in Stockbridge, Mass.

See Edward McClung Fleming, *R. R. Bowker, Militant Liberal* (1952), which contains a bibliography.

BOWLES, SAMUEL (1826–1878), U.S. journalist, who made the *Springfield* (Mass.) *Republican* a leading national newspaper, was born in Springfield, Mass., on Feb. 9, 1826, and died there on Jan. 16, 1878. With the exception of a brief period in Boston, he devoted his life to the *Republican,* established as a weekly by his father, also Samuel Bowles (1797–1851), in 1824 and published as a morning daily after 1845. He is credited with being one of the leaders in the new journalism, giving his paper a national reputation by the vigour, incisiveness and independence of its editorial utterances and the concise and convenient arrangement of its local and general news matter. Then and later the *Republican* office was a sort of school for young journalists, especially in the matter of pungency and conciseness of style, one of Bowles' maxims being "Put it all in the first paragraph." During the controversies resulting in the Civil War he was a general supporter of the Whig and Republican parties, but he was later independent in politics. On travels for his health, he wrote letters to the paper describing the west, which were collected in *Across the Continent* (1865) and other books. Bowles's son, another Samuel Bowles (1851–1915), became a third editor of the paper.

See George S. Merriam, *Life and Times of Samuel Bowles,* 2 vol.

(1885), virtually a history of American political movements after the compromise of 1850; Gamaliel Bradford, "Samuel Bowles," in E. H. Ford and E. Emery (eds.), *Highlights in the History of the American Press*, pp. 178–194 (1954).

BOWLES, WILLIAM LISLE (1762–1850), English poet and critic chiefly remembered for his influence on the young Coleridge, was born at King's Sutton, Northamptonshire, on Sept. 25, 1762. He was educated at Winchester and at Trinity college, Oxford, and took orders in 1792. He subsequently held livings in Wiltshire. He died at Salisbury on April 7, 1850.

In 1789 Bowles published *Fourteen Sonnets* and *Verses to John Howard*, both received enthusiastically by Coleridge and his circle. The sonnets express the fluctuations of the poet's sensibility at the sight of "Dover Cliffs" or the sound of "The Bells, Ostend." Their somewhat tremulous emotional sensitivity recalls Cowper, but they lack Cowper's tough practicality and preoccupation with morality and personal salvation. Bowles loves to capture "the light that never was on sea or land,"

> Presenting fairy vales, where the tired mind
> Might rest beyond the manners of mankind

and it is this that links him with the Romantic poets. In *Biographia Literaria* Coleridge says that his own ideas on poetry were fixed by arguing in favour of Bowles who, with Cowper, he characterizes as "the first who combined natural thoughts with natural diction; the first who reconciled the heart with the head." Bowles's principal longer poems are *The Spirit of Discovery* (1804), *The Missionary of the Andes* (1815), *The Grave of the Last Saxon* (1822) and *St. John in Patmos* (1833).

In 1806 he published an edition of Pope's works with notes and essays which, under a mask of judicial impartiality, attacked the poet's moral character and poetic principles. Bowles's opinions were attacked by Byron in *English Bards and Scotch Reviewers*, 11, 327–384, and in 1819, a defense of Pope's poetical character by Thomas Campbell sparked off a war of pamphlets sustained largely by Byron, which continued until 1826 and was known as the "Pope and Bowles controversy." Bowles had asserted that natural objects and basic passions were intrinsically more poetic than the products of art and manners: a forest was more poetic than a garden, religious awe than love of society. His opponents cited products of art which were undoubtedly poetic—the most telling example was a man-of-war taking the water—and the controversy developed along these arbitrary lines, producing considerable heat but little criticism of permanent value. Bowles's *Poetical Works* were edited by G. Gilfillan (1855).

See J. J. van Rennes, *Bowles, Byron and the Pope-Controversy* (1927). (Jn. C.)

BOWLEY, SIR ARTHUR LYON (1869–1957), British statistician, outstanding for the application of sampling techniques in social inquiries, was the last survivor of the original group of teachers at the London School of Economics and Political Science. He was born at Bristol on Nov. 6, 1869, and was educated at Christ's hospital and at Trinity college, Cambridge, where he gained the Cobden prize with his pioneer work, *A Short Account of England's Foreign Trade in the Nineteenth Century* (1893). From 1895 to 1919 he combined part-time teaching in statistics at the London School of Economics with posts in mathematics and economics at University college, Reading. From 1919 until his retirement in 1936 he was the first holder of the chair in statistics in the University of London. Later he was director of the Oxford University Institute of Statistics (1940–44). His work ranged over a wide field of theoretical, economic and social statistics and his writings were very numerous. Bowley was prominent in the affairs of the Royal Statistical society from 1895, of the International Statistical institute from 1903 and of the London and Cambridge Economic service from 1923. He was elected a fellow of the British academy in 1922 and was knighted in 1950. He died at Haslemere, Surrey, on Jan. 21, 1957. (R. G. D. A.)

BOWLING is a game in which a ball is rolled down a long, narrow lane toward a group of wooden pins, the object being to knock down more pins than an opponent. The game is quite different from the sports of bowls, or lawn bowls, in which the aim is to roll the bowls near a stationary ball called a jack; but there are many points of similarity and their history is complicated by the fact that the name "bowls" has been used for several games (*see* BOWLS).

HISTORY

The history of bowling may be traced back 7,000 years. Sir Flinders Petrie, British Egyptologist, reported finding in the grave of an Egyptian child implements for playing a game decidedly similar to modern tenpins. The date of the Egyptian child's burial was estimated to be 5200 B.C. According to Sir Flinders, the games were fully developed, both as board games and bowling at pins, or skittles.

Stone Age artifacts indicate that early men and boys played some sort of bowling game in which large pebbles and rocks were rolled at pointed stones or sheep joints which served as pins. The ancient Polynesians, according to Malcolm Rogers of the San Diego (Calif.) Museum, participated in an ancient game of bowling in which small elliptical balls and round, flat disks of stone, about 3½ to 4 in. in diameter, were used. One rule of this game, called Ula Maika, set the distance the stones were to be bowled at 60 ft., the same specification used in tenpin bowling today.

Germany.—Bowling has been played for centuries in Germany and the Low Countries. Written records of A.D. 300 state that bowling originated in the monasteries of continental Europe, where it was part of a religious ritual. The peasants of those days habitually carried a club, even when visiting church. It is said that the priests, in an effort to dramatize a point and develop a visual religious explanation, told the people that the clubs could represent evil or the devil. The club was stood in a corner, and the peasant rolled a large stone or ball at it. If he succeeded in hitting it, he was praised; should he fail, he was instructed to lead a better life. The priests, according to the account, became intrigued with the idea of hitting the club or *kegel* themselves and took turns at trying. Soon others tried their skill, and a game was born. Later the nobility and landed gentry took up this form of recreation. By the middle ages, bowling was a universal and very popular game in Germany. It held an important place with the people in village gatherings and celebrations, and wealthy burghers participated in the game on their own private bowling lanes.

England.—As the game spread to England, the people became equally enthusiastic about bowling, so much, in fact, that Edward III became concerned about it. In 1365 he passed an edict forbidding "the hurling of stones" and other sports because he feared that the practice of archery (important for military purposes) would suffer because of the people's fascination with games. About two decades later, Richard II's reign saw these laws renewed with penalties being levied against those who bowled in public establishments. Far from dying out, however, the game became popular with the nobility, and by 1530 Henry VIII ordered bowling lanes added to his residence at Whitehall in order to indulge his fancy for the game.

Various forms of bowling were played in the different European countries through the years. The number of pins varied from 3 to 15, balls differed in size and weight, and there were differences in the distances they were rolled. The basic principle of rolling a ball at pins remained the same, however. Among the different names of bowling games were skittles, half-bowl, Basque *quilles* and German *Kegelspiel*, or ninepins.

Ninepins was universally popular among the Germans and Dutch and was first bowled upon a bed of clay. Later a single board, about one foot in width, was laid upon the clay, and the ball was rolled upon this narrow lane.

United States.—The early Dutch settlers of New York brought the game of ninepins to America with them. It was first played in the new world upon the green, and in 1732 the square north of New York's Battery was leased as a bowling green and still bears this name. In Washington Irving's famous tale of Rip Van Winkle, the strange beings Rip meets in the mountains are playing ninepins, and the noise of their balls striking the pins sounded like distant thunder.

Bowling grew to tremendous popularity in the U.S. during the early part of the 19th century. The game of ninepins reached the peak of favour in the 1840s, according to the *Western Bowlers Journal Bowling Encyclopedia.* In New York City, there were lanes (the game had moved indoors from the bowling green) on nearly every block on Broadway from Fulton Street to 14th Street. In 1849 there were four lanes located uptown and, in surprisingly modern fashion, on the third floor of a building.

As ninepins grew in popularity, so did gambling upon the outcome of the games. Matches for money were made with increasing frequency, and the game eventually fell into the control of gamblers. For this reason, it was outlawed, first in Connecticut and later in New York. Because only the game of ninepins had been outlawed, not bowling itself, the idea was conceived about 1842 of adding another pin to the nine-pin setup to circumvent the law. Thus was born the game of tenpins, which has grown in popularity to become a major sport in the United States and many other countries. Adding a tenth pin changed the arrangement of pins on the lane from the diamond formation of ninepins to the triangle formation of tenpins.

In 1875 and again in 1890, organizations were formed to control the game, but they were short-lived. On Sept. 9, 1895, another group met to form a governing organization for the sport. Among them were skilled bowlers, bowling-alley proprietors (commercial establishments were flourishing by that time) and representatives of bowling equipment manufacturers. Their purpose was to draw up rules and regulations for tenpins that would be universally accepted and to develop uniform standards for lanes and equipment so that bowlers everywhere could play under equal and well-known conditions. The American Bowling Congress (ABC), as the new organization was named, grew and flourished as did the game of tenpins itself.

The American Bowling Congress is the governing body of male bowlers only. By 1916, however, a sufficient number of women were participating in the game to warrant the formation in November of that year of a female counterpart, the Woman's International Bowling Congress (WIBC). The Professional Bowlers Association was organized in 1958. In 1935 an American Junior Bowling Congress was also established for boys and girls of high school age, and the Youth Bowling Association was organized in 1963.

Parallel with the increase in participation in the game was the growth and development of the commercial bowling establishment in the United States. From four- and six-lane houses frequented primarily by men, many have become huge, gaily decorated, well-lighted sports establishments where the whole family plays the game of tenpins.

Modern bowling establishments have 20, 36, or as many as 40 lanes on a single floor. A 64-lane establishment was built with lanes in a continuous line unbroken by pillars. Most of them have refreshment counters, locker rooms where bowlers may store their equipment throughout a season, comfortable spectator seats, and sales counters for bowling supplies such as balls, bags and shoes. Modern electrical equipment will clean a ball for the bowler, detect a foul (stepping over the foul line), throw scores on a screen so spectators may follow a game, and return a ball to the bowler from the pits; semiautomatic and automatic machines set up the pins after a ball is thrown.

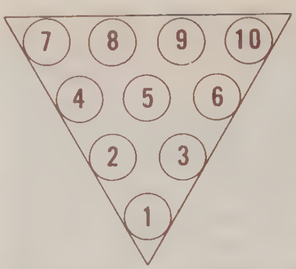
SPECIFICATIONS FOR BOWLING EQUIPMENT

Equipment has been completely standardized through American Bowling Congress specifications so that bowlers everywhere compete under equal conditions.

A bowling lane is 60 ft. long from the foul line to the centre of the head pin and must be no less than 41 in. nor more than 42 in. wide. Behind the foul line is an approach of no less than 15 ft. and usually 16 ft. where the bowler takes 3, 4 or 5 steps before rolling the ball. Pins are set in a 36-in. triangle with a spacing of 12 in. from the centre of one pin to another. First is the no. 1 or head pin and behind it a row of two pins, followed by a row of three and another row of four pins to account for all ten.

On each side of a bowling lane are nine-inch gutters (nine and one-half inches on lanes that are 41 in. wide), which guide the ball down to the pit if it should be misthrown and leave the lane. Each pair of lanes has a ball return, a narrow track to allow the ball to be returned to the bowler from the pits after each throw.

The lane itself is constructed of maple and pine planks fastened tightly together with the narrow edges upward and coated with finish for a smooth and continuous surface. To prevent any possibility of lanes being slotted to guide the ball to the pins, the American Bowling Congress allows a tolerance of only $\frac{40}{1,000}$ in. in levelness. Periodic inspections of bowling lanes are made by ABC officials to ensure that they conform with and meet all specifications of that body.



BY COURTESY OF THE BRUNSWICK-BALKE-COLLENDER CO

FIG. 1.—BOWLING PIN NUMBERS AND ARRANGEMENT

Pins.—Bowling pins are made to equally rigid specifications. A pin must be made of sound, hard maple and weigh not less than 2 lb. 14 oz. nor more than 3 lb. 10 oz. The ten pins in a single set must not vary more than 4 oz. in weight. Each pin must be 15 in. high and the diameter at the base $2\frac{16}{64}$ in., increasing to $4\frac{49}{64}$ in. at the belly and diminishing to $1\frac{43}{64}$ in. at the neck. Only pins meeting such specifications may be used in play sanctioned by the ABC.

Pins originally used in bowling were simple wooden clubs, thick at the base and tapering to the top. These were later turned in the form of a smooth cone, varying in diameter and length according to local tastes. The cone was superseded by a pin shaped like a small keg, flat on both top and bottom. Eventually the shape of a champagne bottle was adopted as standard for pins.

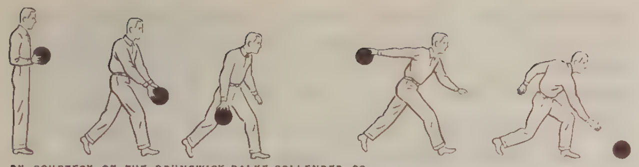
Bowling Ball.—The development of the bowling ball is an interesting bit of evolution. Centuries ago, round stones were used. Later wood was used, in part attributable to the interest in the game by the Flemings who were skilled craftsmen. In later years, iron and rubber balls were tried. With the advent of the power lathe, wooden bowling balls could be turned out, smooth and true. Lignum vitae, a hard tropical wood, was the most popular. Wooden balls were palmed (thrown without finger holes), but in some localities of Europe slots for fingers and a hole for the thumb were tried. About 1890 the two-hole grip (one for the middle finger and one for the thumb) was introduced in the U.S. The three-hole grip—for the thumb, middle and ring fingers—is now the most popular type.

Modern ABC requirements for bowling balls are that they must be made of nonmetallic composition material and must have a circumference of not more than 27 in., and the weight must be between 10 and 16 lb. To keep competition equal for all bowlers, balls must be so constructed and drilled that no less than six sides are in proper balance.

Range Finder.—Through the years many bowlers developed the habit of dropping the ball on a certain board of the lane as a guide point for its travel to the pins. To assist bowlers in this search for accuracy, the range finder was introduced. This is a system of markers imbedded in the lane to guide both footwork in the approach and delivery of the ball on a given spot. A row of markers is located at the far end of the approach to help the bowler start from the same spot each time. Another row just before the foul line helps indicate the stopping position for the feet. Two more rows out on the lane, one 7 ft. and the other 13 to 16 ft. beyond the foul line, allow the bowler to send his ball on exactly the same path each time he rolls it.

PLAYING THE GAME OF TENPINS

Bowling by the 1960s challenged fishing as the most popular participant sport in the United States. Like fishing, it is a sport that can be played at all ages of life. One man, Harry Steers of Elmhurst, Ill., bowled in the annual American Bowling Congress tournaments for more than 50 years. Many skilled bowlers of 70 years or over actively compete in the game. Since skill is the great prerequisite of bowling, rather than great physical stamina, and since team play provides opportunities for many social hours,



BY COURTESY OF THE BRUNSWICK-BALKE-COLLENDER CO.

FIG. 2.—THE STANDARD FOUR-STEP DELIVERY

there are no real age limits to the game. Children's leagues are in operation, using special lightweight balls on regulation lanes. Bowling has also become an organized school and college sport in many areas. Annual tournaments are conducted by the American Junior Bowling Congress and the Youth Bowling Association, and national intercollegiate tournaments are held annually. The various athletic conferences, such as the Big Ten and Eastern Intercollegiate Conference, also sponsor tournaments in which teams from member colleges compete. Millions of adult men and women bowl in thousands of organized leagues throughout the United States.

The game is usually played by one individual against another or by one team against another. Teams are ordinarily composed of five persons, and a number of teams are organized into a league to compete against each other on a definite schedule. There are usually about 12 teams in a league, although the figure may vary either way. League officers are elected, and league business is run according to parliamentary procedure and a set of bylaws. Most U.S. leagues apply to either the American Bowling Congress or the Woman's International Bowling Congress for, sanction, or approval. Among other benefits, the sanction makes teams from the league eligible to compete in the annual tournaments staged by the ABC and the WIBC.

Aside from accuracy which must be developed by practice, bowling is a relatively easy game to play. A minimum of equipment is necessary for the player, and it is inexpensive compared with many other sports. A bowling ball, a pair of bowling shoes and a bag in which to carry them are all that are needed. Lanes, pins and all other equipment are provided by the bowling establishment on the basis of a small charge per line (game) for play. Bowling lanes furnish house balls and rental shoes. Thus it is not necessary to buy any equipment to bowl, and many thousands of casual bowlers do not. Experts at the game recommend, however, that a bowler who has serious intentions of improving his skill obtain his own ball with the holes custom fitted to his hand and finger size.

The action of rolling a bowling ball consists of taking several quick walking steps while the hand which grips the ball drops to the side, swings backward and then forward again just as the last step is taken. It is at this instant that the ball is released with the momentum of the body helping to propel it. Three, four or five steps are taken. A four-step delivery is the most popular and the one recommended by experts. For a right-handed bowler, the last step is taken on the left foot which slides a little toward the foul line just as the hand comes forward with the ball. Good practice requires that the arm follow through after the ball is released to help give it proper direction toward the pins.

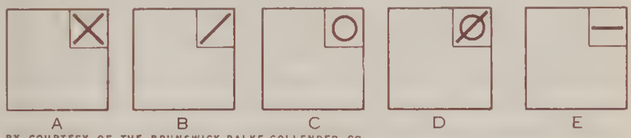
The ball can travel toward the pins in any one of four paths—a straight line, a hook, a curve or a backup. A straight ball is recommended for beginners. The more skilled throw a hook ball that ideally breaks to the left into the 1–3 strike pocket. A hook ball usually sends the pins tumbling in more active fashion than a straight ball with the result that some pins hit by the ball will knock over other pins as they fall.

A number of excellent bowling instruction books have been written to summarize and illustrate the many different techniques of footwork, delivering the ball, follow-through, etc. (see *Bibliography*). Many bowlers have improved their knowledge of the fundamental techniques of the game with such instructional books. Personal instruction on the lanes is also helpful and in the larger cities many bowling establishments offer free professional instruction.

A line, or game, of tenpins is divided into ten frames. Two balls or throws are allowed for each frame, but when the first ball rolled knocks down all ten pins the frame is concluded with one ball.

Scoring the Game.—Scoring is based on the number of pins knocked down per frame, plus a bonus system of strikes and spares. If the first ball of a frame knocks down four pins and the second ball knocks down four more, the score for the frame is simply 8. If all the pins are knocked down by two throws, a spare is scored. This makes the score for that frame 10 plus the number of pins knocked down with the next ball rolled. A strike is scored when the first ball rolled knocks down all ten pins. For a strike frame, the bowler gets 10 plus the number of pins knocked down with his next two throws. A strike in the tenth or last frame gives the bowler two extra balls; a spare in the tenth frame gives him one extra ball. A perfect score, achieved by strikes in all ten frames plus the two extra balls at the end, is 300.

In addition to marking the number of pins on the bowling score sheet, the accomplishment of the frame (strike, spare, error or split) is also marked in the smaller of the two squares that are used to score each frame. The strike mark is an X; for a spare it is a diagonal line (/); a dash (—) is used for an error (failure to make a spare) and an O for a split (two or more pins widely spaced).



BY COURTESY OF THE BRUNSWICK-BALKE-COLLENDER CO.

FIG. 3.—BOWLING SCORE MARKS

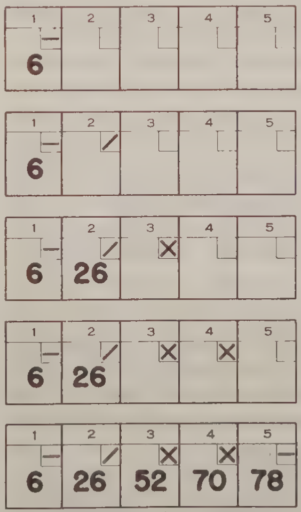
(A) Strike; (B) spare; (C) split; (D) converted split; (E) error

Score for a Sample Game.—To clarify further the system of scoring, the principles are applied here to several sample frames.

If, for example, the bowler rolls two balls in the first frame and gets only six pins, he marks 6 in the large square and the error symbol in the small square.

In the second frame, he gets three pins with the first ball and all the rest with the second ball. Then he marks the spare sign in the small square and nothing in the large square, remembering that he will get 10 plus what he knocks down with his next ball.

On the next ball—the first of the third frame—he gets a strike. So the scoring goes like this: 10 for the spare, plus ten pins on his next ball, *i.e.*, 20; 20 plus the 6 in frame one totals 26, to be marked down as the score for the second frame. Since there was a strike in the third frame, only the strike symbol is marked in the small square. In the fourth frame he gets another strike so he doesn't put a score in the third frame box until after the next ball.



BY COURTESY OF THE BRUNSWICK-BALKE-COLLENDER CO.

FIG. 4.—SCORE OF HYPOTHETICAL GAME (*see* TEXT FOR EXPLANATION)

In the fifth frame he gets only six pins with the first ball and two with the second and no split to mark. So there is an error for the fifth frame to be marked in the small square. Now it is time to do some adding to fill in the scores for frames three and four. In frame three, the bowler adds 10 for the strike, plus the total from the next two balls (10 more for the strike in the fourth and 6 for the first ball in the fifth), plus the 26 already in frame two. This finally allows 52 to be marked in for the third frame. Now, he can also fill in the score for the fourth frame by adding 10 for the strike, plus 8 for the next two balls (the error) to the 52 from frame three. The score up to this point is 70. Since a total of only 8 was made in the fifth frame, this can be added at once to give 78 through the fifth frame. The remaining frames of the game are scored and marked in the same fashion.

BOWLING TOURNAMENTS

Highlight of the year for many U.S. bowlers is the annual American Bowling Congress tournament for men and Woman's International Bowling Congress tournament for women. Both are held in different cities each year and draw individual and team entries from all over the nation. The first ABC tournament was held at Chicago, Ill., in 1901 with an entry of 41 teams and a prize list of $1,592. The tournaments, whose participants and prize money increased greatly through the years, were held annually thereafter with the exception of 1943, 1944, and 1945 during World War II.

The prize fund is developed from contestants' entry fees for the tournament and is distributed to the various teams and individuals on the basis of performance in the tournament events.

The four basic events are for five-man teams, two-man teams, individuals, and all-events (a combination of the first three). ABC tournament play involves a period of more than two months with continuous bowling every afternoon and evening. A classic division to represent professional bowlers was instituted in 1961.

WIBC tournaments for women bowlers include the same four events. It was started in St. Louis, Mo., in 1917 with eight teams competing. Three games are bowled for each of the four events in both the ABC and WIBC tournaments.

A new kind of tournament was started in 1942 to determine the national individual match game champion. This title was determined for many years by unofficial challenge matches and was sometimes in dispute. From 1942 top bowling stars of the U.S. competed in a grueling 100-game tournament over a ten-day period. It is an extremely severe test of tenpin skill, physical stamina and mental alertness and is considered to be the leading test of individual bowling prowess. The bowlers compete for the Bowling Proprietors' Association of America individual match game championship.

Competition for women was added to the All-Star tournament in 1949. The winner for five successive years was Marion Ladewig who completely dominated women's bowling during that period in a fashion seldom achieved by any athlete in any sport. During the 1951 tournament, her average was 211, a margin of two pins per game better than the winner in the men's division. Trailing in second place through the first two days of the 1951 finals, Mrs. Ladewig unleashed a burst of scoring never before seen in championship women's tournament competition. Her first two games for that third day were 255 and 279, followed by 247, 227, 247, 224, 255, and 247 for an eight-game total of 1,981 pins and an average of more than 247 a game.

Mrs. Ladewig's five-year reign was ended in 1955 by Sylvia Wene of Philadelphia, Pa., who won the women's All-Star competition. In 1957, however, Mrs. Ladewig led the women bowlers for the sixth time in eight years, and in 1959 she again won the women's All-Star championship. In the same year, Mrs. Ladewig and LaVerne Carter of St. Louis won the women's national doubles championship at Rego Park, N.Y. Mrs. Ladewig also won WIBC titles in 1959 and in 1960.

ABC Hall of Fame.—To honour the men with the greatest accomplishments in the game of tenpins, the American Bowling Congress Hall of Fame was established in 1941. Ten years later, Hall-of-Fame member Hank Marino was elected "Bowler of the Half Century" by the elections board in one of the highest tributes to be paid to a bowler's accomplishments in the game of tenpins.

INTERNATIONAL

The international bowling organization, Fédération Internationale des Quilleurs (FIQ), was formed in 1952. The first FIQ world championships were held in Helsinki, Fin., in 1954. Subsequent world championships were held in Essen, Ger., in 1955; in Hälsingborg, Swed., in 1958; and in Hamburg, Ger., in 1960. In 1961 the U.S. was invited to join FIQ and the membership was granted to the ABC, with the WIBC receiving permission to sponsor U.S. women's teams through ABC. The 1963 event was held in Mexico City. The next championships, scheduled to be held in Spain in 1966, were postponed until 1967, at Malmö, Swed., when the event was placed on a four-year rotation with the U.S. scheduled as host for the first time in 1971.

The world championships include, for men, eight-, five-, and two-man team titles and the individual or all-event title; and for women, five-, four-, and two-man team titles and the individual title.

OTHER GAMES OF BOWLING

In addition to the universally popular tenpins, there are several other varieties of bowling played. In the United States, for the most part their popularity is confined to rather specific geographical areas of the country. Among these games are duckpins, rubberband duckpins, candlepins, five back and barrelpins.

The most popular game, duckpins, is played along much of the U.S. eastern seaboard with special concentration in Baltimore, Md., and Washington, D.C. The regulation duckpin is only $9\frac{13}{32}$ in. in height and $4\frac{1}{8}$ in. in diameter at its widest part. Ten duckpins are used in the game. The ball is small, without finger holes, and measures 5 in. in diameter with a maximum allowable weight of 3 lb. 12 oz.

Three balls are allowed in each frame of a ten-frame game; there is no bonus for making all ten pins with three balls; other rules are similar to those of tenpins. The National Duck Pin Bowling Congress was founded in 1927.

The rubberband duckpin game is concentrated chiefly in the area around Pittsburgh, Pa. The pins are the same height as regular duckpins but have a rubberband $1\frac{13}{64}$ in. wide set into a slot around the belly of the pin. This gives them additional action when they are hit by the ball. The ball is the same size as that for duckpins but must weigh no more than 3 lb. 8 oz. Only two balls are allowed for each frame of a ten-frame game; other rules are similar to those of tenpins.

Candlepins (a candlepin is a long, narrow cylinder, tapered to both ends) enjoys its greatest popularity in the New England states and eastern Canada. Three balls are allowed as in duckpins. Five back and barrelpins are played in New York.

(J. J. W.)

Skittles or ninepins continued to be the bowling game in Great Britain (see *History* above), at least until the introduction and increasing popularity in the 1960s of U.S. tenpins. Skittles was played in alleys at public houses or clubs, mostly in the west of England, the midlands, south Wales and the Lothians of Scotland. The rules and methods of scoring varied from place to place, but the basic principle of bowling a ball (of wood or rubber and weighing about 10 lb. [4.53 kg.]) at nine pins set in diamond formation remained the same. In the London area, however, the bowlers used a flat, round, loaf-shaped "cheese" made of lignum vitae and weighing from 12 to 14 lb. (5.44 to 6.35 kg.). Control of this older form of the game was assumed by the Amateur Skittles Association, which specified the dimensions of the alley and the distance between each of the nine pins in the diamond frame.

See also SPORTING RECORD: *Bowling*. (N. D. McW.)

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BOWLING GREEN, a city of Kentucky, U.S., 118 mi. S.W. of Louisville, at the head of navigation on the Barren river; the seat of Warren county. (For comparative population figures *see* table in KENTUCKY: *Population*.)

The city is the centre of a rich agricultural area and a market for strawberries, tobacco, grain, livestock and poultry. Its industries produce auto parts, photoflash bulbs, air compressors, clothing and building materials. Bowling Green state university (1910) and Western Kentucky university (1906) are located in Bowling Green. Mammoth Cave National park, 30 mi. N.E. of the city, and Lost River and other nearby caves attract thousands of tourists annually.

Warren county was established in 1796. Two years later a town was established around the courthouse square. There is a tradition that Robert Moore's bowling alley on the open green suggested the city's name. Bowling Green was incorporated in 1810; a new charter was granted in 1858.

During the American Civil War it was on the right flank of the first line of Confederate defense in the west, and for a time was the headquarters of Gen. Albert Sidney Johnston. (J. C. Cr.)

BOWLS, one of the oldest of outdoor pastimes; in the U.S. often called lawn bowling. The aim is to roll the bowls near a stationary ball called a jack. The game is therefore quite different from the modern sport of bowling, but the points of similarity are obvious and both are of very ancient origin; the earliest known forms are discussed in Bowling. Tracing the later history of the two games is complicated by the fact that in early modern English the word "bowls" was used to mean both the present game and the game of skittles or ninepins (and also perhaps billiards), and in many early references to bowls it is difficult to determine which form is meant.

It is certain, however, that the game of bowls, at least in a rudimentary form, was played in the 13th century. A manuscript of that period in the Royal library, Windsor (No. 20, E iv.), contains a drawing representing two players aiming at a small cone (instead of an earthenware ball, or jack). Another manuscript of the same century has a picture—crude, but spirited—of a game which more closely resembles the present game. It shows three figures and a jack. The first player's bowl has come to rest just in front of the jack; the second has delivered his bowl and is following after it with one of those eccentric contortions still not unusual on modern greens, the first player meanwhile making a repressive gesture with his hand as if to urge the bowl to stop short of his own; the third player is depicted as in the act of delivering his bowl.

The Game in England.—As the game of bowls grew in popularity in England it came under the ban of king and parliament, both fearing that it might jeopardize the practice of archery, then so important in battle; statutes forbidding it and other sports were enacted in the reigns of Edward III, Richard II and other monarchs. Even after the invention of gunpowder and firearms had made the bow obsolete as a weapon of war, the prohibition was continued. A statute of 1511 in the reign of Henry VIII confirmed previous enactments against unlawful games. By a further act of 1541—which was not repealed until 1845—artificers, labourers, apprentices, servants and the like were forbidden to play bowls at any time except Christmas, and then only in their master's house and presence. It was further enjoined that anyone playing bowls outside of his own garden or orchard was liable to a penalty of 6*s*. 8*d*., while those possessed of lands of the yearly value of £100 might obtain licences to play on their own private greens. In Mary's reign (1555) the licences were withdrawn, the queen or her advisers deeming the game an excuse for "unlawful assemblies, conventicles, seditions, and conspiracies."

The amount of skill demanded by the game increased considerably in the 16th century, when biased bowls were introduced. "A little altering at the one side," says Robert Recorde, the mathematician, in his *Castle of Knowledge* (1556), "maketh the bowl to run biasse waies." And Shakespeare (Richard II, act iii, sc. 4) causes the queen to remonstrate, in reply to her lady's suggestion of a game at bowls to relieve her ennui, " 'Twill make me think the world is full of rubs, and that my fortune runs against the bias." This passage is interesting also as showing that women were accustomed to play the game in those days. It is pleasant to think that there is foundation for the familiar story of Sir Francis Drake playing bowls on Plymouth Hoe as the armada was beating up the channel, and finishing his game before tackling the Spaniards. Bowls, at that date, was looked upon as a legitimate amusement for Sundays—as indeed were many other sports. When John Knox visited Calvin at Geneva on Sunday, it is said that he discovered him engaged in a game; and John Aylmer (1521–94), though bishop of London, enjoyed a game on a Sunday afternoon but used such language "as justly exposed his character to reproach." The pastime found favour with the Stuarts. In the *Book of Sports* (1618), James I recommended a moderate indulgence to his son, Prince Henry, and Charles I was an enthusiastic bowler although unfortunately he encouraged, by example, wagering and playing for high stakes, habits that ultimately brought the green into general disrepute. Even the Puritans could not suppress betting. So eminently respectable a person as John Evelyn thought no harm in bowling for stakes, and once played at the Durdans, near Epsom, for £10, winning match and money, as he triumphantly notes in his *Diary* for Aug. 14, 1658. Samuel Pepys repeatedly mentions finding great people "at bowles." But in time the excesses of gambling and drinking attending the game, which became associated almost exclusively with taverns, rendered it unfashionable.

Developments in Scotland.—After a long interval salvation came from Scotland, where the game became organized with a code of laws. There, along with its winter analogue of curling, bowls may be considered, much more than golf, a national game. Yet it was not until well into the 19th century that the pastime acquired popularity in that country. It had been known in Scotland since the close of the 16th century but greens were few and far between. There is a record of a club in Haddington in 1709, of Tom Bicket's green in Kilmarnock in 1740, of greens in the grounds of Heriot's hospital, Edinburgh, prior to 1768, and of one in Peebles in 1775. (These are, of course, mere infants compared with the Southampton [Eng.] Bowling green, founded in 1299, which still uses the green on which it has played for centuries and continues the quaint custom of describing certain successful players as "sir.") As the game grew in popularity in Scotland the need was felt for a uniform code of laws and in 1848–49 a committee was appointed to draft one. The body delegated its functions to its secretary, W. W. Mitchell (1803–84), who prepared a code that was immediately adopted as the standard laws. The Scots were also pioneers in laying down level greens of superlative excellence. Not satisfied with seed-sown grass or meadow turf, they experimented with sea-washed turf and found it answered well. The enthusiasm as well as skill with which the game was conducted in Scotland at length proved contagious; thus Scottish bowlers saved the game. Clubs in England began to consider the question of legislation and to improve their greens. Moreover, Scottish emigrants introduced the game wherever they went and colonists in Australia and New Zealand established many clubs which, in the main, adopted Mitchell's laws; clubs were also started in Canada and in the United States, in South Africa, India, Japan and Hong Kong. In Ireland the game took root very gradually.

A Lead From Australia.—Further efforts to organize the game were made in the last quarter of the 19th century, but this time the lead came from Australia. The bowling associations of Victoria and New South Wales were established in 1880, and it was not until 1892 that the Scottish Bowling association was formed. Then in rapid succession came several independent bodies—the Midland Counties (1895), the London and Southern Counties (1896), the Imperial (1899), the English (1903) and the Irish and Welsh (1904). The multiplicity of organizations in England proved a hindrance, so in 1905 the various organizations joined the English Bowling association. Visits to the United Kingdom of teams of bowlers from Australia and New Zealand in 1901, and from Canada in 1904, demonstrated that the game had gained enormously in popularity. Since then accredited teams of players from Australia, New Zealand, South Africa, Canada and the United States have visited Great Britain at regular intervals and British teams have returned those visits.

Bowls in the U.S.—Bowls was the chief pastime of the early settlers of New York; a reminder of that fact is the small park at the lower end of Broadway near the Battery called Bowling Green. The game as it was played in 1700–1800 is portrayed on a stained glass window at the rear of the corridor of the Bowling

Green building, 11 Broadway. Lawn bowling spread from New York and Boston to many cities along the Atlantic coast; a bowling green was built on the estate of George Washington at Mount Vernon in 1732 and enjoyed great prosperity. The game was considered the leading sport until the Revolutionary War but after the war became practically nonexistent for 100 years.

In 1879 Christian Schepflin of Dunellen, N.J., formed a club called the Dunellen Bowling club, thereby bringing about a revival of the sport. The game took on a slow but steady growth, gradually moving westward. A club was formed in the San Francisco area in 1899 by a group of the St. Andrews society. The American Lawn Bowling association was organized in Buffalo, N.Y., in 1915 with the first national tournament held at Franklin field in Boston, Mass., in 1918.

The American Lawn Bowling association joined the International Bowling board in 1938, thereby becoming affiliated with the game's governing body throughout the world. The present American Lawn Bowls association organization is divided into six divisions, the eastern, the central, the southeast, the southwest, the northwest, and the Pacific international.

The Green.—Bowls are played on a level green; there is no prescribed size but 40 or 42 yd. square is generally recommended. Surrounding the green is a shallow space called a ditch. Beyond the ditch are banks, usually laid with turf. A green is divided into spaces usually 18 to 21 ft. in width, commonly called rinks.

Crown Green Bowls.—For this game, which is played in the north and north-midland counties of England, the green has a gradually raised crown or hump in the centre. The game is played by two players each having two bowls. Both the bowls and the jack are biased. Play may be in any direction over the green.

How the Game Is Played.—Every player uses four bowls (of lignum vitae wood or a composition material) in single-handed and in doubles games, three in triples or a three-on-a-side match and two in the rink game or four players to a side. Every bowl must have a certain amount of bias, which was formerly obtained by loading one side with lead but is now imparted by making one side more convex than the other, the bulge showing the side of the bias. No bowl must have less than No. 3 bias—that is, it should draw about 6 ft. to a 30-yd. jack on a first-rate green. The diameter of the bowl shall not be less than $4\frac{3}{4}$ in. or more than $5\frac{1}{8}$ in. and its weight must not exceed $3\frac{1}{2}$ lb. The jack, to which the bowler plays his bowls, is round and not less than $2\frac{1}{2}$ in. in diameter. The player delivers his bowl with one foot on a rubber mat which must be at least 24 in. by 14 in. An end is completed when each player has rolled all the bowls he is playing with (that is, four, three, or two). In scoring, all the balls of one team nearer the jack at the finish of an end than the nearest ball of the opposing team count one point each. In team play game consists of any number of ends, usually 18 or 21; in singles play game is 21 points.

In theory the game is very simple, the aim of the player being to roll his bowl so as to cause it to rest nearer to the jack than his opponent's, or to protect a well-placed bowl, or to dislodge a better bowl than his own. The four players in a rink are known as the lead, second, third (or vice-skip) and skip (or captain), and their positions, at least in matches, are unchangeable. The lead places the mat and rolls the jack. He also bowls first and is chosen to fill that position because of his skill in drawing (rolling) his bowl close to the jack. The second man, also, must be able to draw accurately. His official duty is to mark the game on a scorecard or blackboard. The third player, who does any measuring that may be necessary to determine which bowl or bowls may be nearest the jack, holds almost as responsible a position as the captain, whose place, in fact, he takes whenever the skip is temporarily absent. The skip plays last; it may be that he has to draw a shot to save the end, or even the match, or to lay a block, or to "fire"—that is, to deliver his bowl almost dead straight at the object, with enough force to overcome the bias.

Some Essential Rules.—Every newcomer to the game should learn to play both forehand and backhand. It must always be remembered that the biased side of the bowl is kept to the inside of the rink and that the forehand-backhand reference depends on a left-handed or right-handed bowler. In throwing the jack there must be a clear distance of not less than 25 yd. between the mat and the jack. A bowl which touches the jack during its original course on the green is called a toucher and is distinguished by a chalk mark. If a toucher is driven into the ditch it remains a "live" bowl; other ditch bowls are accounted dead and are removed to the bank. If the jack is driven beyond the limits of the rink it is counted dead, no score is recorded and the end must be replayed, usually in the same direction.

For World Championships *see* SPORTING RECORD: *Bowls.*

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(H. L. EH.)

BOWMAN, ISAIAH (1878–1950), U.S. geographer and university president, early established an international reputation by compiling the first comprehensive work published on the physiographic divisions of the United States (*Forest Physiography,* 1911) and by carrying out extensive field studies in the Andes (1907, 1911, 1913). Born at Waterloo, Ont., on Dec. 26, 1878, he was graduated from Harvard (B.S., 1905) and Yale (Ph.D., 1909) universities. After teaching at Yale for ten years (1905–15) he served for 20 years as director of the American Geographical Society of New York (1915–35), and later was president of the Johns Hopkins University, Baltimore, Md. (1935–48).

By enlarging its membership, staff, and program, he made over the previously rather small American Geographical Society into an institution of worldwide influence, and launched it on a 25-year project of mapping all of the American continents south of the United States, and on collaborative studies of pioneer settlements, polar geography, and many other matters. At Johns Hopkins he effected substantial administrative changes, and new departments of geography, oceanography, and aeronautics were established during his administration.

At the Paris Peace Conference of 1918–19 Bowman served as territorial adviser to Pres. Woodrow Wilson and the U.S. commission; his best-known book was *The New World: Problems in Political Geography* (4th ed., 1928). Pres. F. D. Roosevelt consulted Bowman on matters of scientific and national policy, and during the Roosevelt administrations he served on many governmental advisory committees. He participated in the Dumbarton Oaks (1944) and San Francisco United Nations (1945) conferences. Bowman was a fluent writer, the author of some dozen books and more than 200 periodical articles, addresses, and minor publications. He died at Baltimore, Md., on Jan. 6, 1950.

See G. M. Wrigley's biography, *Geographical Review,* 41:7–65 (Jan. 1951) and, especially for bibliography, G. F. Carter's biography, *Annals of the Association of American Geographers,* 40:338–350 (Dec. 1950).

(J. K. W.)

BOWMAN, SIR WILLIAM (1816–1892), English physician who was the British leader in ophthalmology when that subject entered its brightest period, was born at Nantwich, Cheshire, on July 20, 1816. He was an outstanding general anatomist, a brilliant surgeon and one of the leaders in the application of the compound microscope, then new and at a time when T. Schwann had just enunciated the cell doctrine. Bowman was first apprenticed to Joseph Hodgson, surgeon to Birmingham General hospital, where he acquired his first microscope. In 1837 he joined the medical department of King's college, London, and was awarded the fellowship of the Royal society at the early age of 25. During this period he published important papers on the structure and action of voluntary muscles, the minute anatomy of the liver and the structure and function of the kidneys. While working as assistant surgeon to King's College hospital, London, in 1840, his clinical interests turned particularly to the eye and in 1846 he was appointed assistant surgeon to the Royal London Ophthalmic hospital (later Moorfields Eye hospital), becoming full surgeon in 1851, the year which saw the discovery of the ophthalmoscope by Helmholtz.

He wrote many important papers and an early work, *The Physiological Anatomy and Physiology of Man* (1845–56), published jointly with R. B. Todd, was the pioneer work on physiology with histology. He was president of the ophthalmological section of the seventh international medical congress (1881) and of the newly founded Ophthalmological Society of the United Kingdom (1880–83), which founded an annual eponymous lecture in his honour. Knighted in 1884, Bowman died near Dorking, Surrey, on March 29, 1892. (F. W. L.)

BOWRING, SIR JOHN (1792–1872), English author, linguist and diplomat, who was prominent in many spheres of mid-Victorian public life, but is chiefly remembered as the friend and literary executor of Jeremy Bentham. A member of a long-established Devonshire family, he was born on Oct. 17, 1792, at Exeter, where the foundations of his linguistic abilities were laid during his early career in a merchant's house. He devoted much time to the study of foreign literature, especially that of eastern Europe, and his first published works included *Russian Anthology* (1820–23); *Ancient Poetry and Romances of Spain* (1824); *Servian Popular Poetry* (1827); *Specimens of the Polish Poets* (1827); *Sketch of the Languages and Literature of Holland* (1829); and *Poetry of the Magyars* (1830). Bowring was a great friend of Jeremy Bentham and became an editor of the latter's *Westminster Review* in 1825. Subsequently, as Bentham's literary executor, he published *Jeremy Bentham's Life and Works* in 11 volumes (1843). From 1835–37 and 1841–49 Bowring was a member of parliament. In the house of commons he was a supporter of free trade, the repeal of the Corn laws and of penal reform, and an opponent of flogging in the army. He was also a strong advocate of the introduction of the decimal system into England and, with the support of the prince consort, secured the issue of the florin as an intended first step in this direction. Compelled by economic necessity to take up a diplomatic career, in 1849 he was appointed British consul at Canton and superintendent of trade in China, a post which he held for four years. Knighted in 1854, he was again sent the same year to Hong Kong as governor, invested with the supreme military and naval power. It was during his governorship that a dispute broke out with the Chinese over the case of the "Arrow"; and the irritation caused by his highhanded policy led to the second war with China. In 1855 he visited Siam, and negotiated with the king a treaty of commerce. Bowring's last employment by the British government was as a commissioner to Italy in 1861, to report on British commercial relations with the new kingdom. He died at Claremont, near Exeter, on Nov. 23, 1872. His other writings include *Minor Morals for Young People*, 3 pt. (1834–39); *The Influence of Knowledge on Domestic and Social Happiness* (1840?); *The Kingdom and People of Siam*, 2 vol. (1857); *A Visit to the Philippine Isles* (1859); and the posthumous *Autobiographical Recollections of Sir John Bowring* published by his son, Lewin Bowring, in 1877.

BOWYER, WILLIAM (1699–1777), English printer and scholar, known as "the most learned printer of the 18th century," was the son of William Bowyer, an eminent London printer and patron of the type-founder William Caslon. The younger Bowyer was born in London on Dec. 19, 1699, and, while at St. John's college, Cambridge, began to assist his father in correcting proofs. In 1722 he became a partner, continuing the correcting work while his father ran the mechanical side, and when the elder Bowyer died in 1737 his son carried on the firm. In 1729 they had been appointed printers of the house of commons' votes and in 1736 were appointed printers to the Society of Antiquaries, Bowyer being elected a fellow the same year. He contributed many papers which, together with other writings, were collected and published in 1785 by John Nichols (*q.v.*), "his apprentice, partner and successor."

Bowyer was a prolific writer and printer, producing many literary and religious critical works. The extensive notes on M. Bladen's translations of *Caesar's Commentaries* (1750) were his and in 1763 he edited and printed a two-volume Greek testament. In 1761 he became printer to the Royal society and in 1767 was appointed to print the rules of parliament and the journal of the house of lords. In the same year he moved the expanding business from Dogwell court to Red Lion passage. He died in London on Nov. 18, 1777, leaving many charitable bequests to be administered by the Stationers' company. (J. C. Mn.)

BOX: *see* Boxwood.

BOX ELDER, the name commonly given in the eastern United States to a species of a maple (*Acer negundo*), with pinnately compound leaves, numerous varieties of which are planted for shade and ornament. *See* Maple.

BOXER REBELLION: *see* China: *History*.

BOXING, in modern times, is the art of attack and defense with the fists in which the contestants wear padded gloves, fight bouts of three-minute (or occasionally among amateurs two-minute) rounds, do not wrestle and otherwise generally observe the code (*see* below *The Bare-Knuckle Era*) set forth in the Marquess of Queensberry rules. The boxer depends upon his ability to land hard and often with his own fists and avoid the blows of his opponent.

The terms "pugilism" and "prize fighting" in 20th-century usage are practically synonymous with "boxing," though the first indicates the ancient origins in its derivation from the Latin *pugil*, "a fighter with the cestus (a hand covering)," related to the Latin *pugnus*, "fist," and in turn from the Greek *pux*, "with clenched fist"; while "prize fighting" emphasizes the pursuit of the sport for gain. Samuel Johnson in his *Dictionary* (1756) defined a prize fighter as "one that fights publicly for a reward."

EARLY HISTORY

Undoubtedly men resorted to their fists to settle arguments as a matter of course for many centuries before anyone thought of staging bouts for the entertainment of others. There is evidence that boxing existed in ancient Crete, where a civilization was established by about 1500 B.C. Centuries before the arrival of the Greeks, boxing was known in the Aegean. And no sport was older and more popular throughout ancient Greek history than pugilism. The epics of Homer celebrate the deeds of fist fighters, and Theocritus describes an exciting bout between Amycus and Polydeuces (trans. by James Henry Hallard):

> So, when their fists were bound with thongs of force-giving ox-skin,
> Coiling the long bands round their arms, they met in the mid-ring,
> Breathing slaughter against each other. . . .

The descriptions of fighting in ancient Greece are not evocative of Queensberry skill. The Greeks believed in fine development of physical as well as mental abilities. But the young Greek was always conscious of his possible role as a soldier or warrior and it was with this sort of destiny in mind that he exercised. Therefore, the fighting the Greeks did was largely to prove their courage, strength and endurance—not their agility or cleverness. They fought in the open air, bounded by spectators, with no resined surface to glide upon, no corners or ropes to employ in their strategy. As a matter of fact, they moved very little for agility might have been construed as cowardice. It was, however, accepted practice to maneuver an opponent so that he would face the sun. For the rest, the opponents stood close together and belaboured one another with swinging, clubbing blows. The object seemed to be as much to prove that they could "take it" as that they could deliver punishment. They did not employ straight punches at all. There were no rounds—the bout continued until one of the fighters admitted himself beaten.

In the early days fighters wore thongs of soft leather bound about their fists and (often) two-thirds of the way up their forearms to protect hands and wrists. Beginning in the 4th century B.C. harder leather was used for the thongs, with the result that they became weapons as well as protection. And finally, late in the history of the Roman empire, the Greeks adopted the hand covering called the cestus, which was studded with iron or brass nuggets and was used in battles to the death in the Roman arenas. The famous bronze statue of a Greek pugilist at the Museo delle

Terme in Rome shows an athlete with the hard thongs bound about his hands and forearms. It has the thickened nose and hemorrhaged (cauliflower) ears which still mark many professional boxers.

Although fist fighting was supposed by the Greeks of the classic period to have been a feature of the mythological games at Olympia, it was not actually introduced into the historic Olympic contests until the XXIII Olympiad (688 B.C.) after the re-establishment of the famous games, traditionally in 776 B.C. Onomastos of Smyrna was one of the first Olympic victors. A sport called *pankration* ("complete contest"), which combined boxing and wrestling, was introduced in the XXV Olympiad (652 B.C.). In the XLI Olympiad boxing competition for youths was added. There were no weight divisions, and size and strength were prime qualifications for the pugilist always.

The first Greek fighters were not paid; glory was the only reward they sought. Later wealthy men trained their slaves as boxers and had them perform for special entertainments. In the 1st century of Christianity Romans forced their cestus-clad slaves to bludgeon one another to death in a gruesome perversion of sport for the entertainment of crowds who thronged to arenas to see the kill. With the rise of Christianity and the concurrent decline of the Roman empire, pugilism as entertainment apparently ceased to exist for there is no record of it. When knighthood was in flower it was a poor fellow indeed who did not do his battling with horse, sword, armour and all the other trimmings.

THE BARE-KNUCKLE ERA

With the rise of London as a major city came a type of encounter called a prize fight. Prize fighters were strong men of different sections of the city, whose admirers were willing to bet that they could beat one another and arranged fights to settle the issues. The fighters performed for whatever purses were agreed upon plus stakes (side bets). At first there were few tactics which were not allowed. Wrestling was permitted and it was common to fall on a foe after throwing him. It also was common practice to hit a man who was down. The fighters wore no gloves of any kind and welcomed variations upon punching because their hands could not take the hard punishment implicit in delivering many hard punches consecutively. Nevertheless, one man by 1719 had so far captured public imagination that he was acclaimed champion of England. His name was James Figg (*q.v.*) and he held the title for a span which may have been as great as 15 years, turning back during this time an Italian challenger named Tito Alberto di Carni. Despite the appearance of this foreigner in the records, for years the only outstanding fighters were English. Occasionally an Irishman or American came to London to ply his trade. These invasions became more frequent as the popularity of prize fighting (and the size of prizes offered) increased.

The first fighter greatly to aid the sport itself was Jack Broughton (1704–89), a 200-lb. Englishman who won the championship of his country sometime between 1734 and 1740 (versions differ) and lost it in 1750 to a foul, unskilled brawler named Jack Slack. Broughton's reign was long enough and his character good enough to win a new respect for prize fighting. He preferred to discard the barroom techniques which his predecessors favoured and rely primarily on his fists. (He did, however, like all fighters of the time, also use wrestling holds.) He brought some degree of order out of a brawling chaos not only by the way he fought but by a set of rules which so clarified the proper conditions for a bout that they governed boxing, with only minor changes, until 1838 when the more detailed London Prize Ring rules superseded them. Under Broughton's rules, a round continued until a man went down; after 30 seconds of rest he had to square off a yard from his opponent or be declared beaten; he could not hit an opponent who was down or grasp him below the waist.

Broughton capitalized upon his good name among sportsmen by conducting classes in "the mystery of boxing . . . that wholly British art," as he advertised it for gentlemen at his Haymarket academy in 1747. To attract pupils, he devised "mufflers," ancestors of modern boxing gloves, with the assurance that these would be used in all bouts to protect against bruised faces and hands. This contribution alone establishes his importance to modern boxing. Slack, however, inaugurated a period of dishonesty and foul play in which one fixed bout followed another and sportsmen lost faith entirely in the sport. Finally it was re-established in good repute by Tom Johnson, who became champion in the 1780s and finally lost the title, in an unquestionably honest bout in 1791, to Ben Brain.

The man who succeeded Brain was the first scientific fighter in the history of pugilism. He was an English Jew named Daniel Mendoza (1763–1836) who weighed only 160 lb. (a middleweight by modern standards) but beat the best and biggest fighters in England. Mendoza had good, quick footwork and a swift straight left (a jab). By combining agility with the bothersome jab, he easily befuddled his lumbering opponents. After losing his title to John Jackson, known as "Gentleman Jackson," in 1795, Mendoza opened a school in London at which he coached young noblemen in fighting techniques. Jackson was a clever boxer, although he achieved his championship by grabbing Mendoza's long hair with one hand and clubbing the smaller man with the other. But his chief interest was to use boxing as a way to meet and hobnob with the gentry of his time. He was a masterful teacher and claimed among his pupils Lord Byron, who referred to him in *Hints from Horace:*

> And men unpractised in exchanging knocks
> Must go to Jackson ere they dare to box.

Jackson's chief contribution, in the transformation of prize fighting into boxing, was to gain friends of distinction for the sport of fist fighting—people who were interested in seeing it progress and who could give it a badly needed aura of respectability. It is significant that the Pugilistic club was organized in Jackson's rooms. The organization attempted to create orderly procedures to be followed at every fight and raised funds for making matches and for prizes. At the first meeting Sir Henry Smith presided and many noblemen, including Lord Yarmouth, were present.

Of the bare-knuckle champions who followed, the first to assure himself sports immortality was Tom Cribb (1781–1848), and he did so largely by defeating two American-born former slaves, Bill Richmond (1763–1829) and Tom Molineaux (1784–1818). Richmond was the first man born in America to win acclaim in England as a first-class pugilist. Gen. Earl Percy, who commanded some of the British troops occupying New York, discovered Richmond's talents and took him to England in 1777. Cribb beat Richmond in 90 minutes in 1805. Later, after winning the English championship, he twice beat Molineaux in his greatest performances.

In 1839 the new London Prize Ring rules were first used in a championship fight, the one in which James ("Deaf") Burke lost the English title to William Thompson ("Bendigo"). These rules (revised in 1853) provided for a ring 24 ft. square and bounded by ropes. When a fighter went down the round ended. He was helped to his corner. Time was called after 30 seconds and if he could not get unaided to a mark in the centre of the ring by the end of 8 additional seconds, he was declared "not up to scratch" and beaten. Kicking, gouging, butting with the head, biting and low blows were all declared fouls. The London rules governed pugilism in England and America for over 50 years.

By 1860 America had produced a number of good fighters. One of them, the handsome John C. Heenan, was not content with the championship of the United States. He challenged English champion Tom Sayers. They met at Farnborough, Eng., April 17, 1860. There was a great difference in weights—195 lb. for Heenan to the Englishman's 149 lb.—but Sayers held Heenan to a 42-round draw, the last five rounds fought after a crowd entered the ring.

Although the Heenan-Sayers bout attracted a good deal of attention, the brawling which distinguished old-time pugilism continued to alienate most of the better people of England and it became apparent that if a widely popular sport was to emerge and endure it would have to be extracted from rather than preserved in the hurly-burly of prize fighting. When John Graham Chambers of the Amateur Athletic club devised a new set of rules he tried to emphasize the aspects of pugilism which Daniel Mendoza had first exploited—that is, the science and skill of it. These attributes were expected to draw a better class of patron than the old London rules.

The rules appeared in 1867 and differed from the London rules in four major respects: contestants wore padded gloves; each round consisted of three minutes of fighting followed by a minute of rest; wrestling was illegal; any fighter who went down had to get up unaided within ten seconds and, if he could not do so, was declared knocked out of time and the fight was over.

John Sholto Douglas, 8th marquess of Queensberry (1844–1900), had lent his name to Chambers' rules so that they would be associated with the nobility. At first professionals regarded them askance and thought practitioners of the new code somewhat effete. But gradually, although championships among professionals continued to be decided by the London rules, more and more fighters who were quick with their hands and feet and preferred punching to wrestling learned the Queensberry style. Prominent among these was James ("Jem") Mace (1831–1910) who, though weighing only 160 lb., won the English heavyweight title in 1861 through judicious use of a good left jab and a quick pair of feet. Having proved that he could win under the London code he was more or less free to do as he pleased and he chose to do two things which had a vast influence on the course of boxing history. The first was to go abroad to fight. The second was to show growing interest in the Queensberry style of fighting. In regard to the first move, Nat Fleischer explains its background in his book *The Heavyweight Championship* (G. P. Putnam's Sons, 1949):

> At this time the good people of England, following the example of their blessed Queen Victoria, were in a state of almost orgiastic virtue. A reform wave swept the country. The clergy preached sulphurous sermons against the "ruffians of the ring." Prize fighting was becoming daily a more perilous pastime as the magistrates, falling in line with the popular trend, imposed heavier and heavier jail sentences on persons brought before them who were in any way associated with the ring.
>
> A great exodus followed. [Ned] O'Baldwin, Tom Allen, Joe Wormald, Joe Goss, and a host of lesser lights sailed for the United States. In a sense, they were jumping out of the frying pan into the fire, for the transatlantic brand of Victorianism differed only in detail from the native variety. The fistic tide, nevertheless, set strongly toward the United States.

It was only a matter of time before Mace arrived, too. He actually was at his best when sparring with gloves. His enthusiasm for glove fighting gave the Queensberry code a real advantage, for it was generally conceded that there was nothing effete about Jem Mace. Jem fought his last bout in 1890, in England. Meanwhile, both the London and Queensberry rules were followed by a new generation of fighters in America and the time for decision between them was near.

Queensberry rules had gained favour steadily. Jack McAuliffe, who held the American lightweight title 1885–96, learned these rules and largely fought under them, although sometimes using skintight gloves instead of padded ones. "Nonpareil" Jack Dempsey, the first world middleweight champion, fought under both London and Queensberry rules but saw the latter gain in popularity toward the end of his reign (1884–91).

John L. Sullivan (*q.v.*), who claimed the world's heavyweight championship, was more famous and ruled a more popular division than either McAuliffe or Dempsey and it was, therefore, up to him to make the move which finally aligned professional fighters on the side of the Queensberry rules. He did so not out of a desire to benefit sport. He did so because he felt he could not afford to do otherwise.

Having won the American heavyweight title at the age of 24, Sullivan squandered remarkable speed of hands and feet on the London era, when these qualities were less appreciated than might later have been the case. Luckily, he also had great strength and a mighty punch. These latter qualities made and kept him a bare-knuckle champion. Public authorities had, however, grown increasingly hostile to pugilism. In 1889, when Sullivan defended against Jake Kilrain in the last heavyweight championship bare-knuckle fight to be held in America, prize fighting (London rules) was illegal in every state of the union. Subsequent to the Kilrain fight Sullivan was arrested and plagued with legal actions which interfered with his making a living for the next year. He complained that it cost him $18,670 to settle for the Kilrain match. Therefore when at the age of 34 a dissipated, slow John L. agreed to defend his title against quick, clever "Gentleman Jim" Corbett, Sullivan insisted on Queensberry rules. John L. lost to the epitome of Queensberry skill. Corbett in a five-year reign (1892–97) proved that a big man could be highly scientific. He launched boxing on a lucrative new era.

MODERN BOXING

Divisions.—In Sullivan's time the welterweight, featherweight and bantamweight divisions also were active although the weight limits varied with the champions, since it was then a champion's prerogative to adjust the weight to suit his own convenience, as long as he did not go to extremes. The light heavyweight class, called cruiserweight in Great Britain, was created in 1903 to include all boxers weighing over the middleweight limit and not more than 175 lb. In 1910 the flyweight class was created in Britain, recognized also in the United States, to provide an official division for the smallest boxers. The weight limit was set at 108 lb., later changed to 112 lb. The divisions became heavyweight (over 175 lb.); light heavyweight or cruiserweight (over 160 lb. and not over 175); middleweight (over 147 lb. and not over 160); welterweight (over 135 lb. and not over 147); lightweight (over 126 lb. and not over 135); featherweight (over 118 lb. and not over 126); bantamweight (over 112 lb. and not over 118); and flyweight (not over 112 lb.). Following World War I and World War II boxing was so popular in the United States that two other divisions, junior lightweight (class limit 130 lb.) and junior welterweight (140 lb.) also existed briefly.

Economic Impetus.—When the bruisers of Victorian times left England, they went not only to the United States but to Australia and Canada and, occasionally, to continental Europe. The reasons that professional boxing became centred in the United States were chiefly two: an expanding economy made it possible for promoters to conduct bouts fairly regularly for the entertainment of factory hands, miners, lumberjacks and the other workers who flooded into the new country demanding excitement in their off hours; and successive waves of immigration provided husky, hungry boys who had little education and were willing to fight for quick cash. Boxing became, as it remains, a short cut to riches and social acceptance for those near the foot of the economic ladder.

The famines which drove thousands of Irish to seek refuge in America furnished important raw material for the greatest era professional boxing has known. Before 1915 the Irish had become dominant in every division from heavyweight through bantamweight. Oppression, especially in big cities, sent into the ring whole neighbourhoods of Irish-American boys. Terry McGovern, "Philadelphia" Jack O'Brien, Mike ("Twin") Sullivan and his brother Jack, Packey McFarland, Jimmy Clabby, Jack Britton—these were only a few of the colourful, courageous and highly skilled boys who made a profession of boxing.

Meanwhile, the American Negro, free but discriminated against in the land of his birth, turned to boxing also, hoping quite literally to fight his way to the top. And foreign-born Negroes (such as Peter Jackson, Sam Langford, Joe Walcott and George Dixon) came to capitalize on the boxing boom. Lightweight Joe Gans, born in Baltimore, was perhaps the cleverest boxer, pound for pound, in professional annals. He became a world champion (1902–08), as did heavyweight Jack Johnson (1908–15). German, Scandinavian and central European immigration, which increased after the political troubles of 1848, also contributed greatly to this golden age of boxing in the United States.

Polish-American Stanley Ketchel and German-American Billy Papke, Frank Klaus and Frank Mantell dominated the middleweight division 1908–13. Danish-American Battling Nelson and German-American Ad Wolgast ruled the lightweights 1908–12. Such outstanding Jewish fighters as Joe Choynski, Abe Attell, Battling Levinsky, Harry Lewis were active, but even more outstanding Jewish fighters were active from 1915 to 1930, when Benny Leonard, Sid Terris, Lew Tendler, Al Singer, Maxie Rosenbloom and Max Baer were in the ring.

Beginning about 1920 Italian-Americans assumed an importance in boxing. Their influence has continued great and has produced such champions as featherweight and lightweight Tony Canzoneri, heavyweight Rocky Marciano, featherweights Johnny Dundee (nicknamed the "Scotch Wop") and Willie Pep.

The influence of the Negro was continual from the 19th century, although prejudice against him at times was great. John L. Sullivan found it convenient to "draw the colour line" in refusing to defend against Peter Jackson, and Jack Dempsey would not fight American Negro Harry Wills. But during his professional career Joe Louis (*q.v.*) won complete acceptance and his reign as heavyweight champion (1937–49) was one of the most popular in boxing history. Greatly encouraged, and further prompted by the rigours of depression years, Negroes flooded into the ring beginning in the mid-1930s to start a domination comparable to that enjoyed by the Irish prior to 1910. Among them were Henry Armstrong, who held the featherweight, lightweight and welterweight titles simultaneously; Ray Robinson, welterweight and middleweight champion; Archie Moore, light heavyweight champion; and heavyweight champions Ezzard Charles, "Jersey" Joe Walcott, Floyd Patterson, Charles "Sonny" Liston and Cassius Clay.

Purses.—John C. Heenan and Tom Sayers fought for $2,500 a side and a championship belt in 1860. John L. Sullivan fought Corbett in 1892 for a $25,000 purse and a $10,000 side bet. The man who made boxing big business was George ("Tex") Rickard, its first great promoter. After staging the world's lightweight championship bout between Joe Gans and Battling Nelson to publicize the mining town of Goldfield, Nev., in 1906, he saw that boxing as a spectacle had great potentialities. Through clever press agentry Rickard made it fashionable to be seen at ringside at major bouts. Five of the fights he promoted for Jack Dempsey (*q.v.*), heavyweight champion 1919–26, drew over $1,000,000 in receipts. They were the two bouts against Gene Tunney (1926 and 1927) and a match each against Georges Carpentier of France (1921), Luis Angel Firpo of Argentina (1923) and Jack Sharkey (1927). A natural showman and gambler, Rickard made an art of boxing ballyhoo, playing on people's prejudices in pitting Negro against white (Gans-Nelson and Jack Johnson-Jim Jeffries), alleged slacker against war hero (Dempsey-Carpentier) and American against foreigner (Dempsey-Firpo). His fortunes were tied to Dempsey's, however, and after Jack's retirement he lost over $150,000 on Gene Tunney's 1928 title defense against Tom Heeney of New Zealand.

In the depression years which followed, receipts from boxing shows dwindled greatly. The financial centre of boxing remained the United States, although the bout between Primo Carnera of Italy and Paulino Uzcudun of Spain fought in 1930 in Barcelona drew more ($110,000) than all but a few U.S. bouts that year. In 1935 Mike Jacobs, who had been associated with Rickard, signed Louis to a contract and thus launched a new boxing boom. With Louis fighting exclusively for him, Jacobs had the best drawing card since Dempsey. In two years he was promoting for Madison Square Garden in New York. Louis fought in three bouts that grossed over $1,000,000: Max Baer (1935); Max Schmeling (1938); and Billy Conn (1946). In 1945 the receipts from a year of boxing at Madison Square Garden exceeded $2,000,000 for the first time.

When James D. Norris and Arthur Wirtz succeeded Jacobs as America's outstanding promoters (1949) with their International Boxing club, boxing was undergoing a great change brought about by televising of bouts. Attendance fell off sharply for all but the most attractive matches, people preferring to watch televised bouts at home or in theatres. Therefore receipts from the crowd attending became steadily of less importance. When Rocky Marciano defended his heavyweight title against Archie Moore in 1955, the attending crowd paid $948,117. But television receipts gave the bout a gross of $2,248,117. Some lucrative bouts also were being staged outside the United States. British light heavyweight Freddie Mills drew $200,000 and $182,000 respectively in London bouts against Americans Gus Lesnevich and Joey Maxim. In 1953 English Randy Turpin drew $238,000 in London against French Charles Humez. When Thai bantamweight Chamrern Songkitrat developed into a contender for the world championship, he drew receipts of over $200,000 in 1954 Bangkok bouts against Australian Jimmy Carruthers and Frenchman Robert Cohen.

Individual boxers made fortunes, especially in the years before income taxes were levied on their earnings. Gene Tunney made almost $1,000,000 from the second Dempsey fight. Dempsey earned $2,402,500 in eight title bouts. But the $2,722,000 which Joe Louis earned in 27 title bouts was heavily taxed.

Spread of Boxing.—As the English traveled they took boxing with them to the nooks and crannies of the world. It had attained some popularity in continental Europe before World War I but this popularity increased when American soldiers, who learned boxing as part of their training for bayonet fighting, showed great enthusiasm for the sport. Boxing was a feature of the Inter-Allied games held in Paris in 1919 and not many years afterward future world heavyweight boxing champions Primo Carnera and Max Schmeling of Germany launched their professional careers. The sport gained popularity more slowly in sections of Asia. In Thailand it developed alongside a traditional native sport similar to the old French *savate*, in which blows were delivered with feet as well as hands. During the first half of the 20th century, world champions from the following countries other than England and the U.S. were crowned: Canada, Germany, Italy, France, Ireland, Greece, Australia, Philippine Islands, Cuba, Mexico, Panama, Spain, Puerto Rico, South Africa, Hawaii, Algeria, Wales, Tunisia, Scotland, Japan and Argentina.

SUCCESSION OF MODERN WORLD HEAVYWEIGHT CHAMPIONS

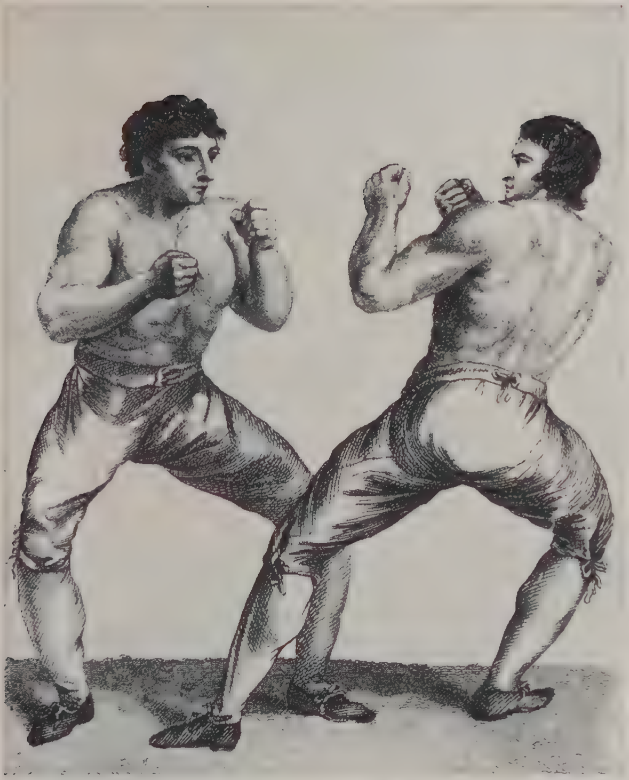
1882	John L. Sullivan (bare-knuckle title)
1892	James J. Corbett (Queensberry title)
1897	Bob Fitzsimmons
1899	James J. Jeffries (retired undefeated 1905)
1906	Tommy Burns
1908	Jack Johnson
1915	Jess Willard
1919	Jack Dempsey
1926	Gene Tunney (retired undefeated 1928)
1930	Max Schmeling
1932	Jack Sharkey
1933	Primo Carnera
1934	Max Baer
1935	James J. Braddock
1937	Joe Louis (retired undefeated 1949)
1949	Ezzard Charles
1951	"Jersey" Joe Walcott
1952	Rocky Marciano (retired undefeated 1956)
1956	Floyd Patterson
1959	Ingemar Johansson
1960	Floyd Patterson
1962	Charles "Sonny" Liston
1964	Cassius Clay (title rescinded 1967)
1970	Joe Frazier

Changing Styles.—Styles of boxing underwent great changes after 1892, became highly individual and generally less circumscribed by convention. The classic style, popular at the turn of the century, was fought from a straight stand-up stance, with the emphasis upon straight blows and long-range boxing. The straight left jab was used prominently both in attack (to pile up points and wear an opponent down) and in defense (to beat the opponent to the punch). Scientific boxing was an art appreciated as such by the fight fans of that time. Corbett, not a heavy puncher, was adept at blocking (stopping a punch with his gloves or arms); slipping (avoiding it by moving his body while keeping his feet stationary); ducking; feinting; parrying (knocking a blow aside); and side-stepping. His own attack was comprised of sharp, quick punches that were timed to keep his opponent off balance. Young Griffo, Australian claimant of the world featherweight title, was such a clever defensive boxer that he could stand on a handkerchief and avoid the blows of an attacker who enjoyed freedom of movement. Lightweight Joe Gans glided on perfectly co-ordinated feet as he blended skill and power into a smoothly efficient style. With these men and their contemporaries, boxing was very much a defensive skill as well as an offensive one.

With the increase in popularity of the sport as a spectacle, however, the crowds began more frequently to demand the knockout. When Jack Dempsey was heavyweight champion he and promoter Rickard demonstrated that there was no substitute for a knockout punch at the boxing box office. Dempsey did more, too. He helped to revolutionize the style of boxing.

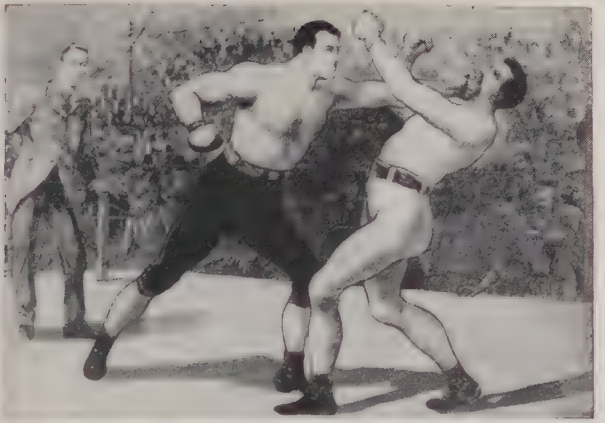
Dempsey was a beautifully co-ordinated athlete who kept on the offensive almost continually, bobbing up and down and moving from side to side as he delivered short, swinging blows out of a crouch at blinding speed. His constant movement and the speed of his attack constituted his defense. He had little patience with

BOXING

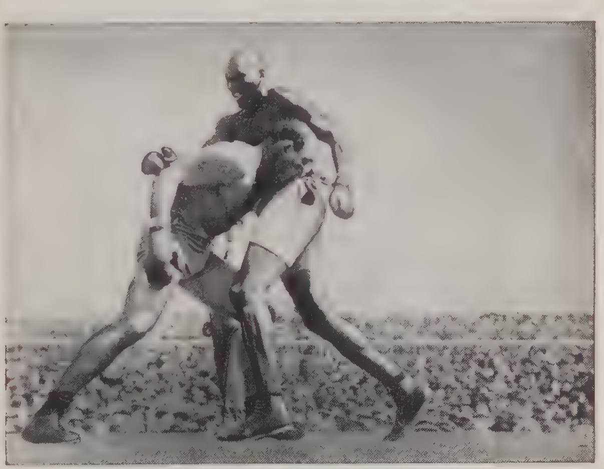


Richard Humphries *v.* Daniel Mendoza, London, 1790. Mendoza was a celebrated figure in early British pugilism

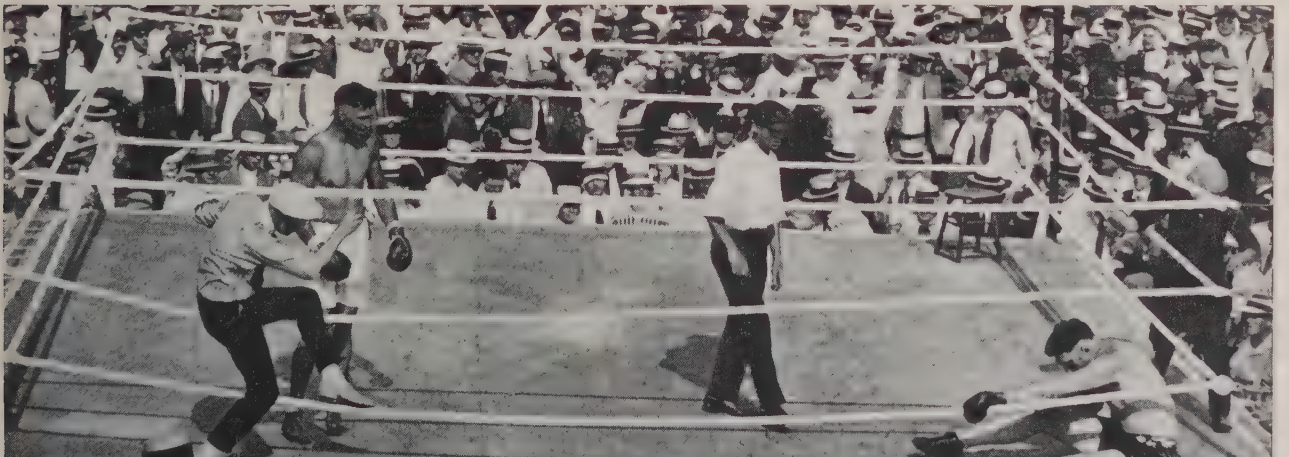
18TH-CENTURY PUGILISM AND EARLY BOXING



Corbett *v.* Sullivan, New Orleans, La., 1892. This was the first world heavyweight bout under the Queensberry rules which required gloves instead of bare fists



Johnson *v.* Jeffries, Reno, Nev., 1910. Johnson was the first Negro to hold the world heavyweight title

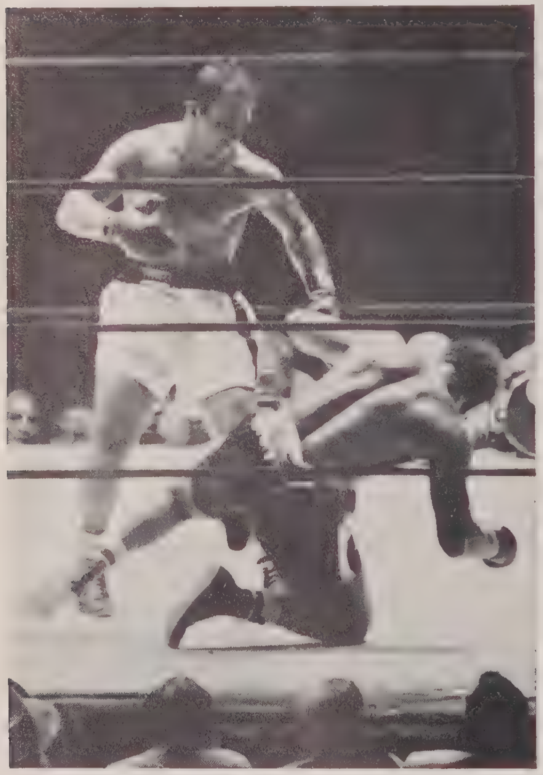


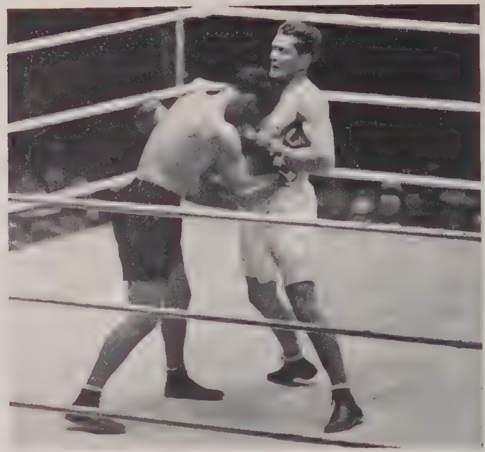
Dempsey *v.* Willard, Toledo, O., 1919

PHOTOGRAPHS, (TOP LEFT) RADIO TIMES HULTON PICTURE LIBRARY, (TOP RIGHT) INTERNATIONAL, (CENTRE RIGHT, BOTTOM) UNITED PRESS INTERNATIONAL

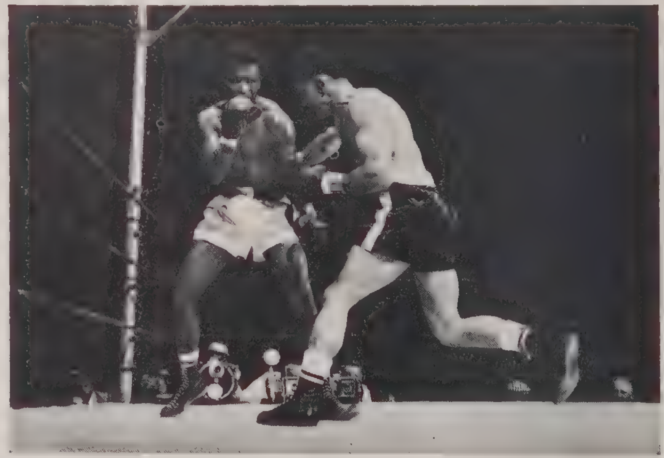
BOXING

Rocky Marciano flooring challenger Archie Moore, light heavyweight champion, in the sixth round of their heavyweight championship fight at New York City, 1955. Marciano retained his championship with a knockout in the ninth round

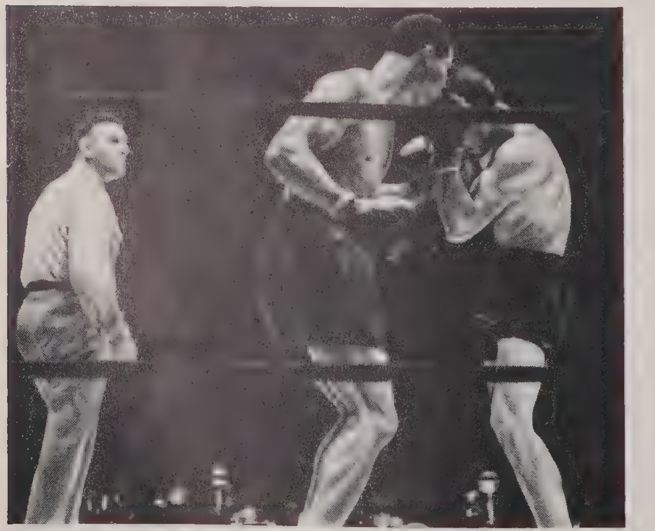




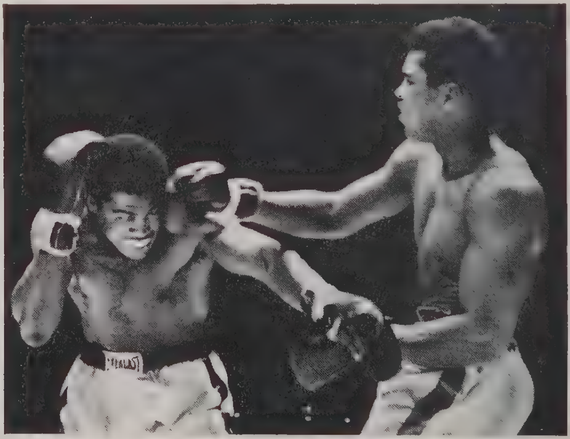
Jack Dempsey (left) and Gene Tunney clinch during their second fight for the heavyweight championship of the world at Chicago, 1927. Tunney won in a 10-round decision



Challenger Carmen Basilio (right) pressing Ray Robinson in a bout for the middleweight title at New York City, 1957. Basilio won a 15-round split decision



Heavyweight champion Joe Louis (left) lands a left hook in the 13th round knockout of Billy Conn in their fight at New York City, 1941



Cassius Clay (Muhammad Ali) lands a hard right to the left eye of Ernie Terrell in the fourth round of their heavyweight championship fight at Houston, Tex., 1967. Clay won by decision

PHOTOGRAPHS, (TOP RIGHT) INTERNATIONAL NEWSREEL, (CENTRE LEFT, CENTRE RIGHT) UPI COMPIX, (BOTTOM LEFT, BOTTOM RIGHT) WIDE WORLD

the jab and less with long-range fighting, preferring the infighting to which his powerful, short hooks were adapted. This spectacular style of boxing as practised by Dempsey had a wide appeal because it often resulted in a knockout and because it reduced defensive maneuvering, which had to be understood to be appreciated, to an absolute minimum. The wider the boxing audience became, the less it cared for the refinements of the old school, the more it roared for the knockout.

Because crowds paid to see heavy punching, professional boxers, especially in the United States, began to stress aggressiveness and punching, even if they had to "take two to land one." The typical stance became a slight crouch (not so pronounced as Dempsey's) and there was an increasing emphasis on infighting. Cleverness was not lost for featherweight Willie Pep, who won the world title in 1942 and again in 1949, and Ray Robinson, who won the welterweight title in 1946 and the middleweight title in 1951 (twice), in 1955, in 1957 and in 1958, rank among the all-time great tacticians of boxing. Joe Louis was an expert boxer as well as a paralyzing puncher. There have been still others. With the advent of home television in the late 1940s, the emphasis went still more to punching. Housewives and clerks who had never been to boxing bouts now were part of the audience. They were chiefly interested in a good show—that is, plenty of action. The refinements of skilled boxing did not interest them enough to make skill a requisite for the bouts they saw.

Amateur.—From the time when the old English bare-knuckle champions began teaching their sport to English gentlemen, there have been enthusiastic amateur pugilists. At first they fought for the pure pleasure of it. Warren Barbour, an extremely competent heavyweight, won the U.S. championship in 1910 but refused to turn professional although some fight experts were confident he could beat the great Negro champion, Jack Johnson. In 1919 another promising American heavyweight, Edward Eagan, won the national title and also refused to become a professional. But the amateur ring nevertheless increasingly became a training ground for professional boxing.

The British Amateur Boxing association was established in 1884 to control amateur boxing in Great Britain. The Amateur Athletic union, established in 1888 in the United States, began that year to conduct annual competitions. Annual collegiate competitions have provided some contenders for A.A.U. honors. In 1923 still another amateur competition was started by a Chicago newspaper. Called the Golden Gloves (the name was first used in New York in 1927), it grew quickly into a national competition rivaling the A.A.U. Such world professional champions as Joe Louis, Ray Robinson, Joey Maxim, Floyd Patterson, Ezzard Charles and Rocky Marciano got valuable experience in amateur competition.

Boxing in seven divisions was introduced into the modern Olympic games in 1904. In 1920 light heavyweight competition was added and in 1952 the classes became ten with class limits as follows: flyweight, 112 lb.; bantamweight, 119; featherweight, 125; lightweight, 132; light welterweight, 139; welterweight, 147; light middleweight, 156; middleweight, 165; light heavyweight, 178; heavyweight, over 178. The spread of amateur boxing is reflected by the number of countries represented by boxers winning Olympic titles over the years (*see* OLYMPIC GAMES).

RULES

Professional.—Uniformity has been notably lacking in the rules under which professional boxing matches are conducted in different countries and in different states of the United States. Generally speaking, however, bouts take place in a "ring" which is 20 to 24 ft. square and surrounded by three strands of ropes. Each bout is comprised of rounds of three minutes of fighting followed by a minute of rest. Rounds range in number from 4 to 20, with 15 the usual length of a championship fight. Padded gloves, ranging from six to eight ounces in weight are worn by the fighters. Fouls include hitting below the belt, butting with the head, hitting with one hand while holding the opponent with the other, hitting an opponent who is down and using the "rabbit punch," a blow delivered to the base of the skull. Penalties for these infractions vary greatly. In the United States a "no foul" rule was adopted after Max Schmeling won the heavyweight championship on a foul claim of doubtful validity in 1930. Under this rule all fighters must wear protective cups. If a boxer strikes below the belt he is only penalized by loss of the round unless his infraction is flagrant and repeated, in which case he is disqualified. Outside the United States a low blow usually brings disqualification.

In general, United States referees permit more infighting and are less strict about holding, butting and other roughing up at close range than European officials. A bout can end in a knockout, when a boxer is knocked down and does not regain his feet before the count of ten (seconds); in a technical knockout, when a boxer is judged by the referee incapable of defending himself even though he has not been counted out; in a draw; in a decision, when a bout goes the scheduled distance and is won on points; or in a no contest, when the referee feels that for some reason the boxers are not putting up a good bout. In the United States in bouts that go the scheduled distance a referee and two judges have equal votes in determining the winner, in some states the vote being in terms of points scored; in some, rounds won; and in some, both. In Britain and most of continental Europe the referee has the whole responsibility.

Amateur.—The rules for conducting amateur boxing are very similar in Great Britain, the United States and continental Europe, although there are some national idiosyncrasies. Perhaps the most notable is that United States referees permit much more infighting and clinching than the others and go between the boxers to cause them to break up a clinch, instead of expecting them to break on voice command. Bouts are fought in rings 16 to 20 ft. square and eight- to ten-ounce gloves are used. Bending below the waist is prohibited by international rules because it may lead to butting with the head. The voting, under international rules, is done entirely by three judges; the referee simply supervises the fighting. Here again the rules of the A.A.U. specify otherwise for United States amateur bouts. There two judges and the referee score each bout by rounds and points and vote for the winner. In 1952, however, the A.A.U. did adopt the ten divisions accepted under international rules and began conducting competitions in them.

TECHNIQUE

Stance and footwork are the basis of good boxing for they make it possible for the boxer to keep his balance while punching and moving. The left foot of the right-handed boxer should be a step ahead of the right, the toes of both feet pointed slightly toward the right. Both knees are bent slightly. The weight of the body rests largely on the right leg. The right heel lifts when a punch is delivered. In advancing the left leg leads, the right follows. In retreating, the reverse takes place. The chin is usually sunk slightly behind the left shoulder. The left hand is advanced, ready to strike or parry, and the right hand is held close to the body, sometimes in front of the chin.

The left jab is delivered by straightening the left elbow with a snap. It is the key blow of boxing, used in both attack and defense. Other basic punches are the left and right hooks, delivered with bent elbow; the right cross, a straight punch delivered with the right hand; and left and right uppercuts, short, swinging blows that come up from the direction of the ring floor. Swings, which are longer than hooks, are delivered also with bent elbows but are not usually so effective since a good boxer can avoid them. When a boxer has co-ordinated footwork with punching he is able to get the maximum body weight behind each punch. He is never off balance. Chief targets for the knockout punch are the chin, the temples and the stomach.

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(M. M. W.)

BOXING DAY, the name given in Great Britain to the first weekday after Christmas, on which Christmas "boxes," or presents, are given to errand boys, postmen, etc. It is a bank holiday (*q.v.*).

BOXWOOD, the wood obtained from the genus *Buxus*, the principal species being the well-known tree or shrub *B. sempervirens*, the common box, in general use for borders of garden walks, ornamental parterres, etc. Even more important in gardens is the dwarf variety *suffruticosa*, which does not too rapidly overgrow the proportions of the parterre. The cold-hardier *B. microphylla koreana* is used in northern gardens. The other source of the ordinary boxwood of commerce is *B. balearica*, which yields the variety known as Turkey boxwood. The common box is grown throughout Great Britain (perhaps native in the chalk hills of the south of England), in the southern part of the European continent generally, and extends through Iran into India, where it is found growing on the slopes of the western Himalayas. Only a very small proportion of the wood suitable for industrial uses is now obtained in Great Britain. The box is a very slow-growing plant, adding not more than one and one-half or two inches to its diameter in 20 years, and on an average attaining only a height of 16 ft. with a mean diameter of 10½ in. The leaves of this species are small, oval, leathery in texture, and of a deep glossy green colour. *B. balearica* is a tree of considerable size, attaining to a height of 80 ft., with leaves three times as large as those of the common box. It is a native of the islands of the Mediterranean, and grows in Turkey, Asia Minor and around the shores of the Black sea. The wood of both species possesses a delicate yellow colour; it is very dense in structure and has a fine uniform grain, which has given it unique value for the purposes of the wood engraver. A large amount is used in the manufacture of measuring rules, various mathematical instruments, flutes and other musical instruments, for turning, for inlaying and for small carvings. The use of boxwood for turnery and musical instruments is mentioned by Pliny, Virgil and Ovid.

JOHN MARKHAM

COMMON BOX (BUXUS SEMPERVIRENS)

BOYACÁ, a densely-settled department in the Andes mountains of eastern Colombia. Area 26,158 sq.mi.; pop. (1964) 1,058,152. Most of the population lives in the cool uplands of the Andes, cultivating potatoes, wheat, barley, haba beans and the lesser Andean root crops under a system of tenancy inherited from the colonial era. Dense forests on mountain slopes yield fine wood. Besides the capital city of Tunja, the principal towns are Chiquinquirá, Sogamoso and Moniquirá. A few miles south of Tunja, near the village of Boyacá, was fought the decisive battle in New Granada's war for independence on Aug. 7, 1819. The famous Muzo emerald mines are located in the western part of Boyacá. At Paipa, 30 mi. north of Tunja, there are famous mineral springs. Colombia's first integrated iron and steel plant (capacity 122,000 tons) was built at Paz del Río, 5 mi. N. of Sogamoso at an elevation of nearly 9,000 ft. Iron ore, coal and limestone are in ample supply but major consuming markets are so distant that the project has frequently been criticized as uneconomic. The larger part of the department of Boyacá lies within the *llanos* or low plains between the Andes and the Orinoco river. This vast area was for a time separated from Boyacá as the Comisaría de Casanare, but it was reincorporated into Boyacá in 1950. (Js. J. P.)

BOYAR (Russ. *boyarin*, plur. *boyare*). The boyars formed the upper stratum of society and of the state administration in medieval Russia. In Kievan Russia of the 10th–12th centuries they constituted the senior group in the princely retinue (*druzhina*), occupying the higher posts in the armed forces and in the civil administration. The boyar council (*boyarskaya duma*) usually advised the prince in all important matters of state, although its position and competence were not defined by law. In Novgorod, despite its democratic constitution, the prosperous boyars were influential in political life and in the local economy. In the northeastern Russian principalities, during the 13th and 14th centuries, the boyars formed a privileged class of rich landowners who were also the prince's aides and councilors; they retained, however, the right to leave their sovereign and enter another prince's service without losing their landed estates.

From the 15th to the 17th centuries the boyars of Muscovy formed a closed aristocratic caste that surrounded the throne of the grand prince (later the tsar) and ruled the country together with him. They were drawn from the ranks of about 200 families descended from former appanage princes whose possessions had been annexed by Moscow, from old Moscow boyar families, or from aristocratic newcomers from other lands. The rank of boyar did not belong to all members of these families, but only to those senior members to whom the tsar granted this title. Below the boyars stood the group of *okolnichie*. Together they formed the boyar council, which, together with the tsar, directed all internal and foreign affairs of the state. According to the code of laws (*Sudebnik*) of 1550, the decisions of the boyar council, as confirmed by the tsar, were recognized as the normal form of legislation. The boyars and *okolnichie* served as heads of the most important government offices (*prikazy*), as governors of the most important provinces, as military commanders and as chiefs of the most important foreign embassies.

The tsar, however, did not have a free hand in the choice of his chief aides. He was bound by the peculiar aristocratic custom called *mestnichestvo*. This was a complicated system of service-relationships between the aristocratic families of Muscovy. They were ranked in a definite genealogical order according to their relative seniority, while posts in the civil and military administration were arranged in a similar hierarchical scale. In filling the highest posts in his army and administration, the tsar had to consider not so much the candidate's personal merits but rather his genealogical seniority as defined by earlier precedents. *Mestnichestvo*, which hampered the choice of the right man for the right position and caused endless quarrels among the boyar families over seniority, was finally abolished in 1682.

After Ivan the Terrible's reign and the "time of troubles," the social and political importance of the boyars declined throughout the 17th century. Peter the Great abolished the very rank and title of boyar and made state service the sole means of attaining a high position in the bureaucratic hierarchy.

Bibliography.—V. O. Klyuchevski, *Boyarskaya Duma Drevnei Rusi* ("The Boyar Duma of Ancient Russia"), 4th ed. (1909), *A History of Russia*, Eng. trans. by C. J. Hogarth, vol. 2 (1912), and *Kurs Russkoi Istorii*, vol. 2 (1957). *See* also A. Markevich, *O Mestnichestve* (1879) and *Istoriya Mestnichestva* (1888); V. Sergeevich, *Drevnosti Russkogo Prava* ("Antiquities of Russian Law"), vol. i, 3rd ed. (1909); G. Vernadsky, *Russia at the Dawn of the Modern Age* (1959).

(S. G. Pu.)

BOY BISHOP, according to a custom widespread in the middle ages, was chosen in connection with the festival of Holy Innocents. In England the boy bishop was elected Dec. 6, the feast of St. Nicholas, the patron of children, and his authority lasted till Holy Innocents' day (Dec. 28). The boy and his colleagues took possession of the cathedral and performed all the ceremonies and offices except Mass. Several ecclesiastical councils had attempted to abolish or to restrain the abuses of the custom, before it was prohibited by the council of Basel in 1431. It was, however, too popular to be easily suppressed. In England it was finally abolished by Elizabeth I.

An analogous custom survived until late in the 18th century in Germany, where on March 12, in honour of St. Gregory, the patron of schools, a schoolboy was elected bishop.

See E. K. Chambers, *The Medieval Stage*, vol. i, pp. 336–371 (1903).

BOYCE, WILLIAM (1710–1779), one of the foremost English composers of church music, notable also for his symphonies and as an organist and musical editor. He was probably born in London in 1710, and was a chorister under Charles King at St. Paul's cathedral, and later a student of Maurice Greene, the organist there. He became organist of the Oxford chapel, Vere street, London, in 1734. Other appointments about this time included that of conductor of the Three Choirs festival (1737).

Boyce's career as a composer was closely related to his many official positions. He became composer to the Chapel Royal in 1736 and many of his anthems and church services were written for use there and at the London churches of which he was organist—St. Michael's, Cornhill, 1736–68, and All Hallows, Thames street, 1749–68. He also composed secular music for the stage, an early example being the music for Lord Lansdowne's masque, *Peleus and Thetis,* first produced in 1740. The serenata *Solomon* (1743) is among the best of such works; it contains the once-popular tenor scena "Softly rise, o southern breeze." His next published work was *Twelve Sonatas for two Violins with a Bass* (1747), which achieved an instant and lasting popularity. In about 1745 he began the publication of the first of several volumes of the collection of his own songs and cantatas, *Lyra Britannica.* In 1749 he received his doctorate of music from the University of Cambridge for his setting of William Mason's ode and of the anthem *O be joyful* for the duke of Newcastle's installation as chancellor. In the same year he wrote the music for *The Chaplet,* "a musical entertainment" by Moses Mendez, which long remained popular. The next year, 1750, saw a revival of Dryden's *Secular Masque,* with music by Boyce, including the well-known *Song of Momus to Mars.* In 1751 came another musical entertainment by Mendez and Boyce—*The Shepherd's Lottery.*

On Greene's death in 1755, Boyce succeeded him as master of the King's Band of Music and thereafter composed the music for the annual new year and birthday odes by the poet laureate. In 1758 he became one of the organists at the Chapel Royal and in 1759 he composed the music for the pantomime, *Harlequin's Invasion,* by Garrick, which includes his most famous song, *Heart of Oak.* In 1760 appeared his *Eight Symphonys,* orchestral works selected from his odes, operas, etc. They had some success, but ten years later, when he published a second set, the *Twelve Overtures,* the more exciting symphonies of the Mannheim school were in vogue and Boyce's shapely and tuneful "ancient style" symphonies were regarded as out of date. Meanwhile, he had begun to publish his famous collection of *Cathedral Music,* 3 vol. (1760–73). Based in part on materials collected by Greene, it was a landmark in the history of church music, the first collection since the Restoration, and the first to be printed in score. Boyce performed his work well by the standards of his time, and his collection, which covered three centuries, was only superseded in the mid-19th century.

Boyce had been long afflicted by deafness, and in 1769 he gave up all appointments except that at the Chapel Royal. He was still able to teach, however, and his pupils included the child prodigies, Charles and Samuel Wesley. He died in London, Feb. 7, 1779.

As a man Boyce was respected and loved. As a composer, his fame long rested mainly on his church music; his anthems are still sung. Later, the vigour of his symphony-overtures was increasingly recognized and many have been reprinted and performed. Some, arranged by Constant Lambert, were used for the ballet *The Prospect Before Us,* first produced at Sadler's Wells, London, in 1940.

See his *Overtures,* ed. by G. Finzi, in *Musica Britannica* (1957).
(Cs. Ch.)

BOYCE THOMPSON INSTITUTE FOR PLANT RESEARCH, INC., of Yonkers, N.Y., was founded and endowed by Col. William Boyce Thompson of Yonkers. The institute was formally opened on Sept. 24, 1924. It is a foundation for research on plants and plant products, insecticides and fungicides. The results of the foundation's research are published.

The greenhouses and other growing chambers give accurate control of growth conditions for plants, including light (quality, daily duration and intensity), humidity, temperature and carbon dioxide concentration of the air. This apparatus is on sufficiently large scale to permit plants to be grown to maturity in large numbers. Special attention is given to adequate equipment so that researches may be carried forward with facility and accuracy. The laboratories are adequately equipped for researches in physiology, pathology, morphology and anatomy, biochemistry, microchemistry, physical chemistry, entomology, organic chemistry and plant breeding. While the laboratories are equipped and manned on the basis of techniques, the problems are generally attacked as projects, focusing all techniques on them necessary for their solution, even adding new lines of technique for particular problems when needed.

The institute has sufficient land available for field plots so that laboratory findings can be tested out on a field basis. A large arboretum gives adequate opportunity for the study of problems of forest and ornamental plants, including propagation, diseases, insect pests, soil adaptation and hardiness.

The institute has held the view that research on plants should contribute alike to science and to practice and that real progress in either requires a fundamental attack. It is world famous for its researches in certain phases of plant science. These include chemicals for forcing dormant plant organs and the effect of such chemicals upon plant metabolism; germination and storage of seeds, especially those offering difficulties in practical fields such as conservation, forestry, horticulture and seed trade; plant hormones and other chemicals that regulate plant development, movement and metabolism; virus and yellows diseases of plants; and synthesis of cellulose by plant cells and structure of primary cell walls. (W. Cro.; X.)

BOYCOTT, CHARLES CUNNINGHAM (1832–1897), English estate manager who achieved notoriety during the agitation over the Irish land question when he became the originator of the word "boycott." Born in Norfolk on March 12, 1832, the son of a parson, he retired from the army with the rank of captain and in 1873 became agent for the earl of Erne's estates in County Mayo, Ireland. The Land league, formed in 1879 when bad harvests threatened a new famine (*see* Ireland: *History*), soon told Boycott that he must reduce rents and in 1880 made a concerted demand for a 25% reduction. In Sept. 1880, after Boycott had attempted to serve writs for eviction, C. S. Parnell urged that without resort to violence the tenants should avoid any communication with those who refused their demands. This tactic was first used on Boycott, and its success was demonstrated when he needed the help of 50 volunteers from Ulster, working under an armed escort of 900 soldiers, to harvest his crops. Boycott left Ireland the same year, but conditions quickly eased after Gladstone's Land act of 1881 had set up fair rent tribunals. Boycott became an agent for estates in Suffolk in 1886 and died there on June 19, 1897.

After 1880 the term "boycott" soon came into common use and was at first used to describe all forms of nonviolent intimidation; it is now generally synonymous with "sending to Coventry."
(D. G.)

BOYD, the name of an old and distinguished Scottish family, one member of which, Sir Robert Boyd, had fought with William Wallace and Robert I (the Bruce), and later acquired the barony (1592) and earldom (1661) of Kilmarnock.

Robert Boyd (d. *c.* 1481), Lord Boyd, a son of Sir Thomas Boyd (d. 1439), was created a peer *c.* 1454 and was one of the regents of Scotland during the minority of James III. He secured the person of the young king in 1466 and was appointed governor of the realm (1466) and chamberlain (1467). He arranged the marriage (1469) between James III and Margaret, daughter of Christian I, king of Denmark and Norway, which secured the cession by Norway to Scotland of Orkney and Shetland. But Boyd's great power aroused jealousies, and he was attainted of treason and sentenced to death in Nov. 1469; he escaped to England, and died *c.* 1481, probably at Alnwick, Northumberland.

Thomas Boyd (d. *c.* 1473), earl of Arran, Robert Boyd's eldest son, received his title in April 1467, on his marriage with Mary, sister of James III, and was principal envoy to Denmark for the negotiations of 1468–69. On his return with King James's bride in July 1469 he learned of his family's fall from power and escaped with his wife to Denmark. He was forfeited by parliament in Nov. 1469, and is thought to have been dead by 1474, the date of his widow's marriage to Lord Hamilton, from whom the Hamilton earls of Arran were descended.

Robert Boyd (*c.* 1517–90), Lord Boyd, was prominent in Scottish politics from his succession to the title in 1551 or 1558. At first he favoured the reformed religion, but was afterward a trusted adviser of Mary Stuart and supported her at the battle of Langside (1568). During the queen's captivity he was often employed on diplomatic errands and was suspected of participation in the murder of the regent Moray. He was in favour under the regent Morton, but was banished to France in 1583 for a short while, for his share in the raid of Ruthven, a plot to seize James VI. He died on Jan. 3, 1590.

Several descendants of the 1st Lord Boyd held the office of chamberlain of Kilmarnock. THOMAS BOYD (*c.* 1547–1611), Lord Boyd, resigned his whole estate to James VI, and on Jan. 12, 1592, was granted the lordship and barony of Kilmarnock. His great-grandson WILLIAM BOYD (d. 1692), Lord Boyd of Kilmarnock, was created earl of Kilmarnock on Aug. 17, 1661, and the barony was merged in this title until both were forfeited by the attainder of his great-grandson, WILLIAM BOYD (1705–46), 4th earl of Kilmarnock, who was captured fighting for Charles Edward, the Young Pretender, at the battle of Culloden in April 1746. He was beheaded on Aug. 18, 1746.

William Boyd's second but first surviving son, JAMES BOYD (1726–78), succeeded to the estates but not to the title of his father. On the death of his maternal great-aunt, he became, in 1758, 15th earl of Erroll, adopting the Erroll family name of Hay. The barony of Kilmarnock was revived in favour of WILLIAM GEORGE HAY (1801–46), 18th earl of Erroll, and the title Lord Kilmarnock was thereafter used by the eldest son of the earl of Erroll. JOSSLYN VICTOR HAY (1901–41), 22nd earl of Erroll, was succeeded in the earldom of Erroll by his daughter, and in the barony of Kilmarnock by his brother, GILBERT ALLAN ROWLAND HAY (1903–), who resumed the name of Boyd.

BOYDELL, JOHN (1719–1804), English publisher, engraver and lord mayor of London, whose good taste and liberality as a publisher of engravings exerted an extensive influence on English art, was born at Dorrington, on Jan. 19, 1719. At the age of 21 he went to London and was apprenticed for seven years to an engraver. In 1746 he published a volume of views in England and Wales and started in business as a print seller. He was sheriff in 1785, and in 1790 became lord mayor of London. In 1786 he published, by subscription, a series of prints illustrating Shakespeare's plays. The pictures from which these were made were commissioned from the most famous artists of the day and were exhibited in Boydell's own gallery in Pall Mall. In 1802, the year of the production of Boydell's *Shakespeare,* the gallery contained 102 pictures, including canvases by Reynolds, Romney, Opie, Barry, Fuseli, Angelica Kauffmann, Stothard and others. Toward the close of his life Boydell sustained severe losses and was compelled to dispose of his Shakespeare gallery by lottery. He died on Dec. 12, 1804, in London.

BOYD-ORR, JOHN BOYD ORR, 1ST BARON, of Brechin Mearns, in the county of Angus (1880–1971), British scientist and authority on nutrition who was awarded the Nobel Peace Prize in 1949. Born at Kilmaurs, Ayrshire, Scot., on Sept. 23, 1880, he was educated at Glasgow University, where he went on to the study of nutrition after enrolling as a theological student. In 1914 he went to Aberdeen University as director of the Institute of Animal Nutrition and in 1929 founded the Imperial Bureau of Animal Nutrition at Rowett. Boyd-Orr first became well-known following the publication of *Food, Health and Income* (1936), the report of a dietary survey by income groups made during 1935. It showed that the cost of a diet fulfilling basic nutritional requirements was beyond the means of half the British population and that 10% of the population was badly undernourished. The findings of this report and of others conducted by the Rowett Institute formed the basis of the British food rationing system during World War II, when Boyd-Orr was a member of the cabinet's scientific committee on food policy and held the chair of agriculture at Aberdeen. In 1945, the year in which he became rector of Glasgow University and a member of parliament for the Scottish universities, he was elected director-general of the United Nations Food and Agriculture Organization (FAO). He held this post until 1948, and his Nobel award the following year was generally considered to have been due to his work with the FAO. Knighted in 1935, he received a barony on Jan. 1, 1949. He died at his home near Brechin, Angus, Scot., on June 25, 1971.

His writings include *The National Food Supply and Its Influence on Public Health* (1934); *Nutrition in War* (1940); *Food and the People* (1943); *Food—the Foundation of World Unity* (1948); and *The White Man's Dilemma* (1953).

BOYE, KARIN MARIA (1900–1941), the leading woman poet of Swedish modernism, was born at Göteborg on Oct. 26, 1900. She studied at the universities of Uppsala and Stockholm, became a leading figure in the Clarté socialist movement inspired by Henri Barbusse and worked on *Spektrum,* a review propagating psychoanalytical theory and modernistic literary views. Her five collections of poems (beginning with *Moln,* 1922) show the evolution of her outlook and style from the simple expression of a middle-class girl's dreams and a young radical's eager acceptance of life to bolder images, wider perspectives and feeling for the tragic problems of mankind. Among her novels are *Kris* (1934), based on her discovery of her own deviant sexual inclinations, and *Kallocain* (1940), which describes the insupportable oppression of a totalitarian society of the future.

Karin Boye committed suicide at Alingås on April 24, 1941. (L. G. G. T.)

BOYER, JEAN PIERRE (*c.* 1773–1850), president of Haiti. A mulatto, he was born in Port-au-Prince and educated in France. After the first Haitian revolts, he served under Gen. André Rigaud, who ruled part of southern Haiti and opposed Toussaint L'Ouverture (*q.v.*). He fled to France after Rigaud's defeat, returned with the French army in 1802, and then joined the revolt that established Haiti's independence. He was private secretary to Alexandre Sabes Pétion and then chief of the presidential guard. When Pétion died, Boyer's friends in the army forced the senate to elect him as president for life.

Boyer occupied northern Haiti after Henri Christophe's death in 1820 and in 1822 conquered the former Spanish colony of Santo Domingo, thus becoming ruler of the entire island. In 1825 France recognized Haiti's independence in return for a promise, not fully carried out, to pay a $30,000,000 indemnity. Boyer was honest and able but his autocratic policy made him unpopular in later years. He was ousted by a revolution in 1843 and died in poverty at Paris, July 9, 1850. He was responsible for much important legislation including the basic law codes of Haiti. *See* also HAITI: *History.* (D. G. Mo.)

BOYLE, ROBERT (1627–91), English natural philosopher, was one of the founders of modern chemistry. He was the 7th son and 14th child of Richard Boyle, the great earl of Cork, and was born at Lismore castle, Ire., Jan. 25, 1627. While still a child he learned to speak Latin and French, and he was only eight years old when he was sent to Eton. In 1638 he went to travel abroad with a French tutor. Visiting Italy in 1641, he remained during the winter of that year in Florence, studying the "paradoxes of the great star-gazer" Galileo. On returning to England in 1644 Boyle devoted his life to study and scientific research, and soon took a prominent place in the band of inquirers, known as the "Invisible College," who devoted themselves to the cultivation of the "new philosophy." They met often in London, at Gresham college; some of the members also had meetings at Oxford, and Boyle went to reside in that city in 1654. Reading in 1657 of Otto von Guericke's air pump, he set himself, with the assistance of Robert Hooke, to devise improvements in its construction, and with the result, the "machina Boyleana" or "pneumatical engine," finished in 1659, he began a series of experiments on the properties of air. An account of the work was published in 1660 as *New Experiments Physico-Mechanical Touching the Spring of Air and Its Effects.*

Among the critics of the views put forward in this book was a Jesuit, Franciscus Linus (1595–1675), and it was while answering his objections that Boyle enunciated the law that the volume of a gas varies inversely as the pressure, which among English-speaking peoples is usually called after his name, though on the continent of Europe it is attributed to E. Mariotte, who did not publish it till 1676. In 1663 the "Invisible College" became the

"Royal Society of London for improving natural knowledge," and the charter of incorporation granted by Charles II named Boyle a member of the council. In 1680 he was elected president of the society, but declined the honour from a scruple about oaths. In 1668 he moved to London, where he died on Dec. 30, 1691.

Boyle's great merit as a scientific investigator is that he carried out the principles which Bacon preached in the *Novum Organum*. Yet he would not avow himself a follower of Bacon or indeed of any other teacher. He performed experiments in the hope of effecting the transmutation of metals, and he was instrumental in obtaining the repeal, in 1689, of the statute of Henry IV against multiplying gold and silver. With all the important work he accomplished in physics—the enunciation of Boyle's law, the discovery of the part taken by air in the propagation of sound, and investigations on the expansive force of freezing water, on specific gravities and refractive powers, on crystals, on electricity, on colour, on hydrostatics, etc.—chemistry was his peculiar and favourite study. His first book on the subject was *The Sceptical Chemist,* published in 1661, in which he criticized the "experiments whereby vulgar Spagyrists are wont to endeavour to evince their Salt, Sulphur and Mercury to be the true Principles of Things." He advanced toward the view that matter was ultimately composed of "corpuscles" of various sorts and sizes capable of arranging themselves into groups, and that each group constituted a chemical substance. He distinguished between mixtures and compounds and showed that a compound might have different qualities from those of its constituents. He studied the chemistry of combustion and of respiration and made experiments in physiology, where, however, he was hampered by the "tenderness of his nature" which kept him from anatomical dissections.

Besides being a busy natural philosopher, Boyle was interested in theology, and in 1665 would have received the provostship of Eton, if he had taken orders. He learned Hebrew, Greek and Syriac in order to pursue his scriptural studies and spent large sums on biblical translations. By his will he founded the Boyle lectures, for proving the Christian religion against "notorious infidels, viz., atheists, theists, pagans, Jews and Mahommedans," with the proviso that controversies between Christians were not to be mentioned.

(*See* also CHEMISTRY: *History of Chemistry.*)

An incomplete and unauthorized edition of Boyle's works was published at Geneva in 1677, but the first complete edition was that of Thomas Birch, with a life, published in 1744, in five folio volumes, a second edition appearing in 1772 in six volumes, quarto. Boyle bequeathed his natural history collections to the Royal society, which also possesses a portrait of him by the German painter, Friedrich Kerseboom (1632–90).

See also references under "Boyle, Robert" in the Index.

See F. Masson, *Robert Boyle, a Biography* (1914); L. T. More, *Life and Works of the Honourable Robert Boyle* (1944).

BOYLE (MAINISTIR NA BÚILLE), a town in County Roscommon, Republic of Ireland, 106 mi. W.N.W. of Dublin and 24 mi. S.S.E. of Sligo by road. Pop. (1961) 1,739. It is situated on both banks of the Boyle, a tributary of the Shannon, between Loughs Gara and Key, at the foot of the Curlew hills. Three bridges connect the two parts of the town. Trade is mainly agricultural.

To the north of the town stand the extensive ruins of a Cistercian abbey founded in 1161 and suppressed in 1569, including remains of a cruciform church, with early Gothic and Romanesque arches carved in beautiful detail down the long nave. There is a large dolmen by the road toward Lough Gara; many prehistoric remains, including dugout boats, have been found in the lake. Boyle was incorporated by James I.

BOYLE'S LAW, a relation, discovered by Robert Boyle, between the pressure, p, and the volume, v, of a gas, viz., $pv =$ constant, at constant temperature. *See* BOYLE, ROBERT; KINETIC THEORY OF MATTER: *The Gas Laws;* THERMODYNAMICS: *Applications to Ideal Gases;* ELASTICITY: *Boyle's Law.*

BOYLESVE, RENÉ (real name RENÉ MARIE AUGUSTE TARDIVEAU) (1867–1926), French novelist who influenced many other writers, including Proust, was born in La Haye-Descartes (Indreet-Loire), April 14, 1867, and was educated in Poitiers, Tours and Paris. His studies of both liberal and fine arts, science and law did not lead to his entering a profession. After ten years in unimportant jobs, he wrote, under his mother's maiden name, his first novel, *Le Médecin des dames de Néans* (1896), in which the essential Boylesve is already to be found, and which anticipated Proust in style. There followed *Le Parfum des îles Borromées* (1898), a bitter book which he softened in tone and cut by nearly half in the definitive edition (1907). *Sainte-Marie-des-Fleurs,* an autobiographical love story, had appeared in 1897. Then came the powerful series known as the *romans tourangeaux—Mademoiselle Cloque* (1899), *La Becquée* (1901), *L'Enfant à la balustrade* (1903; Eng. trans. *The Child at the Balustrade,* 1929) and *La Jeune Fille bien élevée* (1909)—which, although ostensibly works of imagination, reveal Boylesve as the historian par excellence of rural and urban society in the west of France during 1870–1900—a historian and, at the same time, a poet.

Mention should also be made of his most famous and least understood work, *La Leçon d'amour dans un parc* (1902), which purports to be the daring story of an 18th-century love affair, but is fundamentally a novel about a child's education. His least known work, *Le Bel Avenir* (1905), is of interest because it was always his own favourite. His last novels were *Mon Amour* (1908), *Le Meilleur Ami* (1909) and *Madeleine jeune femme* (1912; Eng. trans. *A Gentlewoman of France,* 1916) which is probably his masterpiece, though not his most attractive work. He also wrote many short stories, collected in *La Marchande de petits pains pour les canards* (1909) and *Bonheur à cinq sous* (1917). Boylesve was elected to the Académie Française in 1918. He died, Jan. 14, 1926, in Paris. Among his posthumous works are *Opinions sur le roman* (1929) and *Feuilles tombées,* ed. by É. Gérard-Gailly (1927)—the latter an important fragment of his private journal, which shows rare critical and introspective gifts, and *Profils littéraires* (1961). (E. G.-GA.)

BOYNE (AN BOINN), a river in the Republic of Ireland rising in the Bog of Allen, near Carbury in County Kildare, and flowing in a northeasterly direction past Trim, Navan and Slane to enter the Irish sea 4 mi. below Drogheda. With a total length of 70 mi., it is noted for its salmon fishing and its lower reaches are navigable by coastal shipping. It figures largely in Irish history. The Bronze Age burial tumuli at Knowth, Newgrange and Dowth along its course are of the highest archaeological interest and importance. Slane is intimately associated with St. Patrick and with the introduction of Christianity to nearby Tara, the seat of the Irish kings.

Battle of the Boyne.—On July 11 (new style; July 1, old style), 1690, the forces of King William III and the former king James II came to battle on its banks. James, failing to take Derry and Enniskillen, had left Ulster as a bridgehead to William and had wasted his best Irish regiments in England and France. He assembled in the Oldbridge area, south of the Boyne, 7,000 French infantry, some regular Irish cavalry and untrained Irish infantry and dragoons—altogether about 21,000 men. William led the Dutch Blue Guards, two regiments of French Huguenots, some English, and contingents of Danish, Prussian, Finnish and Swiss mercenaries—altogether about 35,000 men. Fearing encirclement by William's cavalry which crossed the Boyne at Rosnaree on the left and at Oldbridge toward the right, James fled hastily from the battle and from the country. The battle was William's but the Jacobite army successfully withdrew to carry on the war for another year in Ireland. The battle of the Boyne is celebrated in northern Ireland by Orangemen as a victory for the Protestant cause on July 12, which is actually the old style date of the more decisive battle of Aughrim (*q.v.*). *See* GRAND ALLIANCE, WAR OF THE. (U. G. F.)

BOYS' BRIGADE, THE, was founded on Oct. 4, 1883, by William Alexander Smith (1854–1914) for "the advancement of Christ's Kingdom among Boys, and the promotion of habits of Obedience, Reverence, Discipline, Self-respect and all that tends toward a true Christian manliness." As secretary of the Sunday school of the Free College Church mission in Glasgow, Scot., Smith recognized that the task of Christian teaching would be much easier and more effective if a greater discipline could be imposed upon the Sunday school pupils. Accordingly he formed, under the name of the Boys' Brigade, a company of about 30 boys wearing a simple uniform over their ordinary clothes and meeting weekly for drill as well as for Bible class on Sundays. The movement spread quickly throughout the United Kingdom and extended later to the United States, Africa, the West Indies and other countries.

Every company of the brigade is connected with a church or other Christian organization, and the vicar or minister usually holds the rank of chaplain. In addition to the weekly Bible class and drill parade the program includes physical training, athletics, bands, first aid, wayfaring, educational subjects and camping. There are certificates and badges for most of the subjects taught, the highest award being the Queen's badge. Boys may join at the age of 8 and remain members until they are 19. The more than 4,850 units of the Brigade throughout the world have a total membership of approximately 250,000. The Boys' Brigade is governed by an executive committee responsible to the brigade council whose annual meeting is open to all officers.

The Girls' Life Brigade was formed in 1902 to "help and encourage girls to become responsible, self-reliant, and useful Christian women." There are around 68,000 members in the British Isles and 42,000 elsewhere. (I. G. N.)

BOY SCOUTS. The Boy Scout movement was started for the purpose of training boys in the essentials of good citizenship, and it arose in 1908 after the appearance of a book *Scouting for Boys* written by the then inspector general of cavalry in the British army, Lieut. Gen. R. S. S. Baden-Powell (*q.v.*), then more widely known in England as the defender of Mafeking in the South African War. Baden-Powell had intended his ideas to be used by existing youth organizations, but it was soon obvious that a new movement had come into being and, although it had been started in Great Britain for British boys, it very quickly spread to other countries. Chile was the first to take up scouting after Great Britain, and Canada, Australia, New Zealand and South Africa were the first in the commonwealth, but by 1910 it had spread to Sweden, France, Norway, Mexico, Argentina and the U.S.

Foundation and Principles.—It has been said that scouting began with a man, an island and a book. Certainly with the publication of the book the Boy Scouts came into being, but before this Baden-Powell had held an experimental camp on Brownsea Island in Poole harbour, Dorsetshire, during which he put into practice his ideas on the training of boys. These had accumulated from the experiences of his own life—his school days at Charterhouse, his holidays with his brothers trekking, canoeing and sailing, his life as a soldier in India and Africa—and were supplemented by ideas beyond his time and a notable skill in tracking and reconnaissance.

Baden-Powell's idea of training boys was that they should organize themselves into small natural gangs of six or seven under a boy leader—the patrol and the patrol leader. Their training would be complementary to their ordinary education: such things as mapping, signaling, knotting, first aid and all the skills that would arise from camping and similar outdoor activities. But, and perhaps most important of all, to become a scout a boy must promise that on his honour he would do his best to do his duty to God and his country (or sovereign), to help other people at all times and to obey the scout law, itself a simple code of chivalrous behaviour easily understood by the boy.

In every country where scouting exists the same basic pattern remains: a promise and a law, with such small variations as national traditions and culture demand; an emphasis on the delights of the outdoor life and the pursuit of outdoor activities such as camping, swimming, sailing, climbing, canoeing, gliding and exploring caves; a progressive training rewarded by the granting of certain badges; and the daily good turn which from the beginning took the fancy both of the general public and the boys themselves. In every country, too, the highest point of proficiency is marked by the award of a special badge; *e.g.*, the Eagle scout badge in the United States and the Queen's scout badge in Great Britain. From the beginning the left handshake, together with some form of the fleur-de-lis badge and of the motto "Be Prepared," was adopted as the sign of being a scout. The club meetings of the earlier days soon developed into troop nights with their own atmosphere and ethos. Underlying all, has remained that training in observation on which Baden-Powell placed so much stress.

Development.—The scout movement was intended for boys from 11 to 14 or 15, but it was soon realized that programs for younger and older boys were needed. By 1916 Baden-Powell had solved the problem of the younger boy by the introduction of wolf cubs (cub scouts in the U.S.) with their own motto of "Do Your Best," their own uniform, their own badges and training system. Again this was taken up by other countries with possibly more modifications than with the original scouting. In Great Britain and many other European countries the wolf cub pack is based on Kipling's *Jungle Books*. In the U.S. parent participation is a more essential part of the cub program, and other countries have variations without departing far from the idea of the wolf cub pack as a preparation for the scout troop.

Troops for handicapped scouts were started for the blind, deaf and dumb, the crippled and the spastics in 1925.

The older boys were served by a section of rover scouts and later by what are known in the U.S. as explorer scouts, in Great Britain as senior scouts and in France as raider scouts, all of whom carry on their scouting with expeditions on sea and land, at home and abroad. Scouting for older boys emphasizes personal fitness, social, vocational and cultural activities, and citizenship and community service.

Sea scouts had been started in Great Britain in 1910, and the idea spread. Air activities were included in the scout program in some countries during the 1930s, but it was not until 1941 in Great Britain and 1939 in the U.S. that air scouts became a recognized section. The explorer scout program in the U.S., which was expanded to cover such diverse interests as science, auto mechanics, emergency service and conservation, with membership geared to enrollment of high-school age boys, includes the 127,000-ac. Philmont Scout ranch near Cimarron, N.M.

The name of Great Britain's Boy Scouts association, which serves youngsters of 8 years to young men in their early 20s, was changed to the Scout association in 1967.

From the early days Baden-Powell had seen the necessity of training the responsible and enthusiastic volunteers who are scoutmasters, and in the early 1920s he developed a system of training in camp known as the wood badge training, which, with its headquarters at Gilwell park in Epping forest in England, has been copied with little local variation throughout the world.

International Events.—Scouting spread rapidly throughout the world. The outbreak of World War I six years after its introduction retarded scout development little. It was indeed a testing time for the young movement through which, in every country where it existed, it came with flying colours. In the early 1920s its international character became increasingly apparent. In 1920 the first international scout meeting, or jamboree, was held in London. It was on this occasion that Sir Robert Baden-Powell was acclaimed chief scout of the world by virtue of his unique position as the acknowledged founder of the movement.

World jamborees, held approximately every four years, are gatherings of thousands of scouts representing their countries and camping together as one family whatever their colour, class or creed. From the beginning the scout movement has been nonmilitary, nonpolitical, interdenominational and interracial. In these camps the scout law is the only rule, and the boys give a fine example of happy living and kindness and tolerance. For the rover scouts there have been similar camps known as moots. There have been indabas, or international camps for scoutmasters, and there are also agoons, which are international camps for the handicapped boys. There have also been innumerable national camps which parties of scouts from neighbouring countries attend. Possibly it has been these smaller camps, rather than the vast jamborees, which have helped most to keep the scout law of international brotherhood before the national movements.

International Organization.—One outcome of the 1920 jamboree was the formation of the Boy Scouts' international conference and committee, and the foundation of the Boy Scouts international bureau. The purpose of the conference is to promote world unity of purpose and common understanding in the fundamental principles of scouting as set out by the founder. The conference, which ordinarily meets biennially, is composed of six delegates from each country in which there is at least one registered scout association, all countries having equal status and voting power. An international committee of 12 members which functions as the permanent central committee of the world movement is elected by the conference and is empowered to act between meetings of the full conference. The international bureau, under its director, is the permanent secretariat of the conference and committee and, after being established in London and remaining there for some years, was moved in 1958 to Ottawa, Can. It should be emphasized that each country, under its own chief scout, is autonomous.

The essential rightness of the programs and principles of scouting has been proved by its continuity and by its attraction to an increasing number of boys of all the five continents. Wherever scouting is allowed boys flock to become scouts. Scouting was not permitted under the fascist regimes in Italy and Germany, nor was it later allowed under communist regimes, but elsewhere it continued to attract and expand; by the 1960s there were about 8,500,000 active members in the world as a whole. Scouting's essential ideas—the development of a boy's initiative and self-dependence, the development of a spirit of selflessness and helpfulness to others to make him a modern good Samaritan, not only willing to help others, but able by his training to do so even at the risk of his own life, the idea of brotherhood among the nations, which is inherent in scouting—remained as fundamental as they were when the movement began. The details (of scout uniform, for example) might vary from country to country and might change from decade to decade, but the spirit of scouting—its adventure and helpfulness to others—still continued to inspire and attract boys against the background of an everchanging world. (Rn.)

BOZRAH, the ancient name of three cities in western Asia.

1. Bozrah, a stronghold in northern Edom, important between 1200 and 600 B.C., often identified as al Busayrah, a village lying some 3,000 ft. above sea level on the Edomite plateau halfway between the Dead sea and the ruined town of Petra in southern Jordan. The modern village is close to the ancient Roman road that ran from Damascus through Petra to the Gulf of Aqaba. The prophets Isaiah and Jeremiah equate Bozrah with Edom; it was the home of Jobab, the second known king of Edom (Gen. xxxvi, 33).

2. Bozrah (Lat. Bostra; Gr. Bosorra and Bosora; mod. Bosra or Busra), a ruined city in the Hauran region of southwestern Syria, 67 mi. S. of Damascus and 22 mi. S.E. of Der'a. While it achieved its greatest fame as the site of a key Roman fortress east of the Jordan river, Bozrah was a city of the Nabataeans (*q.v.*), possibly the Bosora of I Macc. v, 26. The emperor Trajan, conqueror of Nabataea, made the city capital of the Roman province of Arabia in A.D. 106. Trajan's highway, which ran through Bosrah to the Gulf of Aqaba (*see* above), is still traceable. Under the emperor Alexander Severus (A.D. 222–235) the city became a Roman colony and then achieved the title "metropolis" under the emperor Philip (244–249), a native of the city. It became the see of a bishop early in the 4th century but fell to the Arabs in 636. The crusaders captured it in the 12th century but failed to hold it, and in the same century earthquakes, together with Turkish misrule, brought decline. Monumental remains—temples, theatres, triumphal arches, aqueducts, reservoirs, churches, mosques, a 13th-century citadel—stretch over the modern site. (*See* Bashan; Arabia, Roman Province of.)

3. Bozrah, a city of Moab (*q.v.*) mentioned in Jer. xlviii, 24, possibly the Bosor or Besher of the tribe of Reuben but not definitely located. (J. S. I.)

BRAAK, MENNO TER (1902–1940), who, with E. du Perron (*q.v.*) and S. Vestdijk, was one of the influential Dutch critics of the period before World War II, was born at Eibergen, Gelderland, Jan. 26, 1902. After studying history in Amsterdam, he taught in Rotterdam. With Du Perron he founded the independent review *Forum,* which he edited (1932–35), in 1933 becoming also literary and drama critic on the leading Hague daily, *Het Vaderland.* In *Het Carnaval der burgers* (1930) he defended originality and vitality against convention and in *Démasqué der schoonheid* (1932) he attacked the cult of aestheticism in literature. As a critic, Ter Braak denounced mediocrity. The influence of Nietzsche is evident in *Politicus zonder partij* (1934), which unmasks the underlying falsity of so-called spiritual values, and in *Van oude en nieuwe Christenen* (1937), which propounds the theory that all mass movements are basically inspired by resentment.

Ter Braak's respect for the freedom of the personality made him the enemy of National Socialism and when the Netherlands were occupied, he committed suicide at The Hague (May 14, 1940).

Bibliography.—*See* his *Verzameld Werk,* 7 vol. (1949–51); also H. Marsman, *Menno ter Braak* (1939); J. de Kadt, *Verdediging van het Westen* (1946); H. A. Gomperts, *Jagen om te Leven* (1949). (Gd. W. Hs.)

BRABANT, one of the nine provinces of Belgium, consisting of three administrative *arrondissements* (Brussels, Louvain and Nivelles), 37 judicial cantons, and 356 communes. Pop. (1966 est.) 2,130,276. Area, 1,268 sq.mi. It is the most densely populated province (1,680 per sq.mi.) because of the considerable urbanization; outside the towns density is from 400 to 500 per square mile. The rural population lives in numerous prosperous-looking nucleated villages, but there are occasional large individual farms.

Brabant occupies the central part of the low plateau of Belgium, rising southward from about 60 ft. above sea level in the north to 545 ft. in the south. Paleozoic slates and quartzites underlie the plateau at no great depth in the centre and south, and the rivers have cut down their valleys through the newer overlying strata, exposing these older rocks. Porphyritic diorites are mined at a number of places, notably at Quenast and Tubize, for roadmaking materials. The greater part of the plateau is covered with Eocene rocks, mainly Flanders clay to the west of the Senne valley and sands to the east, with some patches of Oligocene sands to the southwest of Brussels and Pliocene sands west of Louvain. In the broad river valleys much alluvium has been deposited, and in addition a widespread cover of *limon* lies on the interfluves.

The main rivers of the eastern Scheldt basin, the Senne, Dyle and Gette, flow in a north-northeast direction until each is picked up by the east-west line of the Demer-Dyle-Rupel river system, hence flowing to the lower Scheldt. Their valleys are broad shallow troughs, separated by the gentle interfluves of the plateau surface.

This area is of great importance agriculturally. The *limon* resting on sand has developed into brownish loams of excellent quality, while on the valley floors the soils are derived from alluvium. Large hedgeless fields grow wheat and sugar beets, producing high yields through intensive use of fertilizers. In 1958 about 58% of the total area of the province was arable, of which one-third grew fodder crops and nearly two-fifths cereals. In the neighbourhood of Brussels (*q.v.*), the provincial capital, concentration is on market gardening, pig and poultry farming, the production of flowers and nursery cultivation. To the northwest of the city, between Berchem (*q.v.*) and Asse, vast areas of glasshouses produce early vegetables and flowers, while others in the southeast specialize in grapes, particularly in the communes of La Hulpe, Hoeilaart and Overijssel (Overijse). Northeast of Brussels, in the Demer valley, the district known as Petit Brabant has warm, light soils, a transition between the sandy loams farther south and the coarser sands and gravels of the Kempen heathlands near Antwerp. When heavily fertilized these grow early vegetables: peas, asparagus, potatoes, carrots and chicory, especially between Mechelen and Diest. Greenhouse produce, bush and orchard fruits, and flowers are also grown. Cattle raising for both meat and dairy purposes is widespread because of the dense urban population. Nearly 10% of the province is wooded, the largest area being the Forêt de Soignes to the southeast of Brussels.

The industrialization of Brabant is considerable. The outstanding area is Brussels and its suburbs. The Flanders textile industry has spread eastward into Brabant: in Brussels, Braine-l'Alleud, Nivelles and Anderlecht. In the Senne valley, Halle (French, Hal) and Tubize have miscellaneous metallurgical, textile and food-processing industries. At Clabecq, a large integrated iron and steel plant is situated in the Sennette valley, 15 mi. S. of Brussels, on the banks of the Brussels-Charleroi canal. Farther east is a host of smaller towns, many within the Brussels orbit, sharing the well-developed industrial life of Belgium. Louvain (*q.v.*) (Flemish, Leuven), pop. (1961) 32,524, stands on the banks of the Dyle in a well-marked gap through the northern edge of the Brabant plateau. It is a market town for the surrounding agricultural countryside, with food-processing industries (brewing, milling, the manufacture of potato starch, and vegetable canning). It also has a number of metallurgical industries, especially agricultural machinery plants, chemical works, tanneries and sawmills. The Leuven-Dyle Canal links the town with the Rupel and the lower Scheldt. Vilvorde (Flemish, Vilvoorde), pop. (1966 est.) 34,040, is situated where the Senne cuts through the edge of the plateau. The manufacture of fertilizers, vegetable oils, glue, starch and leather is established on the banks of the Willebroek canal in the suburbs, and there are textile and glove factories. Farther east is Tirlemont (Flemish, Tienen) in the Gette valley, pop. (1966 est.) 22,660, which has the largest sugar refinery in Belgium, and flour mills, tanneries, starch factories and a citric acid plant.

For the history of Brabant *see* BRABANT, DUCHY OF; BELGIUM: *History*. (F. J. M.)

BRABANT, DUCHY OF, the name of a duchy in the southern Low Countries, now a province of the kingdom of Belgium. In the early middle ages there existed a *pagus Bracbantensis,* whose name was later given to the much larger duchy that included it. The oldest centre of the duchy was in the region of Louvain and Brussels, and the counts of Louvain and Brussels built up the duchy into an important territorial principality. The history of Brabant is connected with that of the duchy of Lower Lorraine, which in the course of the 11th century was split into a number of small feudal states. The counts of Hainaut, Namur, Luxembourg and Limburg asserted their independence, and the territory of Liège passed to the bishops of that city. The remnant of the duchy, united since 1100 with the margraviate of Antwerp, was conferred in 1101 by the emperor Henry IV, with the title of duke of Lower Lorraine, upon Henry, count of Limburg. On the emperor's death his son, Henry V, who in 1106 had rebelled against his father, gave the title to Godfrey I, the Bearded, count of Louvain and Brussels, and for three generations the representatives of the rival houses contested the possession of the ducal dignity in Lower Lorraine. The issue was decided in favour of the house of Louvain by Duke Godfrey III in 1159. His son, Henry I, the Warrior (1183–1235), abandoned the title of duke of Lower Lorraine and assumed in 1190 that of duke of Brabant. Strictly speaking this date marks the beginning of the duchy of Brabant. Godfrey's successors were Henry II (1235–48), Henry III (1248–61), and John I (1261–94). These were all able rulers. Their usual place of residence was Louvain. In 1283, John I bought the duchy of Limburg from Adolf of Berg and secured his acquisition by defeating and slaying his competitor, Henry of Luxembourg, at the battle of Woeringen (June 5, 1288). From then onward there was a personal union between the two duchies, which conserved their individuality and separate institutions. The battle of Woeringen was an important episode in the expansionist policy of the dukes of Brabant, who tried to secure control of the territories along the great commercial axis of Bruges-Cologne, a policy that was thwarted by the counts of Flanders in the west and the prince-bishops of Liège in the east. John II (d. Oct. 27, 1312) granted the charter of Cortenberg on Sept. 27, 1312. By it the imposition of grants (*beden*) and taxes was strictly limited and regulated, and its execution was entrusted to a council, appointed by the duke for life, whose duty it was to consider all complaints and to see that the conditions laid down by the charter concerning the administration of justice and finance were not infringed. After the rule of his son, John III (1312–55), the ducal dignity passed to John III's daughter and heiress, Johanna (d. 1406). Wenceslas of Luxembourg, her husband, assumed the style of duke of Brabant in right of his wife. On their accession Johanna and Wenceslas granted the famous charter of liberties, known as *La Joyeuse Entrée* (Jan. 3, 1356). This great constitutional charter gave Brabant an exceptional position among the principalities of the Low Countries and allowed it to play an eminent role in later centuries in the resistance against absolutism (*see* JOYEUSE ENTRÉE).

Johanna's title was, however, disputed by Louis II of Male, count of Flanders (d. 1384), who had married her sister Margaret, and a war broke out in 1356 between Wenceslas, supported by the guilds, and Louis, who upheld the burgher-patrician party in the Brabant cities. After the death of Wenceslas (1383) his widow continued to rule over the two duchies of Luxembourg and Brabant but was obliged to rely on the support of the house of Burgundy in her contests with the turbulent city guilds and with her neighbours, the dukes of Jülich and Gelderland. In 1390 she ceded her duchies to Philip the Bold of Burgundy, the husband of Johanna's niece Margaret of Flanders (d. 1405), keeping only the usufruct to herself. Of the three sons by this marriage John the Fearless succeeded to Burgundy, and Anthony to Brabant on the death of Johanna in 1406. On the extinction of the line of Anthony (1430) the duchy of Brabant became the inheritance of the elder branch of the house of Burgundy, in the person of Philip III, the Good, of Burgundy, son of John. From this time onward the history of Brabant is merged with that of the other territories of the Netherlands, united by a personal union under the dukes of Burgundy and their successors. The duchy conserved, however, its own central institutions and laws. Philip III's granddaughter Mary (d. 1482), daughter and heiress of Charles I, the Bold (d. 1477), married the archduke Maximilian and so brought Brabant with the other Burgundian possessions to the house of Habsburg. Brussels, the chief city of Brabant, became under the Habsburg regime the residence of the court and the capital of the Netherlands.

In the course of the Dutch war of independence (1568–1648) the province of Brabant became separated into two portions. In the southern and larger part Spanish rule was maintained, and Brussels continued to be the seat of government. The northern (smaller) part was conquered by the Dutch under Maurice and Frederick Henry of Orange (1597). At the peace of Münster (1648) this portion, which was known as Generality Land and now forms the Dutch province of North Brabant, was ceded by Philip IV to the United Provinces and was placed under the direct government of the states-general. The southern portion, now divided into the provinces of Antwerp and Brabant, remained under the rule of the Spanish Habsburgs until the death in 1700 of Charles II, the last of his line.

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BRABANT, NORTH (NOORDBRABANT), the largest province of the Netherlands, adjoined by Belgium to the south, the islands and peninsulas of Zeeland to the west and Limburg to the east, and bounded on the north by the Merwede and the Meuse (Maas) rivers. Area 1,968 sq.mi. The provincial capital is 's Hertogenbosch. From coastal marshlands in the northwest the land rises gently southeastward to a maximum of 135 ft. The surface ranges from silt and clay near the coast and alluvium along the Meuse and its tributaries to sands and gravels that cover most of the province; these coarser materials are largely terrace deposits of the Meuse and Waal and include bare sand dunes; *e.g.,* near Drunen. Considerable heathlands remain and there are patches of high bog, the largest being in the Peel (marshy land) southeast of Deurne. Colonization of these dry sandy areas began early. Neolithic finds at four sites are followed by Bronze Age and numerous Iron Age remains; there were Roman camps along the Meuse. After the dark ages the division between east and west in North Brabant (discernible in two different Iron Age groups) was continued in political divisions: to the west the Barony of Breda, and to the east the Meirij of 's Hertogenbosch (Bois-le-Duc); the affinities of the west still lie with Belgium and France, those of the east with the Rhineland.

In 1957 the population was 1,425,732, its density less than the Dutch average; nearly all the inhabitants are Roman Catholic. The coastal lands, partly flooded in 1953, are fertile and arable, producing wheat and sugar beet; the riverine lands are more acid, often poorly drained, and mostly permanent pasture. The southern heaths contain many recently planted conifers; agriculture on these poor soils is restricted, and mixed farming is general. Cattle are the chief livestock; rye, oats, potatoes and buckwheat are the chief crops. Extensive areas of heath were reclaimed for arable land or pasture in the 19th century and several new colonies, *e.g.*, Helenaveen, were established in the raised bogs of the Peel where the sale of peat was combined with horticulture and cattle raising. Reclamation slackened after 1900; emigration from rural areas has been heavy and more than one-half the population now lives in towns. Formerly Bergen op Zoom was the centre of the marshlands, Breda (*q.v.*) of the riverlands and 's Hertogenbosch of the inner sandy areas. All retain their market functions and Bergen op Zoom, like several other centres, refines sugar beets; but now the largest settlements in the province are Tilburg (*q.v.*), a woolen textile centre, and Eindhoven (*q.v.;* pop. [1960] mun. 167,577), an industrial centre for the manufacturing of radios, electrical appliances and vehicles. *See* also NETHERLANDS, THE; BRABANT, DUCHY OF. (J. T. C.)

BRABAZON, HERCULES BRABAZON (1821–1906), English watercolourist whose fresh and sensitive sketches have been prized, was born in Paris on Nov. 27, 1821, the younger son of Hercules Sharpe. He succeeded his elder brother in the Brabazon estates, County Mayo, Ire., and under the will of his uncle adopted the surname of Brabazon. Educated at Harrow and Trinity college, Cambridge, he studied painting by copying the English water-colourists William Müller, David Cox and Peter De Wint. Brabazon's later style approached that of Turner, with an even freer use of body colour. He made many sketches on his travels in Europe and Egypt. An amateur and a country gentleman, he was reluctant to exhibit or sell his work. In 1891 he showed at the New English Art club and was elected a member. He died at Battle, Sussex, on May 15, 1906.

See C. L. Hind, *Hercules Brabazon Brabazon* (1912). (D. L. FR.)

BRAČ (It. BRAZZA), an island in the Adriatic sea, forming part of the People's Republic of Croatia, Yugos. Pop. (1961) 14,227. Area 152 sq.mi. The inhabitants speak the čakavski dialect of the Serbo-Croatian language. Though rugged and mountainous, the island yields an abundance of olives, figs, almonds, saffron and chrysanthemums (from which an insect powder is produced), as well as wines of a good quality. The main industries are fishing, silkworm rearing, and stone, slate and marble quarrying. The marble is exported all over the world. The island has no fresh water, which in the summer months is brought from the mainland. The principal village is Supetar (pop. [1961] 1,422) and a tourist trade was beginning to develop by 1960.

The island has been dominated in turn by the pirates of Almissa, by Dubrovnik (Ragusa), Venice, the Holy Roman Empire, Hungary, Bosnia, Napoleon's Illyria and Austria, with one brief period of autonomy. In 1918 it was incorporated in Yugoslavia. During World War II it was occupied for a time by the Italians. Partisans and Allied special forces drove the Germans out of Brač in 1944. (V. DE.)

BRACCIANO, LAKE (LAGO DI BRACCIANO), lies in the Sabatini mountains 25 mi. N.W. of Rome, Italy. The classical *Lacus Sabatinus,* it was formed from a group of volcanic craters. Mineral hot springs along its shores recall its earlier geological history. The surface, which has a total area of 22 sq.mi., is at 538 ft. above sea level. The maximum depth is 525 ft. and diameter about 5½ mi. The lake, which has the Arrone river for an outlet on its southeast side, is known for its eel. The lake towns of Bracciano and of Anguillara Sabazia preserve their magnificent late medieval castles. There is a seaplane base at Vigna di Valle on the south shore. (G. KH.)

BRACCIO DA MONTONE (1368–1424), Italian *condottiere,* distinguished both as a soldier and as one of the first of his profession to try to found a state. Born of a noble Perugian family, he learned the profession of arms under Alberico da Barbiano, first of the great Italian war captains. Braccio and Muzio Attendolo Sforza (*see* SFORZA), also a pupil of Alberico, were lifelong rivals and left their names to rival schools of warfare. Braccio likewise had great ambitions. He began to satisfy them in papal territory, where between 1416 and 1419 he seized power in Perugia and most of Umbria. In 1420 he was granted legitimate title to rule as vicar by Pope Martin V. Not content with this, he went on to seek further land and dominion in southern Italy, but was defeated and severely wounded in the battle of Aquila (June 2, 1424). Refusing food and drink, he died three days later.

See W. Heywood, *A History of Perugia* (1910). (P. J. J.)

BRACE, CHARLES LORING (1826–1890), U.S. reformer and pioneer social welfare worker, was a founder and for 37 years executive secretary of the Children's Aid Society of New York city. Born in Litchfield, Conn., June 19, 1826, of a Hartford family long prominent in religious and political life, he was educated at Yale university and at Union Theological seminary in New York; asked to become the head of "a mission to children" in 1853, he spent the remainder of his life in the Children's Aid society. In 1872 he wrote an unconsciously autobiographical account of it as *The Dangerous Classes of New York, and Twenty Years' Work Among Them,* which established him as a world authority. At his death a leading sociologist estimated that Brace's influence had aided over 300,000 children.

In 1882 Brace published *Gesta Christi: a History of Humane Progress Under Christianity,* a review of "certain practices, principles and ideals—now the richest inheritance of the race—that have been either implanted or stimulated or supported by Christianity." This became a significant contribution to the literature supporting the growing social gospel movement. He also wrote on comparative religion, European and American travel, knew and corresponded with many of the great figures of his time and contributed extensively to the *New York Times* and several journals of opinion and current affairs. He died Aug. 11, 1890.

His daughter Emma Brace edited *The Life and Letters of Charles Loring Brace* (1894). (C. H. HS.)

BRACEGIRDLE, ANNE (*c.* 1663–1748), English actress, a pupil of Thomas Betterton (*q.v.*), was born about 1663, probably in one of the midland counties. Her talents were first noted in 1688 when she played Lucia in Shadwell's *The Squire of Alsatia* at Drury Lane.

Such antithetical playwrights as William Congreve and Nicholas Rowe wrote leading parts for her. For the heroines of Congreve's artificial comedies she could turn on "the Charms and Attractions of a conscious Beauty" (Colley Cibber) when she played Araminta in *The Old Bachelor* or Millamant in *The Way of the World;* but she had also a feeling for Rowe's pathetic sentiments when she acted Selima in *Tamerlane* or Lavinia in *The Fair Penitent.* One of her most famous roles, however, was that of Statira in Nathaniel Lee's *The Rival Queens.*

She left the stage in the prime of her life, about 1707, when she began to be eclipsed by the rising star of Anne Oldfield. Mrs. Bracegirdle enjoyed, perhaps undeservedly, a reputation for virtuous character extraordinary in an actress of the period. It was believed during her life that she was married to Congreve, who left her a legacy of £200. (A. M. N.)

BRACHIOPODA, a phylum of small bottom-dwelling marine invertebrate animals that have a shell composed of two valves. Some brachiopods superficially resemble clams; however, the valves are unequal, and lie above and below the soft body, instead of being nearly equal and on the right and left sides of the body as in clams. Between the valves are the fleshy parts of the animal including two coiled arms (brachia), one on either side of the mouth, that direct food-bearing currents toward the mouth.

The name brachiopod, from the Greek meaning arm-foot, was first proposed by A. M. C. Duméril (1806), who assumed that the brachia were locomotive organs like the molluscan foot. Brachiopods, commonly known as lampshells for their fancied likeness to early Roman oil lamps, are found throughout the oceans of the world, but are much more rare today than they were in past geologic history (see *Paleontology* below). In southern Japan and the Philippine Islands species of *Lingula* are used for food, either the pedicle (stalk for attachment) or the whole animal being boiled. Because of their preservation in rock strata, especially of the Paleozoic era (from 225,000,000 to 600,000,000 years ago), fossil brachiopods are useful to geologists in determining the age of certain strata.

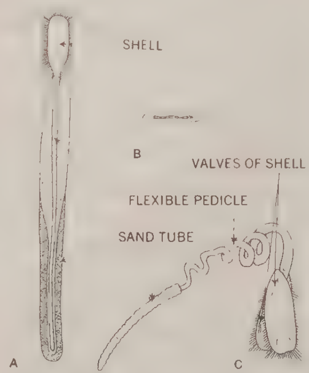
Geographical Distribution.—More than 200 species of modern brachiopods representing 73 genera are known. Several species are known in American waters from Maine to Florida and from Alaska to Mexico. Brachiopods are common about the West Indies. They inhabit the Mediterranean, the northwest coast of Africa and the waters around the British Isles. Off the Philippine, Japanese and Hawaiian islands many species are known. New Zealand, Australian and Antarctic waters also yield numerous species.

The majority of brachiopods—about 60%—are shallow-water dwellers (less than 100 fathoms, or 600 feet) but some of these range into deep water. More than 35% of modern brachiopods occupy waters deeper than 100 fathoms and a few live in the deep sea abyss (2,900 fathoms). *Lingula* is confined to water less than 25 fathoms deep.

Morphology and Habits.—In all brachiopods the two valves are situated on the front (ventral, or pedicle, valve) and back (dorsal, or brachial, valve) of the animal, the former valve usually being the larger. Brachiopods are grouped into two classes, Inarticulata and Articulata (see *Classification* below), based on the presence or absence of a hinge and on shell composition and embryology.

Inarticulata.—In the Inarticulata the valves are joined by a complicated system of muscles. Except during the Cambrian period, Inarticulata have always been less numerous than Articulata. *Lingula,* both modern and fossil, is linguiform (tongue-shaped) in outline and lens-shaped in profile. Another living inarticulate, *Discinisca,* is circular in outline and conical in profile. In general the Inarticulata deviate little from these two forms. *Lingula* shells are chitinophosphatic, *i.e.,* they are composed of alternating layers of chitinoid material and calcium phosphate covered by a smooth periostracum, while in *Discinisca* overlapping layers of the same substances are set at a small angle to the surface. Members of the superfamily Craniacea, unlike other inarticulates, have pitted, calcareous shells. Inarticulate valves are commonly brown to black, but some species of *Lingula* have green blotches. Ornament usually consists of concentric growth lines, but some species are radially marked. The Inarticulata seldom measure over an inch in length and many fossil representatives are tiny.

Lingula makes a vertical burrow 2 to 12 in. long and attaches its pedicle by mucus to the sand in the bottom of the burrow (fig. 1). By extension of the pedicle, part of the shell projects above the surface, disappearing instantly when the animal is alarmed. *Lingula* burrows usually occur in mud flats exposed at low water. *Glottidia* (fig. 1), a relative of *Lingula,* moves by wriggling the pedicle.



FROM "ARCHIVES DE ZOOLOGIE EXPERIMENTALE ET GENÉRALE"; "CHOSES DE NOUMEA"; MEMOIRS OF THE BOSTON SOCIETY OF NATURAL HISTORY"

FIG. 1.—SAND TUBES FORMED BY BRACHIOPODS

(A) Section of tube of *Lingula* showing attachment of shell by extended pedicle (dotted line indicates position of shell when retracted); (B) tube of *Lingula* seen from surface; (C) *Glottidia pyramidata* with wormlike pedicle attached to sand tube

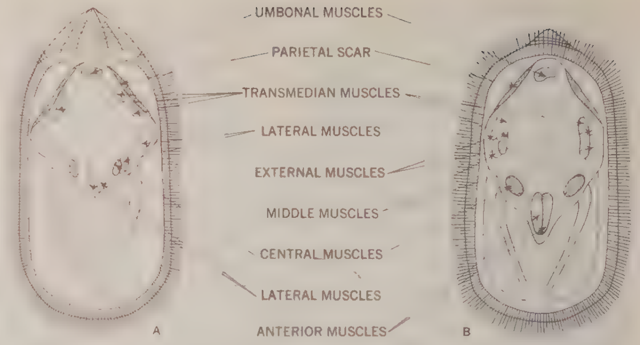


FIG. 2.—INNER SURFACES OF LINGULA VALVES SHOWING MUSCLE ATTACHMENTS: (A) VENTRAL VALVE; (B) DORSAL VALVE

The soft parts of the Inarticulata are similar to those of the Articulata but vary in having a terminal anus and a more complicated muscle system. The shells open vertically but slide laterally as well. Chitinous bristles (setae) fringe the shell, forming three tubes anteriorly, two side ones for incoming, food-bearing currents and the middle one for discharging wastes.

Articulata.—Most of the Articulata have calcareous shells joined by teeth (in the ventral valve) and sockets (in the dorsal). These brachiopods are usually small, but some measuring 6 to 15 in. in one dimension are known. The Articulata are usually lens-shaped in profile but the outline varies. The shells are usually light-coloured, grayish or dark brown, but some are salmon to red, occasionally with bright red radial bands. Fossil Terebratuloidea with colour patterns occur as early as the Devonian period.

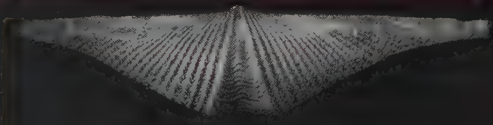
The shell is smooth or variously ornamented by radial ribs (costae), concentric bands, or both. Many genera are spiny-shelled. Most Articulata develop a median fold on the dorsal valve, rarely on the ventral, which facilitates passage of incurrent and excurrent streams.

Many Articulata attach by their fibrous pedicle or cement their ventral valve to a firm object. When cemented, the brachiopod usually becomes misshapen, oysterlike (*Leptodus*), or conical (*Prorichthofenia*). Some extinct Articulata, attached when young, broke away to lie loose on the sea floor. *Echinauris* and others like it, had no pedicle but lived supported by their spines.

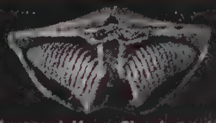
The Shell.—*General Anatomy.*—Posteriorly the shell (fig, 3) tapers to a beak. The swollen portion in front of the beak is called the umbo. The hinge may be short or extended. Length is measured from beak to anterior margin; width is at right angles to this, and thickness is the greatest distance at right angles to both. In many genera a palintrope, or shelf, with curved or plane surface (interarea) lies between the beak and hinge line. The ventral palintrope is divided medially by the delthyrium, a triangular pedicle opening. This may be partially or completely closed by deltidial plates growing from the delthyrial margins; or it may be closed by a single plate, the pseudodeltidium, anchored to the delthyrial edges. The teeth occur at the anterolateral ends of the delthyrium and may be buttressed by dental plates separated or united with a septum to form a spondylium.

The dorsal valve contains brachial attachments called crura, curved processes diverging from the beak. In some ancient forms the crural bases bound a deltoid cavity, the notothyrium, in which the diductor muscles are attached on the floor or to a ridge, or boss (cardinal process). The notothyrium may be closed by a solid plate (chilidium). In advanced genera a hinge plate bearing the diductor muscles occurs between the crural bases. It is divided when incomplete, but forms an undivided, flat or concave hinge plate when continuous. This plate is commonly supported by a median septum in the dorsal valve. The sockets are located between the inside shell wall and the outside of the crural bases. In many specialized genera the crura support loops or spires (brachidia), the inner skeleton of the food-gathering organ.

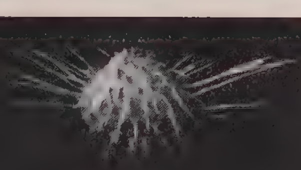
Structural Detail.—The mantle secretes the shell by successive additions at the anterior margin. Thickening occurs by deposition over the inner surface. The relatively simple structured chitino-



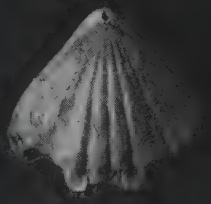
Mucrospirifer. Devonian, Canada, Michigan



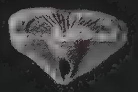
Mucrospirifer. Showing spires



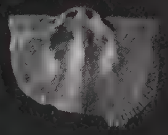
Avonia. Permian, Texas



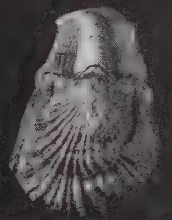
Stenoscisma. Permian, Texas



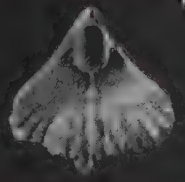
Vellamo. Ordovician, Minnesota, showing pseudodeltidium interarea and foramen



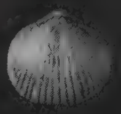
Vellamo. Showing convex chilidium



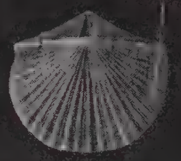
*Streptorhynchus.** Permian, Texas, showing pseudodeltidium



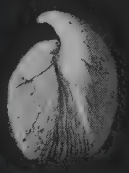
Stenoscisma. Showing spondylium



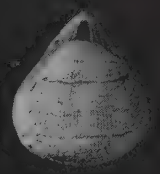
Uncinulus. Silurian, Tennessee



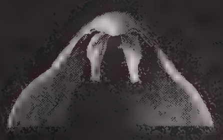
*Hesperorthis.** Ordovician, Oklahoma, showing interarea and delthyrium



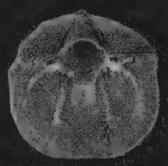
Hemithyris. Recent, Alaska, side view



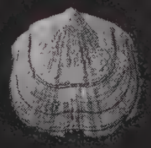
Hemithyris. Brachial view



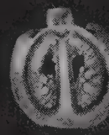
Hemithyris. Showing crura



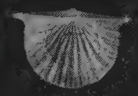
*Billingsella.** Cambrian, Wyoming, showing pseudodeltidium and delthyrial cavity



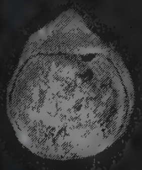
*Billingsella.** Cambrian, Wyoming, exterior



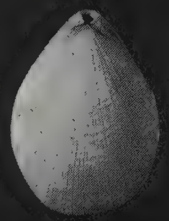
*Thecidellina.** Recent, Christmas Island, interior



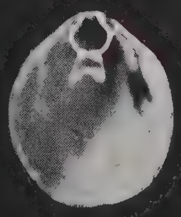
Stropheodonta. Devonian, Michigan



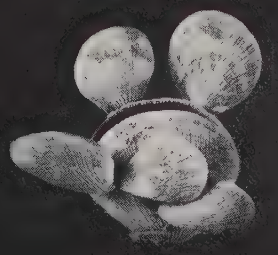
*Thecidellina.** Exterior



Terebratulina. Recent, Pacific



Terebratulina. Showing loop



Terebratulina. Recent, Atlantic, cluster showing growth habit

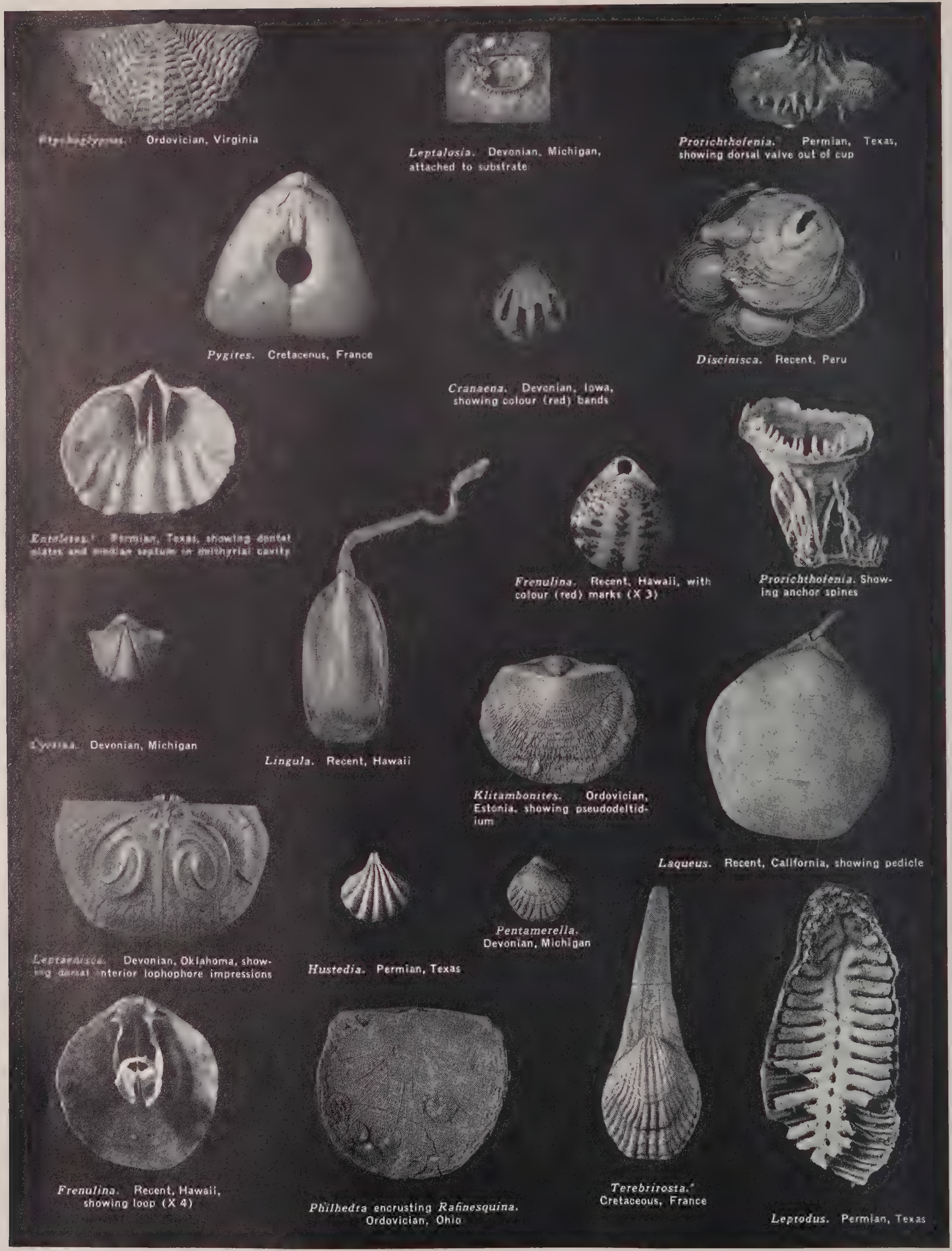
BY COURTESY OF THE UNITED STATES NATIONAL MUSEUM

RECENT AND FOSSIL BRACHIOPODA

*Indicates X 2 magnification. Others are natural size

PLATE II

BRACHIOPODA



Ptychoglyptus. Ordovician, Virginia

Leptalosia. Devonian, Michigan, attached to substrate

Prorichthofenia. Permian, Texas, showing dorsal valve out of cup

Pygites. Cretaceous, France

Cranaena. Devonian, Iowa, showing colour (red) bands

Discinisca. Recent, Peru

*Enteletes.** Permian, Texas, showing dental plates and median septum in delthyrial cavity

Frenulina. Recent, Hawaii, with colour (red) marks (X 3)

Prorichthofenia. Showing anchor spines

Cyrtina. Devonian, Michigan

Lingula. Recent, Hawaii

Klitambonites. Ordovician, Estonia, showing pseudodeltidium

Laqueus. Recent, California, showing pedicle

Leptaenisca. Devonian, Oklahoma, showing dorsal interior lophophore impressions

Hustedia. Permian, Texas

Pentamerella. Devonian, Michigan

Frenulina. Recent, Hawaii, showing loop (X 4)

Philhedra encrusting *Rafinesquina.* Ordovician, Ohio

*Terebrirosta.** Cretaceous, France

Leptodus. Permian, Texas

BY COURTESY OF THE UNITED STATES NATIONAL MUSEUM

RECENT AND FOSSIL BRACHIOPODA

*Indicates X 2 magnification. Those not otherwise indicated are natural size phosphatic shell, characteristic of most Inarticulata, was described earlier. The calcareous shell, of all Articulata and some Inarticulata, is more complex in structure, being composed of three layers: (1) an outer thin, chitinoid periostracum (not seen in fossils); (2) a middle lamellar layer; (3) an inner prismatic layer. The two inner layers are composed of calcite (calcium carbonate).

Three groups of Articulata are recognized on details of shell structure: (1) Punctate, with inner layers pierced by tiny holes, or puncta, into which minute projections of the mantle (caeca) penetrate, thus increasing the surface of the mantle, the main respiratory organ; (2) Pseudopunctate, in which taleolae, minute rods of calcite, project into the inner layers, often beyond the inner surface, and shell exfoliation leaves deep pits (pseudopunctae) simulating puncta where these rods are torn out; (3) Impunctate, having neither puncta nor taleolae (see *Classification* below).

The Animal.—*Soft Parts.*—The fleshy body is divided transversely by a body wall into a posterior visceral cavity (coelom) filled with coelomic fluid and an anterior mantle cavity filled with sea water (fig. 4). The visceral cavity contains the U-shaped digestive canal, four reproductive glands and "liver," held in place by mesenteries. Extensions of the coelom (pallial sinuses, fig. 4) into the mantle lodge the sex organs. The mouth leads into an esophagus, and this into a saclike stomach terminated by a blind intestine. The "liver," or digestive gland, surrounds the stomach. Waste is excreted through the mouth. The nervous system, circling the esophagus, sends nerves to other parts of the body.

The mantle, or brachial, cavity is lined by the thin, shell-secreting fleshy mantle, externally fringed by tactile setae. Within the mantle cavity is lodged the lophophore (fig. 4), a simple or complicated, commonly horseshoe-shaped, loop whose ciliated cirri direct food-bearing currents to the mouth, located between the branches of the lophophore.

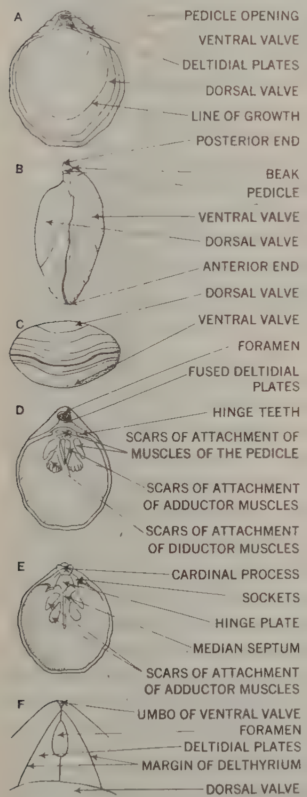
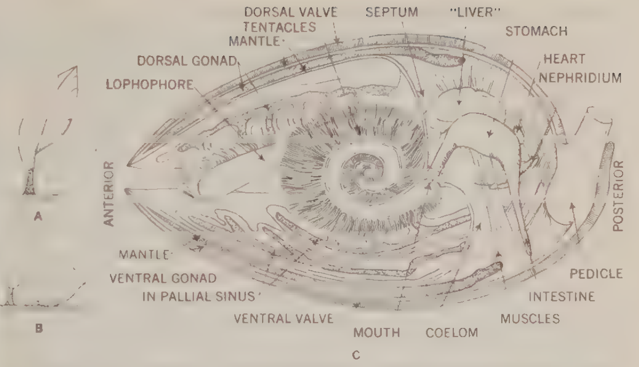

A
PEDICLE OPENING
VENTRAL VALVE
DELTIDIAL PLATES
DORSAL VALVE
LINE OF GROWTH
POSTERIOR END
B
BEAK
PEDICLE
VENTRAL VALVE
DORSAL VALVE
ANTERIOR END
DORSAL VALVE
C
VENTRAL VALVE
FORAMEN
FUSED DELTIDIAL PLATES
D
HINGE TEETH
SCARS OF ATTACHMENT OF MUSCLES OF THE PEDICLE
SCARS OF ATTACHMENT OF ADDUCTOR MUSCLES
SCARS OF ATTACHMENT OF DIDUCTOR MUSCLES
E
CARDINAL PROCESS
SOCKETS
HINGE PLATE
MEDIAN SEPTUM
SCARS OF ATTACHMENT OF ADDUCTOR MUSCLES
F
UMBO OF VENTRAL VALVE
FORAMEN
DELTIDIAL PLATES
MARGIN OF DELTHYRIUM
DORSAL VALVE

FIG. 3.—SHELL OF A BRACHIOPOD

Exterior of shell: (A) dorsal view; (B) lateral view; (C) anterior view. Interior: (D) ventral valve; (E) dorsal valve. (F) Diagram of pedicle opening in Rhynchonella: delthyrium becomes filled with plates, leaving foramen open

Musculature.—The shell opens by contraction of flabellate diductor muscles (fig. 3, 5) which extend from near the centre of the ventral valve to the hinge plate or cardinal process under the dorsal beak. The dorsal valve rotates on a line joining the hinge teeth. Contraction of the diductors stretches the adductors, two muscles in the ventral valve that fork in passing to the centre of the dorsal valve. When the tension of the diductor muscles is released the stretched adductors contract and close the valves. Besides adductors and diductors, pedicle muscles, or adjustors, extend from the ventral valve to the pedicle. These adjust the shell on the pedicle. The muscles leave attachment scars on the inside of the shell that are important in classification.

Reproduction and Development.—The sexes are separate; ova and sperm are discharged into the mantle cavity through funnel-shaped nephridia, two (sometimes one) on either side of the mouth. Fertilization takes place in the mantle cavity or outside. In a few genera the larvae develop inside the female in brood pouches formed by a fold of the mantle. Five articulates and one inarticulate supply all that is known in detail of brachiopod embryology.


DORSAL VALVE
SEPTUM
"LIVER"
TENTACLES
MANTLE
STOMACH
DORSAL GONAD
HEART
NEPHRIDIUM
LOPHOPHORE
A
ANTERIOR
POSTERIOR
MANTLE
PEDICLE
VENTRAL GONAD IN PALLIAL SINUS
INTESTINE
B
VENTRAL VALVE
MUSCLES
MOUTH
COELOM
C

(A, B) AFTER R. R. SHROCK AND W. H. TWENHOFEL, "PRINCIPLES OF INVERTEBRATE PALEONTOLOGY"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., 1953; (C) T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., 1957

FIG. 4.—(A, B) BRACHIOPODS ATTACHED TO SEA BOTTOM; (C) INTERNAL STRUCTURE OF MAGELLANIA, SHOWING SHELLS CUT TO MID-LINE WITH MANTLE AND LOPHOPHORE OF LEFT SIDE REMOVED

In *Terebratulina* (fig. 6) the larvae develop cilia and swim freely for about 12 days; the *Terebratella* swim freely for a shorter time. During this time three regions develop, after which the larvae attach by the tail region which becomes the pedicle. The lobes of the second, or thoracic, region envelop the first, or head region and form two thin, chitinous semicircular plates, the embryonic shell, or protegulum. This develops into a punctate calcareous shell ornamented by fine costae. In *Lacazella* the head of the larva bears four eyes.

The dorsal mantle lobe develops more rapidly than the ventral, and the inner surface bears a shell plate continuous with another on the dorsal side of the thoracic segment. The mantle then inverts, the dorsal mantle plate becoming the external shell and the thoracic plate forming the incipient pseudodeltidium. The ventral valve is thought to be secreted by the rudimentary mantle lobe. A similar inversion of the mantle lobes occurs in *Argyrotheca*, but no thoracic shell plate is formed. In *Lingula* threefold differentiation into regions does not occur. The free-swimming stage may last a month or six weeks, and pairs of cirri on the embryonic brachia protrude, thus serving as swimming organs. The cuticular shell plate, formed over the dorsal and ventral mantle portions, is

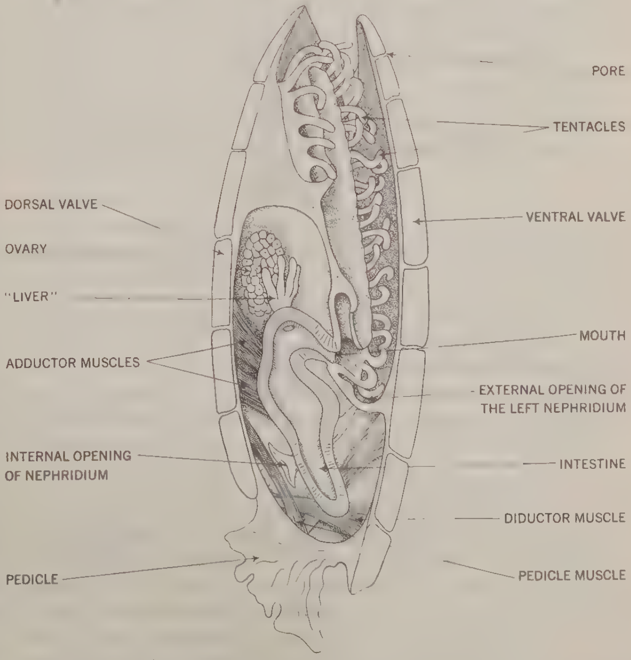
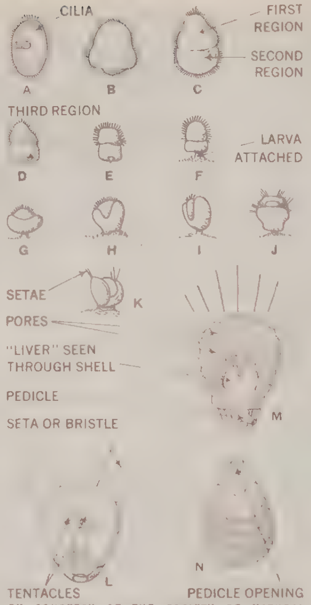

PORE
TENTACLES
DORSAL VALVE
VENTRAL VALVE
OVARY
"LIVER"
MOUTH
ADDUCTOR MUSCLES
EXTERNAL OPENING OF THE LEFT NEPHRIDIUM
INTERNAL OPENING OF NEPHRIDIUM
INTESTINE
DIDUCTOR MUSCLE
PEDICLE
PEDICLE MUSCLE

FIG. 5.—INTERNAL STRUCTURE OF A RECENT BRACHIOPOD (ARGYROTHECA CORDATA)

Longitudinal section with mantle, its tubular extensions and the epidermis omitted

circular in outline, but a fold forms posteriorly to divide the shell into dorsal and ventral valves. These thicken and the fold of thin cuticle serves for a time as a hinge. The pedicle is formed from the ventral mantle fold and not from the caudal region as in *Terebratulina* and *Terebratella.*



BY COURTESY OF THE SOCIETY OF NATURAL HISTORY, BOSTON

FIG. 6.—DEVELOPMENT OF TEREBRATULINA (A-M GREATLY MAGNIFIED)

(A–E) Stages of free swimming larva; (F–I) attachment of larva to substrate, showing second region gradually enclosing first; (J, K) appearance of bristles and horny valves; (L) formation of permanent setae and, within shell, tentacles and other structures; (M) later stage in which setae correspond in position with first formed ribs of shell; (N) adult shell, natural size

Paleontology.—Brachiopods were an abundant form of life in the Paleozoic era but later became subordinate. Nearly 30,000 species, distributed among over 1,700 genera (including 129 inarticulates) have been described. No brachiopods are known prior to the Cambrian period; the Inarticulata throve during the Cambrian and part of the Ordovician but later declined, occupying a subordinate position ever since. Some Lingulacea, Craniacea and Discinacea have survived with little change since the Ordovician.

Even in the early Cambrian highly organized primitive Articulata occurred, indicating a long previous development. The great development of the Trimerellacea and Pentameroidea and appearance of the Terebratuloidea occurred in the Silurian. The Devonian and Carboniferous periods saw the expansion of the Spiriferoidea and Productoidea, some productoids attaining a width of 15 in. In the Permian many bizarre types of cemented brachiopods occurred among the Orthotetacea and Productoidea, possibly foreshadowing their extinction.

Besides the Rhynchonelloidea and Terebratuloidea a few Chonetoidea, Spiriferoidea and Punctospiracea of the Articulata survived the widespread extinction culminating in the Permian. All Spiriferoidea and Punctospiracea became extinct with the Jurassic. In the Mesozoic the Rhynchonellacea, Terebratuloidea and Terebratelloidea flourished, but by the Cenozoic the first group declined, the last two surviving as the commonest modern brachiopods.

CLASSIFICATION

The first mention of brachiopods in a published work appeared in 1596 when J. Bauhin figured a *Rhynchonella* from the early Jurassic of Württemberg. Ten years later Fabio Calonna described *Concha anomia diphya* which he considered to be a pelecypod but is really the brachiopod *Pygope.* In the 18th century several authors figured the Recent species, *Crania anomala* and *Terebratulina retusa.* G. L. C. Cuvier, however, in the early 19th century first suggested their separation from the Pelecypoda. Subsequent investigation of internal structure and development and increasing knowledge of fossil forms established the brachiopods as a phylum.

The classes generally adopted are Inarticulata and Articulata proposed by T. H. Huxley in 1869. C. E. Beecher (1891) divided Brachiopoda into four orders based on the kind of pedicle opening and shell development. Atremata and Neotremata belong to the Inarticulata, while the Articulata include the Protremata and Telotremata. In 1927 J. A. Thomson added Palaeotremata to the Articulata, and proposed major divisions approximating Huxley's terms based on embryology; Gastrocaulia (Inarticulata); Pygocaulia (Articulata). Adequacy of Beecher's orders Protemata and Telotremata was questioned by G. A. Cooper (1944). (Extinct forms are followed by an asterisk.)

CLASS INARTICULATA (GASTROCAULIA)

Valves usually chitino-phosphatic, fastened by muscles only. Intestine long, ending in anus. Pedicle developing within valves of first shell (protegulum) and later protruded.

Order I. Atremata. Valves gape apically, pedicle attached to ventral valve, forming a pedicle groove. Growth mainly lateral and anterior. Superfamilies: Obolacea*, Lingulacea, Trimerellacea*.

Order II. Neotremata. Pedicle, when present, emerging from a foramen at or near the ventral apex. Growth, at least in ventral valve, on all margins. Superfamilies: Paterinacea*, Siphonotretacea*, Acrotretacea*, Discinacea, Craniacea.

CLASS ARTICULATA (PYGOCAULIA)

Articulated valves, always calcareous; anus absent in modern genera. Pedicle developed from caudal segment of embryo and seldom enclosed in the protegulum. Classification unsatisfactory.

Order III. Palaeotremata. Primitive, articulation and delthyria not fully developed. Superfamilies: Rustellacea*, Kutorginacea*.

Order IV. Protremata. Delthyrium open or closed by a pseudodeltidium. Brachial processes primitive.

Order V. Telotremata. Delthyrium closed partially or completely by deltidial plates. Crura or brachidium present.

Discovery of deltidial plates and a loop-bearer in the Protremata casts doubt on these orders. Cooper (1944) suggested a convenient but nongenetic arrangement based on shell structure:

Impunctate Articulata: Suborders and superfamilies: Orthoidea*, Clitambonitoidea*, Pentameroidea*, Triplesioidea*, Rhynchonelloidea (with Rhynchonellacea; Stenoscismatacea*), Atrypoidea*, Spiriferoidea* (Spiriferacea*; Rostrospiracea*).

Pseudopunctate Articulata: Suborders and Superfamilies: Strophomenoidea* (with Plectambonitacea*, Strophomenacea*; Orthotetacea*), Oldhaminoidea*, Productoidea* (with Strophalosiacea and Productacea), Chonetoidea*.

Punctate Articulata: Suborders and Superfamilies: Dalmanelloidea*, Thecideoidea, Punctospiracea*, Terebratuloidea, Terebratelloidea.

BIBLIOGRAPHY.—G. A. Cooper in H. W. Shimer and R. R. Shrock, *Index Fossils of North America* (1944); R. R. Shrock and W. T. Twenhofel, *Principles of Invertebrate Paleontology,* chap. 9 (1953); J. A. Thomson, "Brachiopod Morphology and Genera (Recent and Tertiary)," *New Zealand Board of Science and Art. Manual No. 7* (1927); E. O. Ulrich and G. A. Cooper, "Ozarkian and Canadian Brachiopods," *Geol. Soc. Amer., Special Papers No. 13* (1938); H. M. Muir-Wood, "A History of the Classification of the Phylum Brachiopoda," *British Museum (Natural History)* (1955); E. Percival, "A Contribution to the Life-History of the Brachiopod *Terebratella inconspicua* Sowerby," *Trans. Roy. Soc. New Zealand,* vol. 74, Pt. 1 (1944).

(G. A. CR.)

BRACKEN (BRAKE), a genus of ferns (*Pteridium*), the sole species (*P. aquilinum*) of which is widely distributed throughout the world in temperate and tropical regions. The species is represented by 12 varieties, 4 of which occur in North America and Great Britain. Var. *pubescens* grows from Alaska to Mexico, east to Wyoming, Colorado and Texas. Var. *latiusculum,* growing also in northern Europe and eastern Asia, occurs from Newfoundland to Minnesota, south to Oklahoma and Tennessee. Var. *pseudocaudatum* grows from Massachusetts to Florida, west to Missouri and Texas. Var. *caudatum,* a West Indian plant, grows in southern Florida. Var. *typica* is common in Great Britain. This species has a perennial, black rootstock, which creeps extensively underground and at intervals sends up fronds. These fronds may reach a height of 15 ft. or more, and, although dying in autumn, often remain standing throughout the winter, affording in some regions cover for game. The fronds are used for thatching and occasionally as fodder. (R. M. T.)

BRACKET FUNGUS. The term "bracket" has been given to those hard, woody fungi that grow on trees or timber in the form of semicircular brackets. They belong to the order Polyporeae of the Basidiomycetes, distinguished by the layer of tubes or pores on the undersurface within which the spores are borne. The mycelium, or vegetative part of the fungus, penetrates into the tissues of the tree, causing more or less extensive wood rots (*see* DRY ROT); the "bracket" represents the fruiting body and produces innumerable spores which gain entrance to other trees by some wound or cut surface. Many of these woody fungi persist for several years, and a new layer of pores is superimposed on the previous season's growth.

It has been estimated that a fruiting body of *Fomes applanatus,* the commonest of the bracket fungi, having a pored surface of one square foot liberates 30,000,000,000 spores in 24 hours, and the period of spore discharge for this species is approximately six months.

PHOTOGRAPH, JOHN H. GERARD

BRACKET FUNGI (POLYPORUS RESINOSUS) GROWING ON A TREE TRUNK

BRACKLEY, THOMAS EGERTON, VISCOUNT (*c.* 1540–1617), English lawyer and diplomatist, better known as LORD CHANCELLOR ELLESMERE, secured the independence of the court of chancery from the common law courts, formulating thereby nascent principles of equitable relief. An illegitimate son of Sir Richard Egerton of Ridley, Cheshire, he was educated at Brasenose college, Oxford, and was called to the bar by Lincoln's Inn in 1572. He found early favour with Queen Elizabeth who made him one of her counsel after hearing him plead against the crown. Thereafter his promotion was rapid: solicitor general (1581), attorney general (1592) and master of the rolls (1594), an office which he retained when he became lord keeper of the great seal (1596) and which he held until Elizabeth's death.

But Egerton was more than a mere lawyer and Elizabeth entrusted him with many diplomatic missions. He was a firm friend of Robert Devereux, 2nd earl of Essex, but endeavoured in vain to effect his reconciliation with Elizabeth, being unable to dissuade him from rebellion in 1601. After the accession of James I in 1603, Egerton was created Baron Ellesmere and became lord chancellor. He gave undiscriminating support to James's conception of the royal prerogative, coming into frequent collision with the house of commons, which he also offended by his attempt to control its composition in Goodwin's case (1604). He was equally undiscriminating in his support of James's ecclesiastical policy.

Ellesmere's career closed with a victory gained over the common law and his formidable antagonist, Sir Edward Coke (*q.v.*), the chief justice of the King's Bench. The chancellor's court of equity originated as a tribunal to decide cases not served by the common law—to relax and correct its rigidity and insufficiency. The two jurisdictions were often rivals, the common-law bar often complaining of the arbitrary powers of the chancellor, who had set aside common-law decrees, and the equity lawyers censuring the failures of justice at common law. The disputes, concerning which the king had already in 1615 remonstrated with the chancellor and Coke, came to a crisis in 1616, when the court of chancery granted relief against judgments at common law. This relief Coke and other judges declared to be illegal and a writ praemunire (*q.v.*) was brought against the parties concerned in the suit in chancery. The grand jury, however, refused to bring in a true bill, in spite of Coke's threats, and the dispute was referred to the king, who after consulting his counsel and taking Francis Bacon's advice, decided in favour of equity (Earl of Oxford's case). The chancellor's triumph was great, and from this time the equitable jurisdiction of the court of chancery was unquestioned. In June 1616 he supported the king in his dismissal of Coke in the case of *commendams* (royal permission to a bishop to retain, on promotion, his former living—a practice Coke was opposed to), and he agreed with Bacon that it was the judge's duty to communicate with the king before giving judgments in which the king's interests were concerned. On March 3, 1617, he delivered up to James the great seal, which he had held for the unprecedented term of nearly 21 years. In 1616 he had been created Viscount Brackley, and he declined an earldom on his deathbed. He died on March 15, 1617.

Lord Chancellor Ellesmere is a striking figure in the long line of illustrious English judges. He ignored all communications from suitors, and it was doubtless to Ellesmere (as weeding out the "enormous sin" of judicial corruption) that John Donne, who was his secretary, addressed his fifth satire. Universally esteemed as an equity lawyer, he gained the admiration of William Camden, was extolled by Bacon, his protégé, and by Ben Jonson. His personal integrity was such that he reconciled the common lawyers to the implications of the Earl of Oxford's case. He hoped to see a codification of the laws, and had greater faith in judge-made law than in statutes, advising parliament (Oct. 27, 1601) "that laws in force might be revised and explained and no new laws made." Ellesmere's conception of the duties of his office was traditional. He considered that "the office of the chancellor is to correct men's conscience for frauds, breach of trust, wrongs and oppressions of what nature soever they be and to soften and mollify the extremity of the law." He reformed the administration of the court of chancery and of the star chamber; delays were reduced and fees restricted, although he allowed the masters in chancery too great a discretion. In 1609 he published his argument in the case of the Post Nati (Calvin's case) where the exchequer chamber had held that Scottish persons born after the accession of James I were natural-born subjects of the king of England; it appears to be his only certain work. Other works have been ascribed to him, most probably wrongly, including *The Privileges and Prerogatives of the High Court of Chancery* (1641); *Certain Observations Concerning the Office of the Lord Chancellor* (1651); *Observations on Lord Coke's Reports,* ed. by G. Paul (*c.* 1710).

See Lord Campbell, *Lives of the Lord Chancellors,* vol. ii (1845; 4th ed. 1857); W. S. Holdsworth, *A History of English Law,* vol. v, 3rd ed. (1945). (G. H. J.)

BRACKNELL, a new town (*see* NEW TOWNS) in Berkshire, Eng., lying within the jurisdiction of Easthampstead rural district council, 11 mi. E.S.E. of Reading and 29 mi. W.S.W. of London by the road through Staines. Old Bracknell had little importance until the 19th century when the Windsor-Wokingham road was built and caused congestion in the Wokingham cattle market, with the result that the Bracknell cattle market became and remained the principal one in east Berkshire. When the new town was formed in 1949, the population of about 5,000 was engaged in brickmaking, timber yards, dairying and metalwork. Bracknell, which was to have a planned population of 25,000 and an area of 2.9 sq.mi., had 20,380 residents by 1961 and many new industries which included the manufacture of gasoline pumps, boilers, tools, ball bearings, furniture and clothing.

A college of further education and a county library were planned for the central area of the town. The town rests on London Clay in the northwestern portion; the remainder, where there are coniferous trees, is largely on Bagshot Sands deposits.

BRACQUEMOND, FÉLIX HENRI (properly FÉLIX JOSEPH AUGUSTE) (1833–1914), French engraver and painter, a leading engraver both of his own designs and those of old and modern masters, was born in Paris on May 22, 1833. Trained as a trade lithographer, he produced plates after the works of artists from Hans Holbein to Eugène Delacroix (and later Gustave Moreau). As a painter his public career began in 1852 when he exhibited at the Paris Salon; by then he had entered the studio of J. Guichard, a pupil of J. A. D. Ingres and Delacroix and master of Berthe Morisot.

Bracquemond numbered Edouard Manet and the young Impressionists, some of whom he instructed in engraving, among his friends. He also designed textiles and bookbindings and painted on porcelain. He died in Paris on Oct. 29, 1914. (D. C. T. T.)

BRACTON (BRATTON, BRETTON), **HENRY DE** (d. 1268), English judge and writer on English law. His real name was Bratton, and it is only after his death that his name appears as Bracton. He seems to have entered the king's service as a clerk and he began to appear as a justice in 1245. From 1248 until his death in 1268 he was steadily employed as a justice of assize in the southwestern counties, especially Somerset, Devon and Cornwall. During the earlier part of this period he was also sitting as a judge in the king's central court which was soon to be distinguished as the king's bench. From this position he retired or was dismissed in or about 1257, shortly before the meeting of the "mad parliament" at Oxford in 1258. In 1267 he was a member of a commission appointed to hear the complaints of the disinherited partisans of Simon de Montfort. Like most of the lawyers of his time, Bracton was a priest; he held several livings and ecclesiastical appointments in the diocese of Exeter.

Bracton's fame rests on two works: the *Note Book,* which is a collection of cases; and the *Treatise on the Laws of England,* which he never finished but of which Sir W. S. Holdsworth wrote, in *A History of English Law* (Methuen and Co. Ltd., London, 1936), that it "had no competitor either in literary style or completeness of treatment till Blackstone composed his commentaries five centuries later." Two principal characteristics of importance in the development of the common law must be noted, namely: (1) the emphasis on practice and procedure; and (2) the dependence on decided cases (*see* also ENGLISH LAW). There are various editions of the treatise.

Some indication of the extent to which Bracton's reputation has stood the test of time was given in 1923 when a stone commemorating him as "Author of the first systematic treatise on the Laws of England" was presented to the dean and chapter of Exeter cathedral where he was buried.

Bracton's Note-Book was edited by Frederic Maitland (1887); *Selected Passages from the works of Bracton and Azo* was published by the Selden society (1895); and Bracton's *De Legibus et Consuetudinibus Angliae* was edited by George Woodbine, 2 vol. (1915–22).

See Sir W. S. Holdsworth, *A History of English Law,* vol. ii and vi, new ed. (1936, 37); "The Bracton Memorial," *Law Times,* vol. 155, pp. 302–303 (1923). (W. T. Ws.)

BRADDOCK, EDWARD (1695–1755), British general, was born in London, Eng. He joined the Coldstream Guards in 1710 and served in Holland during the siege of Bergen op Zoom in 1747. He was appointed major general in 1754 and arrived in Virginia the following February to command all British forces in North America against the French. Although hampered by administrative confusion and lack of resources, after several months of preparation he undertook to attack Ft. Duquesne (Pittsburgh, Pa.) in an extremely arduous wilderness expedition. His force cut a road westward from Cumberland, Md., the first road across the Allegheny mountains. George Washington, then Lieut. Col. of Virginia militia, was among the 700 provincials and 1,400 British regulars under his command. Braddock's force safely crossed the Monongahela river and reached a point only 8 mi. from Ft. Duquesne. The forward column of 1,459 officers and men, being short of Indian scouts, was ambushed in a ravine by 254 French and 600 Indians on July 9. Wounded during the ensuing slaughter and riot, Braddock died four days later and was buried at Great Meadows, Pa. *See* also FRENCH AND INDIAN WAR.

See L. McCardell, *Ill-Starred General: Braddock of the Coldstream Guards* (1958); L. H. Gipson, *The British Empire Before the American Revolution,* vol. vi (1946). (W. R. SL.)

BRADDOCK, a borough of Allegheny county, Pa., U.S., on the Monongahela river, 10 mi. S.E. of Pittsburgh; part of the Pittsburgh standard metropolitan statistical area. (For comparative population figures *see* table in PENNSYLVANIA: *Population.*)

John Frazier traditionally is regarded as the first settler (1742); his cabin is said to have been the first built by a white man west of the Alleghenies. Incorporated as a borough in 1867, Braddock's growth was primarily a result of the industrialization of the Pittsburgh region in the post-Civil War period. Most of the work force is engaged in primary steel production. Braddock was named for Gen. Edward Braddock (*q.v.*), who in 1755 was ambushed there by the French and Indians. (P. R. J.)

BRADDON, MARY ELIZABETH (1837–1915), English novelist, best known for her popular melodrama, *Lady Audley's Secret,* was born in London, Oct. 4, 1837. Her first novel was *The Trail of the Serpent* (1861). In 1862 she produced her three-volume novel *Lady Audley's Secret,* originally written serially at the request of John Maxwell for his magazine *Robin Goodfellow.* A lurid story of crime in high society which yet did not transgress Victorian ideas of propriety, it was a sensational financial success. She subsequently married John Maxwell, published over 70 further novels, and edited several magazines. Although she may have owed some of her success to the fact that critical attacks on her novels merely served to increase her sales, in her later novels especially she shows a capacity for social satire and a skill in conveying atmosphere which causes regret that her talent for storytelling should have overpowered her latent sense of style. Her last novel was *The Green Curtain* (1911). She died at Richmond, Surrey, on Feb. 4, 1915.

BRADE, WILLIAM (*c.* 1560–1630), English violist and composer who was one of the most important of the group of English musicians living in Germany in the early 17th century. He worked in many places in Germany (including Berlin, Gottorf, Hamburg, Halle and Güstrow), and also at Copenhagen, and finally returned to Hamburg in 1626. His music, which greatly influenced his German contemporaries, including S. Scheidt and J. H. Schein, is often unorthodox: his more experimental dance suites incorporate, among other features, unusual rhythms, which tend to obscure the normal characteristics of the dance forms. However, he also composed suites in which the dance types are clearly differentiated. His music, largely consisting of dance suites and fancies (called *canzoni*) was published between 1607 and 1621 in contemporary collections at Hamburg, Lübeck, Berlin and Antwerp. He died at Hamburg, Feb. 26, 1630. (A. D. F.)

BRADFORD, JOHN (1510?–1555), English Protestant martyr, was born at Manchester. He was deputy paymaster at the siege of Montreuil (1544) and studied law in the Inner Temple (1547), when, influenced by a fellow student, Thomas Sampson, he "sold his chains, rings, brooches and jewels of gold," giving the proceeds to the poor. Determined then to study theology, he entered St. Catherine's hall, Cambridge (1548), received his M.A. degree (1549) and was appointed a fellow of Pembroke hall. Nicholas Ridley, bishop of London, ordained him deacon and made him his chaplain (1550) and a prebendary of St. Paul's (1551); as a chaplain (1553) to Edward VI, he became a popular preacher. Soon after Queen Mary's accession he was imprisoned on a charge of sedition (Aug. 1553), examined, mainly on his eucharistic beliefs (Jan. 1555), and burned as a heretic before a large crowd at Smithfield on July 1, 1555, in his last moments encouraging his young companion, John Leaf.

See A. Townsend (ed.), *The Writings of John Bradford* (1848–53).

BRADFORD, WILLIAM (1590–1657), governor and historian of the Plymouth colony in colonial America, was born at Austerfield, Yorkshire, Eng., probably in March 1590. A year after Bradford's birth, his father died and he was reared by his grandfather and uncles who trained him in farming. At the age of 12, Bradford read the Scriptures and, against his friends' advice, became a Separatist (*see* CONGREGATIONALISM). He joined the harassed nonconformists when they migrated to Holland in 1609 in search of religious freedom. In spite of his comparative youth, Bradford became a leader of the group of Pilgrims who sailed to America in 1620. A passenger on the "Mayflower," he signed the Mayflower compact, helped locate the spot for settlement, and after recovering from serious illness, was unanimously elected governor in 1621 upon the death of Gov. John Carver. Though he urged rotation in office, he was re-elected 30 times, serving every year except five from 1621 to 1656.

Under Bradford's judicious guidance, Plymouth was put on a sound basis both economically and politically. Some historians have objected to the broad extent of the powers exercised by Bradford in the first years of the Plymouth settlement. Others, more realistically, have shown that under his leadership Plymouth was essentially democratic, that the powers he exercised were given to him by the people in annual elections, and that the people could have chosen another governor had they been dissatisfied.

A self-taught man, a Calvinist and a congregationalist, Bradford was skilled in languages and literature. No portrait of him exists, but the inventory of his estate shows a man who liked fine, colourful clothes. He married twice and was the father of four children. He died at Plymouth on May 9, 1657. Bradford's *History of Plymouth Plantation, 1620–1647,* a journal of the

Pilgrims, ranks among the major literary achievements of his time and remains our best source of knowledge of the Pilgrims. Though not published until 1856, contemporary historians such as Morton, Hubbard, Mather, Prince and Hutchinson used it in manuscript form. Bradford also wrote several *Dialogues* and some poetry, and collaborated with Edward Winslow in writing the journal known as Mourt's *Relation*.

See also MASSACHUSETTS: *History*.

See Samuel Eliot Morison (ed.), *Of Plymouth Plantation* (1952); Bradford Smith, *Bradford of Plymouth* (1951). (B. K. B.)

BRADFORD, WILLIAM (1663–1752), American colonial printer, was born in Leicestershire, England, on May 20, 1663. He learned the printer's trade in London and in 1682 emigrated to Pennsylvania, where in 1685 he introduced the "art and mystery" of printing. His first imprint was an almanac, *Kalendarium Pennsilvaniense or America's Messenger* (1685). In 1690, with William Rittenhouse (1644–1708) and others, he established in Roxboro (Pa.), now a part of Philadelphia, the first paper mill in America. In the spring of 1693 he moved to New York, where he was appointed royal printer for the colony, a position that he held for more than 50 years. On Nov. 8, 1725, he issued the first number of the *New York Gazette,* the first paper established in New York and from 1725 to 1733 the only paper in the colony. Bradford died in New York on May 23, 1752.

See NEWSPAPER: *Early Papers in Philadelphia and New York.*

BRADFORD, WILLIAM (1827–1892), U.S. marine painter whose pictures attracted much attention by reason of their novelty and colour effects, was born at New Bedford, Mass. He was a Quaker and a self-taught artist, painting the ships and the marine views he saw along the coast of Massachusetts, Labrador and Nova Scotia; he went on several arctic expeditions with Isaac Hayes and was the first American painter to portray the frozen regions of the north. His "Steamer 'Panther' in Melville Bay, under the Light of the Midnight Sun" was exhibited at the Royal Academy in London in 1875. Bradford was a member of the National Academy of Design, New York City. His style was somewhat influenced by Albert van Beest, who worked with him at Fairhaven for a time, but Bradford is observant of minute detail whereas Beest's aim was general effect. John Greenleaf Whittier's poem "Amy Wentworth" was inspired by a Bradford painting and is addressed to him.

Bradford died in New York City on April 25, 1892.

BRADFORD, a city, municipal, county and parliamentary borough, in the West Riding of Yorkshire, Eng., 9 mi. W. of Leeds by road. Pop. (1961) 295,992. Area 38.9 sq.mi. The centre of Bradford is in a small valley opening southward from that of the Aire and the outskirts extend into the surrounding hills. Bradford's situation on the lower eastern spurs of the Pennines had much to do with its history and development.

Bradford is mentioned as having belonged before 1066 to one Gamel and appears to have been almost destroyed before 1086. By that time it had been granted to Ilbert de Lacy, in whose family it continued until the death of Henry de Lacy, earl of Lincoln, in 1311. Already Bradford was becoming an important market centre. A charter for a market every Thursday was granted to Edmund de Lacy in 1251 and a fair of five days' duration was granted in addition in 1294. The *inquisitio post mortem* taken in 1311 shows that the earl had there a hall or manor house, a fulling mill, a market and a fair. Edward IV granted or confirmed to certain feoffees, in whom he had vested his manor of Bradford, a market on Thursdays and two yearly fairs. The church of St. Peter, which occupies the site of a previous Norman church, dates from 1458 and has a fine original roof of oak. After the diocese of Bradford was formed in 1919, out of those of Ripon and Wakefield, the parish church of St. Peter was made the cathedral.

The grammar school existed in the 16th century and received a charter of incorporation from Charles II.

From the mention of a fulling mill in 1311 it is possible to surmise that woolen manufacture had already begun. By the reign of Henry VIII it had become an important industry and added much to the status of the town. John Leland in his *Itinerary* says that Bradford is "a praty quik Market Toune. It standith much by clothing." Toward the end of the 17th and beginning of the 18th century the woolen trade decreased, and worsted manufacture began to take its place. On the introduction of steam power and machinery the worsted trade advanced with great rapidity. The first steam-powered mill in Bradford was built in 1798; by the early 1960s there were about 400 mills serving the textile and clothing industry alone.

In 1836 Titus (later Sir Titus) Salt developed the alpaca manufacture in the town; mohair was shortly afterward introduced; and the great works at Saltaire were opened. Later, S. C. Lister (Lord Masham) introduced the silk and velvet manufacture, having invented a process for manipulating silk waste whereby what was previously treated as refuse was made into goods that could compete with those manufactured from the perfect cocoon. The Bradford wool exchange is the chief wool-buying centre, and Bradford's commercial relations with South America and Australia are very important. It is the chief centre for wool-combing and the worsted industry and has a conditioning house for testing all kinds of textiles. The local water—much of which is brought from the Nidd valley about 32 mi. away—after draining through peaty soil, is very soft and consequently is specially suited to wool washing and other manufacturing processes. There are deposits of coal and iron in the vicinity.

The technical college was opened in 1882. The Mechanics' institute was founded in 1825, and in 1871 the present building, near the town hall, was opened. The Cartwright Memorial hall contains an art gallery and museum and commemorates Edmund Cartwright (*q.v.*).

Other public buildings are Bolling hall (14th century), the ancestral home of Edith Bolling, wife of Pres. Woodrow Wilson, and opened in 1915 as a museum of English social history, St. George's hall (1853), the wool exchange (1867), the Gothic town hall (1873), the market hall (1878) and Britannia house (1933). The Margaret McMillan Memorial Training college for the training of infant and nursery teachers was completed in 1956. Most of the buildings in Bradford are built with freestone quarried locally, which blackens easily under the influence of smoke. There are about 2,000 ac. of parks and open spaces.

Bradford was incorporated in 1847, created a county borough in 1888 and a city in 1897. The council is presided over by a lord mayor, a dignity conferred in 1907. The borough returned two members to parliament from 1832 until 1885, when three were returned. Since 1918, four members represent Bradford. (W. H. LM.)

BRADFORD, a city of McKean County, Pa., U.S., near the northern border of the state, 85 mi. SE of Buffalo, N.Y., on the forks of the Tunenguant Creek. Pop. (1970) 12,672. (For comparative population figures *see* table in PENNSYLVANIA: *Population.*)

Bradford is the commercial and industrial centre of Pennsylvania's richest oil field. The first oil well was drilled in 1861 and commercial oil production began in 1875. Production increased rapidly to a peak in 1881 when the area was producing 40% of the world's output. Production declined at the end of the 19th century, but increased after 1906 when a flooding process was introduced. Although in the early 1970s the city's principal industries were still centred about the oil industry, the economy had diversified to include the manufacture of such items as electronic components, glass, cutlery, and corrugated boxes. Lumber, brick, and wooden articles were manufactured from the products of the surrounding hills.

Bradford was established about 1827 by settlers from New England. It was called Littleton after Col. Lebitt C. Little, an early resident, until 1873, when it took the name Bradford for the New Hampshire town from which many early settlers came. It was incorporated as a borough in 1873 and chartered as a city in 1879. It adopted the council-manager form of government in 1962.

A two-year branch of the University of Pittsburgh was opened in Bradford in 1963. The 473,000-ac. Allegheny National Forest is 3 mi. from the city. (W. A. C.; X.)

BRADFORD-ON-AVON, an urban district in the Westbury parliamentary division of Wiltshire, Eng., on the Bristol Avon 9 mi. E.S.E. of Bath. Pop. (1961) 5,757. Its houses of gray Cotswold stone rise up the steep sides of the valley, and the river is spanned by a nine-arched medieval bridge on which is a chapel.

Bradford was the scene of a victory of Cenwalch of Wessex over rebels in 652. A monastery existed there of which St. Aldhelm was abbot when he was made bishop of Sherborne in 705. In Abbey yard—probably the site of the monastery—stands the Saxon church of St. Lawrence, considered by Edward Freeman to be "the most perfect surviving church of its kind in England, if not in Europe." It consists of a nave, chancel and porch and was only rediscovered in 1856 when it was carefully restored. Up to the string-molding it is almost certainly St. Aldhelm's original fabric. In 959 the witan (*q.v.*) or witanagemot was held at Bradford. The monastery was sacked by the Danes in 1003, but the abbess of Shaftesbury, to whom the monastery and manor was given for refuge in 1001, held the manor until the Reformation.

Bradford appears as a borough in Domesday Book. The town was at one time the centre of the west of England wool trade and was famous for its broadcloth and mixtures, the waters of the Avon being especially suitable. Flemish merchants settled there during the reign of Edward III. Despite the introduction of weaving machinery in the 17th century and the great prosperity of the 19th century, there came a decline in the 1840s; the last cloth mill in Bradford closed in 1905.

The main industry is rubber with subsidiaries such as the making of ledgers. The 12th-century parish church of Holy Trinity has had continued additions; the 14th-century stone-tiled tithe barn, one of the best in the country, is preserved as a museum of agricultural implements; Kingston house, restored and called the Hall, was built about 1600 and later used for a time as a wool store.

BRADLAUGH, CHARLES (1833–1891), English freethinker and radical, prominent during the second half of the 19th century for his championship of individual liberty, was born at Hoxton, London, on Sept. 26, 1833, the son of a poor solicitor's clerk. He earned a living by odd jobs, and came into contact with a group of freethinkers who were disciples of Richard Carlile.

At the end of 1850 he enlisted as a soldier, but in 1853 was bought out with money provided by his mother. He then found employment as a lawyer's clerk, and gradually became known as a free thought lecturer, under the name of "Iconoclast." He edited the *National Reformer* for several years from 1860, and displayed much resource in legal defense when the paper was prosecuted by the government on account of its alleged blasphemy and sedition in 1868–69. The passing of the Evidence Amendment act in 1869 was the result of another legal contest (1867–69) as to whether Bradlaugh, being an atheist, and so unable to take the oath, could give evidence in a court of law. Bradlaugh played a prominent part in the republican movement which enjoyed a certain amount of popular support in the early 1870s. In 1874 he became acquainted with Mrs. Annie Besant, who soon became co-editor of the *National Reformer*. In 1876 the Bristol publisher of an American pamphlet, on the population question, called *Fruits of Philosophy* (*see* KNOWLTON, CHARLES), was indicted for selling an indecent work, and, pleading guilty, was lightly sentenced; but Bradlaugh and Mrs. Besant took the matter up, in order to vindicate their ideas of liberty, and aggressively republished and circulated the pamphlet. In the prosecution which resulted they were convicted and sentenced to a heavy fine and imprisonment, but the sentence was stayed and the indictment ultimately quashed on a technical point. The affair, however, had several side issues in the courts and led to much prejudice against the defendants, the distinction being ignored between a protest against the suppression of opinion and the championship of the particular opinions in question.

Mrs. Besant's close alliance with Bradlaugh terminated in 1885, when she drifted from secularism, first into socialistic and labour agitation and then into theosophy as a pupil of Mme Helena Blavatsky. Bradlaugh himself took up politics with increasing fervour. He had been unsuccessful in standing for Northampton in 1868, but he was returned by that constituency to parliament as an advanced radical in 1880. A long and sensational parliamentary struggle now began. He claimed to be allowed to affirm under the Parliamentary Oaths act, and the rejection of this pretension, and the refusal to allow him to take the oath on his professing his willingness to do so, terminated in Bradlaugh's victory in 1886. But this result was not obtained without protracted scenes in the house of commons. In July 1880 Bradlaugh was unseated; in Aug. 1881, having been re-elected, he attempted to force his way into the house, but was ejected. In 1882, at the opening of the session, he entered the house and, producing a Bible from his pocket, administered the oath to himself. After several re-elections and exclusions, and much litigation, Bradlaugh was victorious in Jan. 1886, when the new speaker insisted on his being allowed to take the oath. When the long struggle was over, the public had gradually got used to Bradlaugh, and his transparent honesty and courageous contempt for mere popularity gained him increasing respect. He died in London on Jan. 30, 1891. Hard, arrogant and dogmatic, with a powerful physique and a real gift for popular oratory, he was a natural leader in causes which had society against them, but his sincerity was as unquestionable as his combativeness.

BIBLIOGRAPHY.—*Charles Bradlaugh* by his daughter Hypatia Bradlaugh Bonner and J. M. Robertson (1894); J. M. Robertson, *Charles Bradlaugh* (1920); J. P. Gilmour (ed.), *Champion of Liberty: Charles Bradlaugh* (1933). (A. BRI.)

BRADLEY, FRANCIS HERBERT (1846–1924), influential British philosopher prominently associated with the Absolute Idealist movement. He was born in Clapham (London; then in Surrey), on Jan. 30, 1846, a son of the Rev. Charles Bradley, an Evangelical preacher of some note who fathered 22 children in all. He was educated at Cheltenham, at Marlborough and at University college, Oxford, where he took second-class honours in Greats. He was elected to a fellowship at Merton college in 1870. Shortly afterward he fell ill of a kidney disease which made him a semi-invalid for the rest of his life. He retained his fellowship at Merton, which involved no teaching duties, until his death on Sept. 18, 1924. Three months before, he had been appointed to the Order of Merit, being the first philosopher to receive that distinction. He was unmarried.

Bradley came upon the British philosophical scene at a time when the empiricist theories of J. S. Mill and others were under attack from writers sympathetic to the ideas of Kant and Hegel, and much of his early work consisted in pressing home this attack. In *Ethical Studies* (1876; 2nd ed., 1927), his first major book, he exposed the confusions of the doctrine of utilitarianism as held by Mill; and in *The Principles of Logic* (1883; 2nd ed., 1922, corrected 1928), where his mastery of philosophical prose is at its most evident, he trenchantly denounced the slovenly psychologism and uncritical reliance on the principle of the association of ideas which was all that the empiricists could offer in the way of a logic. In both works Bradley acknowledged his debt to German writers and disclaimed originality, but he was never the simple "Hegelian" that some critics took him to be. Thus while one of the most striking essays in *Ethical Studies*, that on "My Station and its Duties," was devoted to a brilliantly persuasive exposition of the Hegelian conception of "social ethics," Bradley did not hesitate to point out the shortcomings of this doctrine if taken as a complete account of the moral life; and in *The Principles of Logic*, where, without accepting formalism, he tried to treat logic as a special science distinct from psychology on the one hand and from metaphysics on the other, his break with Hegelian doctrine, if not with Hegelian ways of thinking, was still more obvious. Professing to write "from a level not much above that of common sense," he tended to treat topics independently and without much system; there was, moreover, manifest throughout the work a persistent suspicion of thought in all its forms as a source of mere abstractions, a suspicion which Bradley perhaps derived from R. H. Lotze. Later, under the influence of Bernard Bosanquet, Bradley repudiated some of the central ideas of this book, but his emphasis on the ultimate "failure" of thought remained.

Bradley's work in the fields of ethics and logic made him, much against his will, the leading figure in a particular philosophical school, and this fact is of importance in assessing the effect of his third and most ambitious book, his "metaphysical essay" *Appearance and Reality* (1893; 2nd ed., 1897). Bradley's followers expected from this book a demonstration of the spiritual nature of the universe, a vindication of the truths of religion and of the superior reality of the soul. What they got was, in the author's own words, "a critical discussion of first principles," meant "to stimulate inquiry and doubt." Reality was indeed spiritual; it was, said Bradley, a harmonious system of experience, a spiritual unity in diversity. But though this result was certain, to demonstrate it in detail was beyond human capacity. If nothing else ensured this conclusion, it was made inevitable by the fatally abstract nature of human thinking, once again insisted on. Immediate feeling could give us an idea of reality as a harmonious whole, individuated yet undivided, but the idea could not be worked out at the conceptual level. The outlook for any constructive metaphysics was accordingly bleak. Nor could Bradley's admirers find much consolation in his treatment of religion and the self. Religion, he declared, was "not final and ultimate" but, in the end, a matter of practice: the philosopher's absolute had little to do with the God of religious men. As for the self, the idea was beset with at least as many difficulties as any other popular metaphysical notion. To say that souls were the only realities, or that they were more real than other things, was definitely false.

The immediate effect of *Appearance and Reality* was thus to encourage rather than to answer doubt; and in general it has been the negative and critical side of Bradley's thought which has proved influential. Bertrand Russell and G. E. Moore, who led the attack on idealism in the early years of the 20th century, had each benefited from his sharp dialectic; important parts of the new logic which these philosophers introduced were already to be found in Bradley. Not that Bradley himself was prepared to accept their criticisms or ways of thinking: on the contrary, he protested to the last that they and other critics misrepresented him. But, rightly or wrongly, he failed to establish his position on this point. He is valued less for his conclusions than for the manner in which he reached them, for his determination to let nothing stand in the way of an honest enquiry into truth.

Besides the fields mentioned above, Bradley did notable work in philosophical psychology, while his early essay on *The Presuppositions of Critical History* (1874) is still worth consulting.

See also references under "Bradley, Francis Herbert" in the Index volume.

Bibliography.—Bradley's psychological essays and minor writings were put together in *Collected Essays,* 2 vol. (1935). In addition to the works named in the text he himself published *Essays on Truth and Reality* (1914). For biographical details *see* A. E. Taylor, "Francis Herbert Bradley," in the British Academy's *Proceedings, 1924–25* (1926). *See* further: B. Bosanquet, *Knowledge and Reality* (1885); J. H. Muirhead, *The Platonic Tradition in Anglo-Saxon Philosophy* (1931); C. A. Campbell, *Scepticism and Construction* (1931); R. W. Church, *Bradley's Dialectic* (1942); J. Pucelle, *L'Idéalisme en Angleterre* (1955). (W. H. W.)

BRADLEY, GEORGE GRANVILLE (1821–1903), English headmaster and liberal Anglican clergyman, was born at High Wycombe on Dec. 11, 1821. He was educated at Rugby school under Thomas Arnold and then at University college, Oxford, where he became a fellow in 1844. At once he returned to Rugby, whence, having proved his ability both as teacher of classics and administrator, in 1858 he took orders and succeeded his former Rugby colleague G. E. L. Cotton as head of Marlborough college, a new public school which was then in an unsatisfactory condition. He soon eliminated disorder, improved finances and raised teaching to equality with the best. Subsequently, as master of University college (1870 to 1881), he elevated both the personal quality of its students and their academic standards. In 1881 he succeeded his close friend A. P. Stanley as dean of Westminster abbey, the buildings and finances of which his efforts restored. He died in London on March 13, 1903.

Bradley's works include the standard *Life and Letters of Stanley* (1892) (with R. E. Prothero), two sets of lectures on *Ecclesiastes* (1885) and *Job* (1887) and a revision (published in 1881) of Thomas Arnold's *Latin Prose Composition.*

See F. D. How, *Six Great Schoolmasters* (1904). (G. F. A. B.)

BRADLEY, JAMES (1693–1762), English astronomer and third astronomer royal, who discovered the aberration of light, was born at Sherborne, Gloucestershire, and educated at Balliol college, Oxford. His early astronomical observations were made at the rectory of Wanstead in Essex, under the tutelage of his uncle, the Rev. James Pound (1669–1724), and he was elected a fellow of the Royal society on Nov. 6, 1718. He was appointed Savilian professor of astronomy at Oxford in 1721. His discovery of the aberration of light, made while attempting to detect a stellar parallax, was communicated to the Royal society in Jan. 1729, but he withheld announcement of the supplementary discovery of the nutation until Feb. 14, 1748, when he had tested its reality by careful observations during an entire revolution (18.6 years) of the moon's nodes. He succeeded Edmund Halley as astronomer royal in 1742 and while holding that office made fundamental contributions to both the instruments and techniques of observational astronomy. He observed the eclipses of Jupiter's satellites for many years to correct the existing tables, which he then used to make accurate determinations of the longitudes, from Greenwich, of Lisbon and New York. He retired in broken health in 1761 to Chalford, Gloucestershire, where he died the following year, on July 13. His observations, which are often considered to mark the beginning of the modern era in physical astronomy, were the subject of an ownership dispute, but were finally published in two volumes (1798–1805) at Oxford.

See S. P. Rigaud, *Miscellaneous Works and Correspondence of James Bradley, D.D.* (1832). (O. J. E.)

BRADLEY, JOSEPH P (1813–1892), justice of the U.S. supreme court from 1870 to 1892, whose opinions dealing with the commerce clause of the constitution (art. 1, sec. 8) were of notable significance. He was born at Berne, near Albany, N.Y., on March 14, 1813. A farm boy with an insatiable thirst for learning, he managed to find a way to Rutgers college and thence to the New Jersey bar. He grew to be both a reflective master of the law and an active participant in large undertakings; the Camden & Amboy railroad was his most important client. In 1870 he was appointed to the supreme court and assigned to the 5th (southern) circuit, where he at once came to grips with the problems of Reconstruction. His advent made a bare majority to sustain the validity of the legal tender legislation of the Civil War. In the electoral commission of 1877, it was his decisive vote that made Rutherford B. Hayes president. Each of these episodes produced unwarranted partisan charges. As to the power of congress to enforce racial equality, under the postwar amendments, his original views "were much modified by subsequent reflection." In 1883, in the civil rights cases, he held invalid the statute wherein congress had forbidden discrimination on grounds of colour in inns, public conveyances and places of amusement: the 14th amendment is directed at state, not private action. Throughout his 22 years on the court, Bradley was the great exponent of the proposition that the commerce clause makes the nation a single free-trade area—a design which parochial legislation may not defeat. He was influential in bringing the court to uphold state regulation of the rates of railroads and grain elevators. His was one of the most acute and powerful minds in the court's entire roster. Bradley died on Jan. 22, 1892, in Washington, D.C. His *Miscellaneous Writings* were compiled and edited by Charles Bradley (1902).

Bibliography.—Five essays by Charles Fairman approximate a biography: "Mr. Justice Bradley's Appointment to the Supreme Court and the Legal Tender Cases," *Harvard Law Review,* 54:977–1034, 1128–55 (1941); "The Education of a Justice: Justice Bradley and Some of His Colleagues," *Stanford Law Review,* 1:217–55 (1949); "What Makes a Great Justice?—Mr. Justice Bradley and the Supreme Court, 1870–92," *Bacon Lectures on the Constitution of the United States,* 425–485 (1953); "The So-Called Granger Cases, Lord Hale, and Justice Bradley," *Stanford Law Review,* 5:587–679 (1953); "Mr. Justice Bradley," *Mr. Justice,* pp. 69–95, ed. by A. Dunham and P. B. Kurland (1956). (C. Fn.)

BRADLEY, OMAR NELSON (1893–   ), U.S. soldier, commander of the 12th army group in Europe during World War II, was born in Clark, Mo., on Feb. 12, 1893. On graduation from the United States Military academy in 1915 he was commissioned second lieutenant of infantry. At the opening of World War II he was commandant of the Infantry school, later commanding the 82nd and the 28th divisions. In 1943 he led the 2nd corps in north Africa and in the Sicilian campaign. In the fall of that year he took command of the U.S. 1st army in the United Kingdom and started planning for the Normandy invasion. He led the 1st army in the landings in France and in the early battles of 1944, relinquishing this command in August to assume command of the 12th U.S. army group. Under his leadership, the 1st, 3rd, 9th and 15th armies, the largest force ever placed under a U.S. army group commander, carried on operations in France, Luxembourg, Belgium, the Netherlands, Germany and Czechoslovakia.

From 1945 to 1947 Bradley was administrator of veterans' affairs, and from 1948 to 1949 chief of staff of the U.S. army. He was the first chairman of the joint chiefs of staff after unification of the armed services, 1949–53, and was promoted to the rank of general of the army while in that post. In 1951 he published a volume of reminiscences, *A Soldier's Story*. (F. C. Pe.)

BRADMAN, SIR DONALD GEORGE (1908–), Australian cricketer, perhaps the most remarkable batsman of all time, was born at Cootamundra, New South Wales, on Aug. 27, 1908. He perfected his timing and quickened his eyesight by hitting a soft ball against a corrugated water tank and first played for New South Wales in 1927. Bradman scored 6,996 runs in test matches, in which his average of 99.94 runs was unparalleled. His judgment bordered on the miraculous and this, allied with incredibly deft footwork, enabled him to pulverize good-length bowling. In England in 1930, when he made the then test record of 334, no bowler could subdue him, but sticky wickets (rain-affected pitches) and fast, short-pitched "body-line" balls, as bowled by H. Larwood in Australia in 1932–33, momentarily checked him. A brilliant outfieldsman and a shrewd and successful captain, he retired from first-class cricket in 1949 and was knighted the same year. *See* also CRICKET.

BIBLIOGRAPHY.—D. Bradman, *Farewell to Cricket* (1950); J. H. Fingleton, *Brightly Fades the Don* (1949); A. G. Moyes, *Bradman* (1948). (J. H. Fi.)

BRADSHAW, JOHN (1602–1659), president of the "high court of justice" which tried Charles I, was the second son of Henry Bradshaw, of Marple and Wibersley in Cheshire and was baptized on Dec. 10, 1602. He was admitted into Gray's inn in 1620 and was called to the bar in 1627, becoming a bencher in 1647. On Sept. 21, 1643, he was appointed judge of the sheriff's court in London. In Oct. 1644 he was counsel, with William Prynne, in the prosecution of Lord Maguire and Hugh Macmahon, implicated in the Irish rebellion; in 1645 for John Lilburne in his appeal to the lords against the sentence of the star chamber; and in 1647 in the prosecution of Judge David Jenkins. In 1647 he was made chief justice of Chester and a judge in Wales, and on Oct. 12, 1648, he was presented to the degree of sergeant-at-law. On Jan. 2, 1649, the lords threw out the ordinance for bringing the king to trial, and the small remnant of the house of commons which survived Pride's Purge (*see* ENGLISH HISTORY) determined to carry out the ordinance on their own authority. The leading members of the bar of both parties having refused to participate in the proceedings, Bradshaw was selected to preside. The king refused to plead before the tribunal, but Bradshaw silenced every legal objection and denied to Charles an opportunity to speak in his own defense. Bradshaw also conducted the trials of several royalists, including the duke of Hamilton and Lord Capel. He was appointed, in 1649, attorney general of Cheshire and North Wales and chancellor of the duchy of Lancaster, and on March 10 he became president of the council of state. When, after the expulsion of the long parliament (April 1653) Oliver Cromwell came to dismiss the council, Bradshaw is said, on the authority of Edmund Ludlow, to have confronted him boldly and denied his power to dissolve the parliament. He refused to sign the "engagement" drawn up by Cromwell pledging members of the parliament of 1654 to support the Protectorate, and in consequence withdrew from parliament. After the abdication of Richard Cromwell, Bradshaw again became a member of the council of state and on June 3, 1659, was appointed a commissioner of the great seal. He died on Oct. 31, 1659, and was buried in Westminster abbey.

BRADWARDINE, THOMAS (*c.* 1290–1349), archbishop of Canterbury and savant, noted as a theologian and mathematician, called the "profound doctor," was educated and taught at Oxford, where he became professor of divinity and chancellor. In 1335 he left the university and successively held important church offices. After serving as chancellor of the diocese of London, he became a chaplain of Edward III during the early part of the Hundred Years' War. He distinguished himself by his apostolic labours among the soldiers and served as a peace commissioner in 1347. Returning to England he became archdeacon of Lincoln in 1347, and after a contested election, archbishop of Canterbury in 1349. He was struck down by the Black Death 40 days after his consecration. Among his disciples were Nicholas of Autrecourt, John Wycliff and John of Mirecourt.

Bradwardine's most famous work was a treatise on grace and free will entitled *The Cause of God Against Pelagius*, in which he so stressed divine concurrence with all human volition that his followers concluded from it a universal determinism. Bradwardine also wrote works on mathematics, entitled *Speculative Geometry; Practical Arithmetic; Proportions . . .* ; and *Squaring the Circle*, printed 1495–1530, as well as an unpublished *Art of Memorization*.

See W. F. Hook, *Lives of the Archbishops of Canterbury*, vol. iv. (D. D. McG.)

BRADY, MATHEW B. (*c.* 1823–1896), probably the best known photographer in U.S. history, was born in New York state, as he himself said, "in the Lake George country about 1823–24." Through his friendship with William Page, the artist, he met Samuel F. B. Morse, who taught him to take daguerreotypes. In 1844 Brady opened his first New York gallery. Although Brady's name is synonymous with famous battlefield pictures of the Civil War, his career prior to the war is as important to history as his battlefield accomplishments.

As early as 1844 Brady won awards for his skilful daguerreotypes. In 1851 he was awarded a medal for a collection of 48 uncoloured daguerreotypes which he exhibited at the Crystal Palace exhibition in London. It was not only his skill as a photographer which won him everlasting fame, but also his plan, begun in 1845, to take portrait photographs of every great man and woman. The scope of his career is shown by his collection of presidential portraits; he photographed every president of the United States from John Quincy Adams, the sixth president, to William McKinley, with one exception, William Henry Harrison, who died only a month after his inauguration in 1841.

To cover the Civil War, Brady spent his entire fortune of almost $100,000 to hire and equip a corps of photographic teams which covered every phase of the conflict and became the forerunner of the 20th-century newsphoto services. Many of his photographers later photographed the west for the Union Pacific railroad and as official photographers for government railroad surveys.

Although his main activities were directing his cameramen from his Washington office and supervising the operation of his fashionable galleries in New York and Washington, Brady also photographed the battlefields. He was at the first battle of Bull Run in 1861 and at Antietam in 1862 and photographed the battlefields of Gettysburg shortly after the battle had ended; he was at Fredericksburg in 1862 and was under cannon fire at Petersburg in 1864. He also took the memorable photographs of Abraham Lincoln and of Robert E. Lee at Lee's house in Richmond after he had surrendered his army to Ulysses S. Grant at Appomattox.

The Civil War project ruined Brady financially. To meet one bill he gave the creditor a set of his war views. In the financial panic of 1873 he was forced to sell his New York gallery and became bankrupt. He was unable to pay the storage bill for his negatives, and the plates were sold at public auction on July 31, 1874, when they were purchased by the war department for $2,840.

Through the efforts of Gen. Benjamin F. Butler and James Garfield, later president, congress finally appropriated $25,000 for Brady. He continued with his Washington gallery but most of the work was done by assistants and his nephew, Levin Handy.

On Jan. 15, 1896, Brady died alone and forgotten in the alms ward of the Presbyterian hospital in New York city.

See James D. Horan, *Mathew Brady: Historian With a Camera* (1955); Roy Meredith, *Mr. Lincoln's Camera Man* (1946). (Js. D. H.)

BRADY, NICHOLAS (1659–1726), Anglican clergyman and poet, author, with Nahum Tate (*q.v.*), of a well-known metrical version of the Psalms, was born at Bandon, County Cork, on Oct. 28, 1659. He graduated at Trinity college, Dublin, and became prebendary of Cork. In 1690 Brady prevented the burning of the town of Bandon, after James II had given orders for its destruction. He soon afterward settled in London, where he held the livings of Clapham and Richmond.

Brady and Tate's *New Version of the Psalms* was licensed in 1696 and largely displaced the old version of T. Sternhold and J. Hopkins. Among Brady's other works was a blank verse translation of Virgil's *Aeneid* (1726). He died at Richmond, Surrey, on May 20, 1726.

BRADY, WILLIAM A. (1863–1950), U.S. actor, manager and motion-picture producer, was born in San Francisco, Calif., June 19, 1863. He made his debut as an actor there in 1882 and by 1888 was touring with his own company. He had considerable success as Svengali in *Trilby*. In New York city, at the Manhattan, 48th Street and Playhouse theatres, he produced over 250 plays, including *Way Down East*, an all-star revival of *Uncle Tom's Cabin*, and *Street Scene*. Grace George, his second wife, starred in many of them. An early motion-picture producer, he was president of the National Assembly of the Motion Picture Industry, 1915–20. He died Jan. 6, 1950, in New York.

Alice Brady (1892–1939), Brady's daughter by his first wife, Rose Marie Rene, after a period in operetta, became a leading actress in straight plays. One of her greatest performances was as Lavinia in *Mourning Becomes Electra* (1931). She also acted in a number of motion pictures. (B. Ht.)

BRAEMAR, a district in southwest Aberdeenshire, Scot., extending 24 mi. from Ballater (east) to Glen Dee (west), with a breadth of 3 to 6 mi. Glen Dee lies among hills from 1,000 to nearly 3,000 ft. high. The villages and clachans (Gaelic for hamlets) from 600 to more than 1,000 ft. above the sea, have pure, bracing air. The deer forests comprise the royal forests of Balmoral and Ballochbuie, Glen Ey forest, Mar forest and Invercauld forest. Castles, mansions and lodges, mostly in Scottish baronial style, include Balmoral (*q.v.*) and Abergeldie castles belonging to the crown, Invercauld house, Braemar castle, Mar lodge and Old Mar lodge. Braemar (officially Castleton of Braemar) is the foremost village, the capital of the Deeside highlands. The well-known Braemar gathering for highland games is held in August in Princess Royal park near the village. Not far from the spot where the brawling Clunie rivulet joins the Dee the earl of Mar raised the standard of revolt in 1715. His seat, Braemar castle, reputed to be a hunting lodge of Malcolm Canmore, was forfeited along with the estates. The new castle built by the purchasers in 1720 was later acquired by Farquharson of Invercauld, who gave the government the use of it after the battle of Culloden.

BRAG, an old English game which is an ancestor of poker (*q.v.*). From 3 to 12 may play, using the regular 52-card pack. There are three wild cards, called braggers—ace of diamonds, jack of clubs and nine of diamonds. The dealer antes and then deals three cards to each player, face down. Each player in turn may drop, call or raise; if no player calls, dealer collects one chip from each. At the conclusion of betting there is a showdown. Three of a kind and pairs are the only combinations of value, and natural cards outrank equal combinations made with a bragger. (For example, three natural aces would beat an ace, jack of clubs and nine of diamonds.) There are several variants, including one in which all jacks and nines are braggers. (R. L. Fy.)

BRAGA, (JOAQUIM) TEÓFILO (FERNANDES) (1843–1924), Portuguese literary historian, Republican statesman, and poet, the first to attempt a complete history of Portuguese literature, was born at Ponta Delgada in the Azores on Feb. 24, 1843. His family was Catholic and monarchist by tradition, but he himself soon became noted for his intransigent republicanism and anticlericalism at Coimbra university where he graduated in law in 1868.

After attempting to secure a professional chair in law, Braga became professor of modern literatures in the *Curso Superior de Letras* in Lisbon in 1872. Of a buoyant, pugnacious temperament, he wrote profusely on literary, social, historical and political subjects, and produced some verse. He was influenced by French 19th-century writers and his *Visão dos Tempos* (1864) was inspired by Victor Hugo's *Légende des siècles*. Jean Michelet stirred his nationalist enthusiasm for the medieval and popular elements in literature, and later he was a firm upholder of Auguste Comte's positivism. Braga's investigations ranged widely over the whole of Portuguese literature but, owing to his lack of a sense of proportion and his determination to fit the facts to his own sociological and philosophical theories, the valuable material he accumulated is often swamped by digressions and theorizings which have lost much of their validity. Nevertheless, a number of his works remain important: his *História do Romantismo em Portugal* (1880) is still the most comprehensive picture of the Romantic period, and his studies of Almeida Garrett, *Garrett e o Romantismo* (1904) and *Garrett e os Dramas Românticos* (1905), are valuable, as are also the books on the 18th-century poets, *Bocage, sua vida e época literária* (1877) and *A Arcádia Lusitana* (1899), and his *História da Poesia Popular Portuguesa* (1867).

An unswerving Republican, Braga became president of the provisional government which set up the Republic of 1910; he held the presidential office again in 1915. In spite of blindness he never lost enthusiasm and was planning another major work just before his death, at Lisbon, on Jan. 28, 1924.

See J. de Carvalho, "Teófilo Braga," in *Perspectiva da literatura portuguesa do seculo XIX*, vol. II (1948); A. J. Saraiva and O. Lopes, *História da literatura portuguesa* (1954). (N. J. L.)

BRAGA, a city in the district of the same name and the capital of Minho province in northern Portugal, stands at the head of a railway from Oporto, about 30 mi. N.E. of that city. Pop. (1960) 42,636. The city is an archiepiscopal see. Braga is the Roman Bracara Augusta, capital of the Callaici Bracarii, or Bracarenses, and a centre for military roads. In the early 5th century it was taken by the Suevi and about 485 by the Visigoths. The city is noted as the place where the Visigoths renounced the Arian and Priscillianist heresies. Its archbishops are primates of Portugal and long claimed supremacy over the Spanish church.

From the Moors, who captured Braga early in the 8th century, the city was retaken in 1040 by Ferdinand I, king of Castile and Leon; and from 1093 to 1147 it was the residence of the Portuguese court. Its 12th-century cathedral was rebuilt during the 16th century in the blend of Moorish and florid Gothic styles known as Manueline. The church of Santa Cruz has a handsome façade, which dates from 1642. There are several convents and a library containing many rare books and manuscripts. On a hill about 3 mi. S.E. stands the celebrated sanctuary of Bom Jesus do Monte, visited at Whitsuntide by many thousands of pilgrims, and about one mile beyond it is Mt. Sameiro (2,535 ft.), crowned by a colossal statue of the Virgin Mary and commanding a magnificent view of the mountainous country, which culminates in the Serra do Gerez, on the northeast. The principal manufactures of the city are firearms, jewelry, cutlery, cloth and felt hats. Large cattle fairs are held in June and September.

Braga District has an area of 1,054 sq.mi.; pop. (1960) 593,587.

BRAGANZA (Port. Bragança), the name of an administrative district and its capital in the extreme northeast of Portugal. The city, also capital of the province of Trás-os-Montes e Alto Douro (*q.v.*) and an episcopal see since 1764, is on a branch of the Sabor river, 8 mi. S. of the Spanish frontier, and consists of a walled upper town, containing the castle and cathedral, and of a lower or modern town. Area (district) 2,527 sq.mi.; pop. (1960) district 230,266, town 8,141.

Historically, the town is important as the seat of the house of Braganza which provided the kings of Portugal from 1640 to 1910 and the emperors of Brazil from 1822 to 1889. Afonso (d. 1461), an illegitimate son of John I of Portugal, was made duke of

Braganza in 1442, having previously acquired considerable estates and hereditary rights by his marriage with Beatriz, daughter of the constable, Nuno Álvares Pereira. Successive dukes—Fernando I (d. 1478), Fernando II (d. 1483), Jaime (d. 1532), Teodósio I (d. 1563), João I (d. 1583), Teodósio II (d. 1630) and João II—enlarged their patrimony by matrimonial alliances. João I, moreover, married Catherine, a niece of King John III of Portugal and, after 1580, a claimant to the Portuguese throne (*see* Portugal: *History*). Finally, when the national revolution of Dec. 1, 1640, terminated the union with Spain, João II became king of Portugal as John IV. Subsequently the title duke of Braganza was borne by the heir presumptive to the throne. The new dynasty lasted until the deposition of Manuel II and the proclamation of a republic on Oct. 5, 1910.

Meanwhile, with the proclamation of Brazilian independence in 1822, the house of Braganza had provided two heads of the new empire. Pedro, the elder son of John VI of Portugal, was emperor from 1822 to 1831, and his son, Pedro II, was emperor from 1831 until his deposition on the proclamation of the Brazilian republic in 1889. With Pedro II's death in 1891 the male line of this branch of the family became extinct. (For the house of Orléans-Braganza or Bourbon-Brazil *see* Bourbon.)

Manuel II, who died in England, without issue, on July 2, 1932, bequeathed the possessions of the house of Braganza to the Portuguese state. The property was made into a quasi-autonomous administrative unit, supporting the Fundação da Casa de Bragança. This foundation supports a library, museum and lecture centre housed in the palace of Vila Viçosa, which from the 16th century was the principal residence of the Braganza family.

(Da. A. P.)

BRAGG, BRAXTON (1817–1876), Confederate officer in the American Civil War, was born at Warrenton, N.C., March 22, 1817. After graduating from West Point in 1837 he served as an artillery officer in the Seminole Wars of 1837 and 1841, and under Gen. Zachary Taylor in the Mexican War. In 1862, as a major general in the Confederate Army he led a bold advance from eastern Tennessee across Kentucky to Louisville. Tactically the ensuing Battle of Perryville (Oct. 8) was a draw; unwilling to fight to a decision, Bragg withdrew into Tennessee. Though he was bitterly censured, the personal favour of Pres. Jefferson Davis kept him at the head of the Army of Tennessee, and on Dec. 31, 1862, and Jan. 2, 1863, he fought the indecisive Battle of Murfreesboro (or Stones River) against Rosecrans. In the campaign of 1863 Rosecrans constantly outmaneuvered the Confederates and forced them back to the border of Georgia. Bragg, however, inflicted a crushing defeat on his opponent at Chickamauga (Sept. 19–20) and for a time besieged the Union forces in Chattanooga. But large forces under Grant were concentrated upon the threatened spot, and the great Battle of Chattanooga (Nov. 23–25) ended in the rout of the Confederates. Bragg was now deprived of his command, but President Davis made him his military adviser. In 1864, he led an inferior force from North Carolina to Georgia to oppose Sherman's march. In Feb. 1865, he joined Gen. Joseph Johnston, and he was thus included in the surrender of that officer to Sherman.

In spite of his want of success Bragg was a brave and at times a skilful officer, but he lacked the resourcefulness, dash and craftiness of Lee. His irritability prevented him from securing the loyalty from subordinates that military commanders need, but the Confederates had in the west no organizer to equal him. Bragg's greatest military fault was in not following up his successes. His victories were fruitless.

After the war Bragg was a civil engineer in Alabama and Texas. He died at Galveston, Tex., on Sept. 27, 1876.

See also references under "Bragg, Braxton" in the Index.

See Don C. Seitz, *Braxton Bragg, General of the Confederacy* (1924); Bragg Manuscripts, Western Reserve Historical Society. (G. D. Le.)

BRAGG, SIR (WILLIAM) LAWRENCE (1890–), British physicist, worked with his father Sir William Henry Bragg (*q.v.*), in the study of crystals by means of X-ray diffraction. He was born on March 31, 1890, in Adelaide, Austr. He received his education at Adelaide university and Trinity college, Cambridge, where he became a fellow in 1914. He discovered the Bragg law in 1912 while a student at Cambridge, and after receiving his degree, joined his father in the study of X-ray diffraction. As a result of their work, the structures of many kinds of crystals were discovered with the aid of the X-ray spectrometer. For their work in the analysis of crystal structure by means of X-rays the Braggs were awarded the Nobel prize for physics in 1915.

During World War I the younger Bragg served as technical adviser on sound ranging in the map section of British army headquarters in France. He was elected to the Royal society in 1921, and he was Langworthy professor of physics at the Victoria university of Manchester, Eng., from 1919 to 1937. During 1937–38 he was director of the National Physical laboratory, and in the latter year was made Cavendish professor of experimental physics at Cambridge. In addition to various papers on crystal structure, he published with his father *X-Rays and Crystal Structure* in 1915. Other writings include *The Crystalline State* (1934); *Electricity* (1936); and *Atomic Structure of Minerals* (1937).

BRAGG, SIR WILLIAM HENRY (1862–1942), British physicist, is best known for studies of crystal structure by means of X-ray diffraction. He was born at Wigton, Cumberland, July 2, 1862, was educated at King William's college, Isle of Man, and Trinity college, Cambridge. In 1886 he was appointed professor of mathematics and physics at Adelaide, Austr., where he carried out his earlier researches in radioactivity. In 1909 he was appointed Cavendish professor at Leeds and in 1915 Quain professor of physics in the University of London. His researches upon various radioactive phenomena and his power of lucid exposition brought recognition from scientific bodies both at home and abroad; in 1906 he was elected a fellow of the Royal society; in 1915 he received the Nobel prize for physics and the Barnard Gold medal (Columbia university), both of which distinctions he shared with his son William Lawrence Bragg (*q.v.*).

The joint work of father and son went far toward elucidating the arrangements of atoms and crystals, an achievement rendered possible by their development of the X-ray spectrometer.

In 1923 he was appointed Fullerian professor of chemistry at the Royal institution and director of Davy-Faraday research laboratory; subsequently he became director of the Royal institution. He was president of the British Association for the Advancement of Science, 1928–29, and from 1935 to 1940 was president of the Royal society. He died March 12, 1942.

In addition to many publications, chiefly upon radioactivity and crystallography, in the *Philosophical Magazine* and the *Proceedings of the Royal Society,* he also wrote *The World of Sound* (1920); *Concerning the Nature of Things* (1925); and *The Universe of Light* (1933).

BRAGI, according to Norse mythology, is a god of poetry and the son of Odin. Evidence that he actually was worshiped is scant, and some authorities believe that he should be identified with the poet Bragi Boddason the Old, who worked in Norway in the 9th century. (G. T.-P.)

BRAHE, Swedish noble family, descended in the female line from the Danish family of Brahe and a senior member of the Swedish nobility through marriage into the house of the Vasas. Per Brahe (1520–1590), the nephew of Gustavus I Vasa, wrote a historical work *Per Brahe den äldres fortsättning af Peder Svarts krönika* (pub. 1897) and *Oeconomia* (1677 and 1920), a manual for young noblemen. Created count of Visingsborg in 1561 by Eric XIV Vasa, he was the first Swedish count.

Per Brahe the younger (1602–1680), a grandson of Per Brahe, was born on Feb. 18, 1602, at the castle of Rydboholm, near Stockholm. During the war with Poland he served in Prussia from 1626 to 1628 and was a colonel of horse from 1628 to 1631. At the diet of 1629 Brahe was president of the nobility (*lantmarskalk*) and became a privy councilor (*riksråd*) in 1630. From 1632 to 1644 he was a member of the regency council for Queen Christina, concluding the armistice with Poland of 1635. As governor general of Finland from 1637 to 1641 and from 1648 to 1654 he reformed the administration, promoted urban, commercial and agricultural developments and founded the university of Åbo (Turku) in 1640, being its chancellor from 1646 to 1680. Between 1641 and 1680 Brahe was lord high chancellor and as such was an influential member of the regency council from 1660 to 1672 for Charles XI. He died on Sept. 12, 1680, at his castle of Bogesund, near Stockholm.

Per the younger's brother, Count NILS BRAHE (1604–1632), was born at Rydboholm on Oct. 14, 1604. He served as a general under Gustavus II Adolphus and was appointed a colonel of the "yellow regiment," the king's renowned life guard, in 1631. He distinguished himself at the crossing of the Rhine at Oppenheim (Dec. 1631) and at the battle of the Lech (April 1632). At the battle of Lützen (Nov. 16, 1632) where he commanded the Swedish centre, he was mortally wounded and died on Nov. 21, 1632, at Naumburg. The marriage of his son, Adm. Count NILS BRAHE the younger (1633–1699), to a daughter of C. G. Wrangel, the lord high constable, brought Skokloster castle, near Stockholm, to the family.

Count MAGNUS BRAHE (1790–1844), a close friend of Charles XIV John (the former French marshal Bernadotte), exercised a secret but preponderant influence on public affairs from 1828 onward, being marshal of the kingdom from 1834 to 1844. When the last count, MAGNUS BRAHE (1849–1930), died, Skokloster and Rydboholm castles, with their great art collections, passed to the family of von Essen, related to the Brahes by marriage; the earlier archives from both castles are however in the Swedish public record office (*riksarkivet*) in Stockholm.

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On Nils Brahe the elder see *Sveriges Krig 1611–1632*, vol. v and vi (1938, 1939). (B. O. H. H.)

BRAHE, TYCHO (1546–1601), Danish astronomer, the discoverer of the "new star" in Cassiopeia and one of the great practical astronomers of the later Renaissance, was born on Dec. 14, 1546, at the family seat of Knudstrup in Scania, Den. He studied at Copenhagen, Leipzig, Rostock and Augsburg, and in 1571 was permitted by his maternal uncle, Steno Belle, to install a laboratory at his castle of Herritzvad, near Knudstrup, where on Nov. 11, 1572, he discovered the famous "new star" in the constellation Cassiopeia. His observations were published in *De Nova Stella* (1573), in which he proved that the star was beyond the moon, contrary to the general belief.

He gave lectures in Copenhagen, by royal command, in 1574 and traveled to Germany and Italy in 1575. He returned to Denmark in the following year when Frederick II granted him the island of Hven, near Copenhagen, together with ample means to found an observatory there. In return, Tycho acted as astrologer and almanac maker for the royal family. The corner stone of Uranienborg ("castle of the sky") was laid in 1576 and the finished building provided working spaces, living quarters and instruments on a scale much greater than had previously been available to astronomers. Uranienborg, together with a later building, Stellaborg, is the forerunner of the great modern observatories.

The appearance of the new star in 1572 had given Tycho the idea of forming a precise star catalogue which, together with most of his other work, was carried out on Hven between 1576 and 1596. In 1596 Frederick was succeeded by Christian IV who was less tolerant of Tycho's arrogance and heavy drain on the royal treasury. Tycho's pensions having been withdrawn, he left Denmark in 1597 and finally reached Prague in June 1599, where he was assured of favour and protection by the emperor Rudolph II, who granted him the castle of Benatky, near Prague, together with an ample pension. Although most of his instruments were moved from Hven to Prague, and Kepler joined him in Jan. 1600, very few observations were made and Tycho died there on Oct. 24, 1601.

Tycho's principal work, *Astronomiae instauratae Progymnasmata*, 2 vol. (1602–03), was edited by Kepler. The first volume treated of the motions of the sun and moon and gave the places of 777 fixed stars—this number was increased to 1,000 by Kepler in 1627 when he published his "Rudolphine Tables." The second volume, which had been privately printed at Uranienborg in 1588 with the title *De Mundi aetherii recentioribus phaenomenis*, was mainly concerned with the comet of 1577 which, Tycho showed, as he had for the new star, possessed no appreciable parallax and was therefore an extraterrestrial phenomenon. This volume also includes an account of the Tychonic system in which a middle ground was sought between the Ptolemaic and Copernican systems. The immobility of the earth was retained from the Ptolemaic system but the other planets were made to revolve around the sun, which, with these planets, annually circuited the earth. In both the Tychonic and Ptolemaic systems, the sphere of the fixed stars performed a diurnal rotation. Tycho, in correspondence, tried to convert Galileo from the Copernican system on the basis of the fact that his precise observations showed no sensible relative motion of the fixed stars, but Galileo was unconvinced and groups Tycho with Aristotle and Ptolemy in his *Dialogue on the Two Systems of the World*, although he expresses admiration for Tycho's observational results.

In *Astronomiae instauratae Mechanica*, Tycho published at Wandbeck, in 1598, a description of his instruments, together with an autobiographical account of his career and discoveries, including the outstanding one of a new variation in the motion of the moon. His *Epistolae Astronomicae*, printed at Uranienborg in 1596, were embodied in a complete edition of his works issued at Frankfurt in 1648. He was the first to allow for the effect of refraction, by the earth's atmosphere, on astronomical observations and introduced methods for the correction of instrumental errors and the averaging of accidental errors. He substantially corrected the received value of nearly every astronomical quantity and his observations on Hven are characterized by their accuracy and their continuity.

See J. L. E. Dreyer, *Tycho Brahe* (1890); E. Stromgren, *Nord. astr. Tidsskr.* (1946). (O. J. E.)

BRAHMA AND BRAHMAN. Brahma (masculine) is the first member of the Hindu trinity, the creator-god whose Vedic prototype was Prajapati, the lord of the creatures. The other members of the trinity are Vishnu and Shiva, and with the rise of Shivaism and Vishnuism in the Epic period as the two most popular cults, the importance of Brahma declined (*see* also HINDUISM: *Gods*). Only one prominent temple dedicated to Brahma remains, that at Pushkar, near Ajmer, India.

The familiar picture of Brahma is that of a four-faced and four-armed bearded deity seated on a lotus seat below which is placed a swan. The four faces represent the four Vedas, the chief Hindu scriptures. The sacrificial spoon, a string of beads and a manuscript that he holds in his hands indicate that he is the God of wisdom and piety. His consort is Sarasvati, the goddess of learning. He is known as the lotus-born and the first-born, and he is described as the grandfather of gods and men. His mind-born sons, the sages Sanaka, Sanandana, Sanatana and Sanatkumara, are the exemplars of the path of renunciation, while his worldly sons such as Daksha are charged with the duty of perpetuating the species.

Brahman (neuter) is the supreme reality that upholds the universe. Originally the word probably meant "prayer" or "speech" from the root *brh*, "to burst forth." It also means that which is great and mighty. The seers of the Upanishads seem to have arrived at the conception of Brahman when inquiring into the origin of the objective universe. When they adopted the method of subjective investigation, they concluded that the root principle is Atman (the soul or self). Finally Brahman is identified with Atman, and defined in one of the Upanishad texts as "that whence all beings come into existence, wherein they reside and where unto they return at the end."

Brahman is thought of in two ways: as the all-inclusive sustaining spirit of the universe, or as the reality of which the universe is only the surface appearance. The former is the cosmic view (*saprapanca*) according to which Brahman is endowed with attributes (*saguna*), postulated by the theistic schools of Vedanta. The latter is the acosmic view (*nishprapanca*) which considers Brahman to be unconditioned and attributeless (*nirguna*) and is held to be a more adequate view of Brahman by the absolutist schools. Since Brahman is the unconditioned reality, it can be indicated only negatively as "not this, not this." This, however, does not mean that Brahman is "nothing." It is the plenitude of being (*sat*), consciousness (*chit*) and bliss (*ananda*). Although both the theistic and the absolutistic standpoints are to be found in the Upanishads themselves, the most outstanding exponents of these in the systematic period of Indian philosophy were respectively Ramanuja in the 11th century A.D. and Shankara in the 9th century A.D. (*See* also INDIAN PHILOSOPHY.)

Of the two conceptions, that of the personal God Brahma and that of the impersonal Absolute Brahman, it is difficult to say which was earlier. The seeds of both are to be found even in the Rigveda.

The term Brahma also refers to one of the four principal priests that officiate at Vedic sacrifices. His functions are to supervise the ritual acts and to set right any mistakes. The expression *brahmana* means (1) the parts of the Veda which are concerned with sacrifices (*see* BRAHMANAS); (2) one who has realized Brahman; (3) "a Brahman"; *i.e.*, member of the Brahman caste.

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(T. M. P. M.)

BRAHMAGUPTA (588–*c.* 660), Hindu mathematician and astronomer. He set forth the astronomical system of Brahma in verse form, the *Brahma-sphuta-siddhanta* (*c.* 628).

Two of the chapters in this work are devoted to mathematics, including an arithmetical progression, a quadratic equation and proofs of various geometrical theorems on the right-angled triangle, on areas of triangles and quadrilaterals and on surfaces and volumes. These two chapters were translated into English by H. T. Colebrooke in his *Algebra, with Arithmetic and Mensuration, from the Sanskrit of Bramegupta and Bhascara, preceded by a dissertation on the state of science as known to the Hindus* (1817). Another translation is given in P. C. Sengupta, *The Khandakhādyaka, an Astronomical Treatise by Brahmagupta* (1934).

(O. OE.)

BRAHMAN, the highest-ranking group in the Hindu hierarchy of hereditary castes (*see* CASTE [INDIAN]). The elevated position of the Brahman goes back to the first millennium B.C. when the Aryans who had settled in northern India were already divided into Brahmans or priests, warriors, traders and husbandmen, and menials, and the Brahmans had gained prominence among the three upper classes known as "twice-born." Since then there has been no fundamental change in their position and they still enjoy great prestige and many advantages, though their claim to tangible privileges is no longer officially admitted. The basis of the age-old veneration of Brahmans is the belief that they are inherently of greater ritual purity than members of other castes and that they alone are capable of performing certain vital religious tasks. The study and recitation of the sacred scriptures was traditionally reserved for this spiritual élite and for centuries all Indian scholarship was in their hands.

Because of their high prestige and their intelligence and learning, Brahmans wielded influence even in secular affairs, and although political power lay normally with members of the warrior caste they acted frequently as advisers and ministers of ruling chiefs. During the period of British rule Brahmans largely retained their role as intellectual leaders—at first in the service of government and later in the nationalist movement. After India achieved independence (1947) Brahmans continued to lead the Congress party, and dominated the central government, but in many states there developed a reaction against their dominant position in the administration, and in southern India, where Brahmans were particularly firmly entrenched, an anti-Brahman movement gathered considerable strength. This does not, however, affect their traditional position as priests, ministering both in temples and at domestic rites. Every orthodox Hindu of clean caste must have a Brahman family priest (*purohita*), to whom he pays customary dues in return for services at weddings, funerals and other ceremonial occasions.

The ritual purity of the Brahmans is maintained through the observance of numerous taboos, many of which relate to diet and contact with lower castes. Most Brahman castes are strictly vegetarian and their members must abstain from certain occupations. They may not plow or handle any impure material, such as leather or hides, but they may farm and do such agricultural work as does not offend against these specific restrictions. They may also accept employment as domestic servants and many well-to-do Hindus have Brahman cooks, who are useful because members of all castes may eat the food they prepare.

Orthodox Brahmans spend much time on religious practices, which consist of recitations and prayers, a daily ritual bath and the regular worship of household deities. Brahmans never bow to other castes but others bow to them in recognition of their high ritual status. At an early age boys are invested with a sacred thread made of three strands of cotton, which is worn next to the skin over the left shoulder. Those who have undergone this initiation rite are known as *Duija* ("twice-born"). Most Brahmans are strict in the observance of marriage rules, and while polygamy is permitted traditionally to Brahman men, Brahman women who have been widowed or deserted by their husbands are not allowed to remarry. Well into the 19th century Brahman widows sometimes committed *sati* or self-immolation on the husband's funeral pyre, a pious act approved by public opinion.

The Brahmans of India are divided into ten main territorial divisions, five of which are associated with the north and five with the south. The northern group consists of Saraswati, Gaur, Kanauj, Maithil and Uthkal Brahmans and the southern group of Maharashtra, Andhra, Dravida, Karnata and Gurjara Brahmans. Within each of these groups there are sectarian divisions based on an emphasis on the study of specific Vedas, and also endogamous subcastes, most of which have local associations. Each of these subcastes is again divided into exogamous clans or *gotra*, believed to consist of the descendants of certain legendary saints or *rishi*. Despite this variety of sects and regional divisions, Brahmans represent the only caste group whose status is constant throughout India, and recognition of their supreme ritual status is one of the marked features of Hindu unity. Outside India Brahmans are also found in Nepal and in small numbers in the Tamil-speaking parts of Ceylon. *See* BRAHMA AND BRAHMAN; HINDUISM.

See also references under "Brahman" in the Index.

(C. v. F.-H.)

BRAHMANAS, treatises in prose explaining the significance of the *Vedas* as used in ritual sacrifice (*see* SANSKRIT LITERATURE; VEDIC RELIGION).

The word *brāhmaṇa* (otherwise meaning "a Brahman"; *see* BRAHMA AND BRAHMAN) is derived from *brahma* in its Vedic sense of devotion or prayer.

The *brāhmaṇas* belong to the period 800–500 B.C., a time when the collections into *saṃhitās* ("books") of the sacred hymns had acquired a position of sanctity. They represent a digest of accumulated teachings, illustrated by myth and legend, on various matters of ritual, and on hidden meanings of the sacred texts. Assuming complete familiarity with the ritual, they do not form a guide to sacrificial procedure. The oldest *brāhmaṇas* are found in the *Kṛṣṇayajur-veda*, where the *saṃhitā* is interspersed with prose comments. In the Katha and Maitrayaniya schools such comments form the only extant *brāhmaṇa*, whereas the Taittiriya school has a supplement, in three books, entitled the *Taittirīya Brāhmaṇa*. The last portion of the *Taittirīya Brāhmaṇa* (together with the beginning of the *Taittirīya Āraṇyaka*) has been incorporated bodily from the prose portions of the Katha *saṃhitā*. The treatises designated as *āraṇyaka* ("forest treatises") represent a subsequent development in brahmanical discussion, being more theosophical in content, and were either to be studied by pious Brahmans who, having retired to the forest, no longer partook in ritual sacrifice, or else were to be imparted by teacher to pupil in the forest; *i.e.*, away from the village. *Āraṇyakas* act as a link between the *brāhmaṇas* and the *upaniṣads*, the latter often being inserted in the *āraṇyaka*.

The *Sāmaveda* owns numerous *brāhmaṇas*, but properly there are two, the *Pañcaviṃśa* ("25 book"), *Taṇḍyā* or *Prauḍha Brāhmaṇa* of the Kauthuma school; and the *Jaiminīya Brāhmaṇa* of the Jaiminiyas or Talavakaras. These show almost complete accordance in their exposition of the *gavāmayana* ("going of cows" ceremony), the *jyotiṣṭoma, ukthya,* and *atirātra* (Soma ceremonies), the *dvādaśāha* ("12 days' rite"), and finally the different rites lasting from 1 to 12 days. The last chapters of the *Ṣaḍviṃśa* (26th book), called the *Adbhuta Brāhmaṇa,* as also the conclusion of the *Jaiminīya Brāhmaṇa,* describe the atonements required where mistakes or evil portents have occurred during sacrifices. The *Jaiminīya* wanders into digressions, quoting long anecdotes, whereas the *Pañcaviṃśa Brāhmaṇa* adheres more rigidly to the order of the sacrifice, indulging occasionally in statements hostile to the Kausitaki school of the *Rigveda.* The *Kauśītaki* (or *Śāṅkhāyana*) *Brāhmaṇa,* in 30 chapters, explains the religious significance of the *agnyādhāna* ("setting up the sacrificial fire"), the *agnihotra* ("daily morning and evening sacrifice"), the new and full moon rites, and the *cāturmāsyas* ("four months' rites"). Most of the *brāhmaṇa,* as also of that of the Rigvedic Aitareyins, is then occupied with the *agniṣṭoma* ("the one-day rite of the soma"). The *Aitareya Brāhmaṇa,* in eight books of five chapters each, also treats the *gavāmayana* and the *dvādaśāha.* The remaining three books deal with the *agnihotra* and with the rites for the installation of kings.

The *Aitareya* and *Kauśītaki Āraṇyakas* begin with the soma ritual, but turn to speculation concerning the world-soul under the names of *prāṇa* and *puruṣa,* a theme dealt with in the *Kauśītaki Upaniṣad,* which, like the *Aitareya Upaniṣad,* is contained in the *brāhmaṇa.*

To the *Śuklayajurveda* belongs the *Śatapatha Brāhmaṇa* (of 100 "paths"), consisting of 100 lessons. Ranking next to the *Rigveda* in importance, this *brāhmaṇa* survives in two slightly differing recensions, the Kanva and the Madhyamdina, following the order of the *saṃhitā* exactly, the first nine (Madhyamdina, ten) sections corresponding to the first 18 divisions of the *saṃhitā.* The remaining sections, besides complementing the earlier portions, introduce elements more connected with domestic ritual; the last section introduces the *Bṛhadāraṇyaka,* which concludes with the *Bṛhadāraṇyaka Upaniṣad.*

Finally, to the *Atharvaveda* belongs the comparatively late *Gopatha Brāhmaṇa.* Relating only secondarily to the *saṃhitā* and borrowing considerably from other *saṃhitās* and *brāhmaṇas,* it is partly concerned with the role played by the Brahman, the priest who presides over sacrificial procedure. (J. E. B. G.)

BRAHMANISM: *see* Hinduism.

BRAHMAPUTRA (Tibetan, Tsangpo; Chinese, Ya-lu-ts'ang-pu chiang), a great river of Tibet, northeastern India (Assam) and East Pakistan, with a total length of about 1,800 mi. Its source, in about 82° 10′ E., 30° 30′ N., is in a great glacier mass in the Kailas range of the Himalayas, just south of the lake called Gunkyud Tso in western Tibet. Tributaries join the infant river from near the pass of Maryum La (16,900 ft.), which separates its basin from the Manasarowar lake district, in which two other great Indian rivers, the Indus and Sutlej, have their source. The river flows through southern Tibet for about 700 mi., keeping a course roughly parallel to, and 100 mi. from, the main chain of the Himalayas. It is known there as the Tsangpo, meaning in Tibetan "the purifier," but this is not a distinctive name, for it is applied to any large river; the Tibetans themselves call it by different names in different parts of its course. It receives many tributaries, of which the most important are: on the left bank, the Raka Tsangpo, which joins it west of Zhikatse, and the Kyi Chu, on which stands Lhasa; on the right bank, the Nyang Chhu, which flows by the large trade centre of Gyangtse and joins the Tsangpo at Zhikatse. Zhikatse is the principal place on the Tsangpo itself and the second town of Tibet, with the great monastery of Trashi Lhumpo, formerly the seat of the Tashi Lama.

From Lhatse Dzong (Janglache) in 87° 37′ E. to a day's journey below Tsethang (11,850 ft.) 50 mi. S.E. of Lhasa the Tsangpo has a wide navigable channel. It is one of the most remarkable inland systems of navigation in the world, for boats navigate it for 400 mi. at a height of 12,000 ft. and more above sea level. The boats are coracles made of hide stretched over frameworks of slender branches. Large ferry boats, shaped like oblong boxes, ply in some places. Elsewhere there are suspension bridges made mainly of bamboos and in a few cases with heavy chains: some have a 300-ft. span.

At Tsela Dzong the Tsangpo is joined from the north by the Gyamda, 2 mi. wide at the point of junction. Further east at Pe (9,680 ft.) the river is still a broad placid stretch of water, 660 yd. wide. Then turning abruptly to the northeast and north it makes its way by a succession of stupendous gorges between the huge mountain masses of Gyala Peri (23,458 ft.) and Namcha Barwa (25,446 ft.), which are in one place only 8 mi. apart. Through these deep narrow gorges the Tsangpo rushes tumultuously down in a series of cascades and rapids, turning the flank of the range in a hairpin bend. It takes up from the north the Po Tsangpo, a swift torrent 80 yd. wide, and then, turning to the south and southwest, emerges from the foothills as the Dihang. It flows into Indian territory across the North East Frontier agency (administered by the governor of Assam as agent for the president of India) and into Assam proper west of Sadiya town. Near Sadiya it receives from the north the Dibang and the Sesiri and from the east the Luhit, which, as it flows in the same direction as the main river, is wrongly called by the Assamese the Brahmaputra. From the point of junction the mighty river, which is now for the first time known by the Indian name of Brahmaputra, *i.e.,* the son of Brahma, rolls majestically down the Assam valley for 450 mi. Its channels oscillate from side to side over a bed about 6 mi. wide and it forms many islands, one of which, Majuli, has an area of 485 sq.mi. In times of flood it overflows its banks and resembles an inland sea.

Sweeping round the spurs of the Garo hills, the river enters the alluvial plains of East Pakistan, through which it flows for another 150 mi. until it joins the Ganges at Goalundo. From the confluence of the Tista to Goalundo it is called Jamuna. The united stream of the two rivers then flows southeast under the name of the Padma and makes its exit into the Bay of Bengal by the broad estuary of the Meghna. Till the end of the 18th century the Brahmaputra flowed through the centre of the district of Mymensingh to join the Ganges near Bhairab Bazar, but early in the next century, as this channel became choked with silt, the stream deserted it and moving westward across the friable soil of the delta cut its channel along the western boundary of Mymensingh.

It has well been said that the Brahmaputra for its size and utility ranks among the most important rivers in the world. It is 250 mi. longer than the Ganges. It drains an area of 361,000 sq.mi. and its flood discharge during the rainy season, when its level rises 30 to 40 ft., has been estimated at 500,000 cu.ft. per second. It not only builds up land, but also fertilizes it and distributes its produce. It is the highway of commerce through the fertile valley of Assam and East Pakistan. Unbridged throughout its length in Indian and Pakistan territory it is navigable by steamers as far as Dibrugarh, 800 mi. from the sea.

The upper course of the Brahmaputra was long an unsolved mystery; it was even thought at one time that the Tsangpo might be the upper channel of the Irrawaddy and might thus have no connection with the Brahmaputra. The explorations of Kinthup, an Indian surveyor, along the Tsangpo as far as Pemakochung in 1884 and of J. F. Needham up the Dihang in 1886 first established the identity of the Tsangpo and Brahmaputra beyond reasonable doubt. Capt. C. G. Rawling, with Capt. C. H. D. Ryder, Capt. H. Wood and Lieut. F. M. Bailey marched up the Tsangpo from Zhikatse to its source in 1904–05; but its course from Pemakochung through the Himalayas to its debouchment in the Abor hills of Assam remained a mystery. It was known that after flowing at a level of 12,000 ft. on one side of the range it reappeared at 1,000 ft. on the other; and it was thought that there might be tremendous waterfalls hidden in the mountains. Exploration was barred by the hostility of mountain tribes, but in 1913, after the Abor expedition had inspired them with wholesome respect, Bailey and Capt. H. T. Morshead explored 100 mi. of the river and found marvelous gorges and rapids but no falls higher than 30 ft. A gap of 50 mi. still remained, but in 1924 Capt. F. Kingdon Ward found that in this part of its course also the river descends not by great waterfalls but by rapids and cascades pent in towering cliffs and narrowing in one place to a width of 30 yd. *See* Siang Frontier Division. *See* also references under "Brahmaputra" in the Index.

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(L. D. S.)

BRAHMO SAMAJ ("Association for the Worship of God"), a protestant theistic movement within the fold of Hinduism, was founded in Calcutta in 1828 by Ram Mohun Roy (*q.v.*). It does not accept the authority of the Vedas, has no faith in avatars and does not insist on belief in *karma* and rebirth. It discards Hindu rituals, adopts some Christian practices in its worship and, influenced by Islam and Christianity, denounces polytheism, idol worship and the caste system. It has no authoritative canon of its own and relies more on reason than on faith. It has preserved neither the comprehensiveness and philosophic depth of orthodox Hinduism nor the concrete appeal of the older theisms connected with the worship of Vishnu, Siva and Sakti.

Whereas Ram Mohun Roy wanted to reform Hinduism from within, his successor, Debendranath Tagore (*q.v.*), broke away in 1850 by repudiating Vedic authority and making reason and intuition the basis of Brahmoism. However, he tried to retain some of the traditional Hindu customs, and a radical group led by Keshub Chunder Sen (*q.v.*) seceded and organized the Brahmo Samaj of India in 1866. The new branch became eclectic and cosmopolitan and was also most influential in the struggle for social reform. It sponsored the Band of Hope temperance society, encouraged the education of women and campaigned for the remarriage of widows and for legislation to prevent child marriages. When Keshub arranged for his daughter to marry the prince of Cooch-Behar, though both parties were under age and he was thus violating his own reformist principles, many of his followers rebelled and in 1878 formed a third *samaj*, the Sadharan Brahmo Samaj. While Keshub attempted to establish a new universal religion called Nava Vidhan (the New Dispensation), the Sadharan Samaj gradually reverted to the teaching of the Upanishads and carried on the work of social reform. Although the movement has lost force in the 20th century—by the second half of the century it embraced only 0.2% of the Indian people—it has been partially successful in that its fundamental social tenets are now accepted by Hindu society.

See Sitanath Tathvabhushan, *The Philosophy of Brahmaism* (1909); Sivanath Sastri, *History of Brahmo Samaj*, 2 vol. (1911–12).

(D. S. Sa.)

BRAHMS, JOHANNES (1833–1897), German composer, was the greatest master of symphonic and sonata style of the second half of the 19th century and the protagonist of the classical tradition of Haydn, Mozart, and Beethoven in a period when the standards of this tradition were generally questioned or overturned by the Romantics.

Life.—The son of Jakob Brahms, an impecunious double-bass player, he was born in Hamburg on May 7, 1833. Showing early promise as a pianist, he had his first tuition in music from his father, and at the age of seven was sent for piano lessons to Otto Cossel, who three years later passed him to his own teacher, Eduard Marxsen. This distinguished teacher wisely recommended against the suggestion of Brahms *père* that the boy should undertake a tour of the United States, and Johannes remained with him for several years. Between the ages of 14 and 16 Brahms earned money to help his family by playing in rough inns in the dock area of Hamburg and, in the meantime, composing and sometimes giving recitals. In 1850 he met Eduard Reményi, a Jewish-Hungarian violinist of somewhat irresponsible character, with whom he gave concerts, and from whom he learned something of Hungarian national music—an influence that remained with him all his life.

The first turning point came in 1853, when he met Joseph Joachim, who instantly realized the talent of Brahms, whom he recommended to Schumann; and an immediate friendship between the two composers resulted. Schumann wrote enthusiastically about him in the *Neue Zeitschrift für Musik;* in an article that was to become famous, he said, "It seemed to me . . . that . . . a musician would inevitably appear to whom it was vouchsafed to give the highest and most ideal expression to the tendencies of our time, one who would not show his mastery in a gradual development, but, like Athena, would spring fully armed from the head of Zeus. And he has come, a young man over whose cradle Graces and Heroes stood watch. His name is Johannes Brahms." From this moment Brahms was a force in the world of music, though there were always factors that made difficulties for him.

The chief of these was the nature of Schumann's panegyric itself. There was already conflict between the "neo-German" school, dominated by Liszt and Wagner, and the more conservative elements, whose main spokesman was Schumann. His praise of Brahms displeased the enemy; Brahms himself, though kindly received (as was almost everyone) by Liszt, did not conceal his lack of sympathy with the self-conscious modernists. He was therefore drawn into controversy, and most of the disturbances in his otherwise uneventful personal life arose from this situation. For example, his close friendship with the conductor Hermann Levi was broken off because of Levi's increasing admiration for Wagner's music; whereas Hans von Bülow, once an ardent Wagnerian, came over to Brahms's side as a consequence of his wife's elopement with Wagner. Gradually Brahms came to be on close terms with the Schumann household, and when Schumann was first taken mentally ill in 1854, Brahms assisted Clara Schumann in managing her family. He appears to have fallen in love with her, but though they remained deep friends after Schumann's death in 1856, their relationship did not, it seems, go farther.

Between 1857 and 1860 Brahms moved between the court of Detmold—where he taught the piano and conducted a choral society—and Göttingen, while in 1859 he was appointed conductor of a women's choir in Hamburg. By 1861 he was back in Hamburg, and in the following year he made his first visit to Vienna, with some success. Having failed to secure the post of conductor of the Hamburg Philharmonic concerts, he settled in Vienna in 1863. His life there was on the whole regular and quiet, disturbed only by the ups and downs of his musical success, by altercations occasioned by his own quick temper and by the often virulent rivalry between his supporters and those of Wagner and Bruckner, and by one or two inconclusive love affairs. His music, despite a few failures (such as that of the First Piano Concerto, Leipzig, 1859) and constant attacks by the Wagnerites, was established, and his reputation grew steadily. By 1872 he was principal conductor of the *Gesellschaft der Musikfreunde,* and for three seasons directed the Vienna Philharmonic Orchestra. His choice of music was not as conservative as might have been expected (Berlioz' *Harold en Italie* was one of the works he conducted), and though the "Brahmins" continued their war against Wagner, Brahms himself always spoke of his rival with respect. He showed no such regard for Bruckner, whose symphonies he described with characteristic sarcasm as "boa constrictors"; it may well be that his contempt for Bruckner sprang from his realization that Bruckner's adoration of Wagner was entirely without analytic understanding. Brahms had no difficulty in understanding Wagner, but did not sympathize with his aims. Yet he was able at length to find something in Bruckner—near the end of his life he was seen to applaud the Austrian's F minor Mass, and he persuaded Richard von Perger to conduct Bruckner's *Te Deum.* Brahms is sometimes portrayed as unsympathetic toward his contemporaries. His kindness to Dvořák is always acknowledged, but his encouragement even of such a composer as the young Mahler is not always realized, while his enthusiasm for Nielsen's First Symphony is not generally known.

Once in Vienna, Brahms traveled only occasionally. Like Beethoven, he disliked traveling and feared the sea; he was invited to England to receive an honorary D. Mus. at Cambridge, but declined to make the journey (1877). Italy attracted him—the country, and decidedly not its music—and he visited it several times. He made tours of Germany, the Netherlands, and Hungary, and ventured as far north as Copenhagen, where his tactlessness landed him in trouble; on being shown the Thorwaldsen Museum he remarked that it was a pity such a magnificent museum was not in some really important city like Berlin or Vienna. He was compelled to leave there hastily. His lack of tact and his general dislike of women frequently led him into difficult situations; yet so far as women were concerned it is a fact that—apart from Joachim—the two musical friends whose criticism he most valued were Clara Schumann and Elisabeth von Herzogenberg (1847–1892). The latter, the daughter of a diplomat, came first to him as a pupil, but remained a lifelong friend and brilliantly intelligent correspondent. The nearest Brahms ever came to marriage was in his affair with Agathe von Siebold in 1858; from this he recoiled suddenly, and he was never thereafter seriously involved in the prospect. The reasons for this are unclear, but it is most probable that his immense reserve and his inability to express emotions in any other way but musically were responsible, and he no doubt was aware that his natural irascibility and resentment of sympathy would have made him an impossible husband. He wrote in a letter, "I couldn't bear to have in the house a woman who has the right to be kind to me, to comfort me when things go wrong." All this, together with his intense love of children and animals, goes some way to explain certain aspects of his music, its concentrated inner reserve that hides and sometimes dams powerful currents of feeling.

Brahms's last tour, in Germany, 1895, was made with Richard Mühlfeld, a fine clarinetist for whom he had written a trio, a quintet, and two sonatas. Brahms's health was already precarious, and he was unwilling to discuss the matter with anyone. By the middle of 1896 he was definitely ill; in May of that year Clara Schumann died, and Brahms, in a desperate journey to Frankfurt to attend her funeral service, missed a night train, was too late, and had to go on to Bonn, where she had been taken to be buried beside her husband. After this, he was compelled to seek medical treatment, and his liver was discovered to be seriously diseased. He appeared for the last time at a concert in March 1897; and in Vienna, on April 3, 1897, he died of cancer.

Works.—Since the feud between the Wagnerians and the Brahmsians is now a matter of history, it can be seen that Brahms supplied to the art what was needed to complement and counteract the rapid growth of Romantic individualism. He was a traditionalist in the sense that he revered above all things the subtlety and the power of movement displayed by Haydn, Mozart, and Beethoven, with an added influence from Schubert. The Romantic preoccupation with the emotional moment had created new harmonic vistas, but it had also two inescapable consequences. First—and especially in the work of Liszt—it had produced a tendency toward rhapsody that often resulted in want of structure. Secondly, it had slowed down the processes of music, so that Wagner had been able to discover a means of writing music that moved as slowly as his often argumentative stage action. Many composers were decreasingly concerned to preserve the skill of taut, brilliant, and dramatic symphonic development that so eminently distinguished the masters of the turn of the 18th and 19th centuries, culminating in Beethoven's chamber music and symphonies.

Brahms was acutely conscious of this loss, repudiated it, and set himself to compensate for it, to keep alive a force he felt strongly was far from spent. Both during his lifetime and long after his death he was dubbed a "conservative." But he was desirous not merely to reproduce old styles, but to infuse the language of his own time with constructive power. Brahms's musical language bears little resemblance to Beethoven's or even Schubert's; harmonically it was much influenced by Schumann, and even to some extent by Wagner—if we examine his early F ♯ minor piano sonata (op. 2), we can also find a trace of the influence of Liszt. Indeed, in this work of his late adolescence it is clear that for a brief time he fancied himself as something of an *avant-gardiste,* abandoning for experiment the more rigorous methods of the E ♭ minor Scherzo (op. 4) that slightly preceded it, and returning to them in the C major sonata (which he preferred to publish as op. 1) soon afterward in 1853. In that year he also composed a third piano sonata (F minor, op. 5), in which he is often more harmonically adventurous than any of his contemporaries—indeed, one passage directly anticipates Debussy.

Schumann was perceptively correct, at the start of Brahms's career, in referring to his being "fully armed"; he may well have foreseen that Brahms's essential musical nature was to remain decisively constant throughout his life. Critics who blame Brahms for not "developing" the character of his art fail to see that Brahms developed inwardly rather than outwardly; that it was concentration of thought that deepened a personality whose maturity was reached earlier than is usual. One of the best ways of discovering this is to study his late revision of the early Trio in B major (op. 8), for piano, violin, and cello. The first version was written in 1854 when he was 21; he afterward regretted its publication and would have destroyed it if he could have, as he did fully three-quarters of what he composed. But the accident of publication made sure that Brahms would leave the world one of the most remarkable lessons in composition by a great composer: unable to endure any longer the existence of a published work that failed to satisfy him, in 1889 the 56-year-old master reworked the entire trio, of which only the scherzo escaped drastic treatment. A study of these two scores reveals that Brahms is able to take his youthful subject matter as a starting point without a trace of incongruity, now creating a new sense of breadth while at the same time composing a considerably shorter work. His inner concentration had developed to give him a mastery of movement that the earlier score merely hinted at; it is this sense and supple control of movement that largely distinguishes his later from his earlier music.

It is often supposed that because Brahms frequently indicates moderate tempi his sense of movement was generally slower than that of his most admired predecessor, Beethoven. But tempo and pace of thought are two different things; when Brahms begins a movement in apparent leisure (as in the openings of the Second and Fourth symphonies, or that of the Clarinet Quintet) he is always able to vary startlingly the rate of his thought, often tightening and speeding it (without a change of tempo) to a striking degree. It is a question of subtlety in command of tonality, harmony, and rhythm, and no 19th-century composer after Beethoven is able to surpass him in this respect. At all periods in Brahms's work we find a great variety of expression, from the subtly humorous to the tragic, but his larger works show an increasing mastery of movement and an ever greater economy and concentration.

The four symphonies, four concerti, two orchestral serenades, and two concert overtures, together with his larger sonatas and chamber works, reveal Brahms a supreme master of extended composition, with an intensely characteristic kind of melody and harmony in which the organic nature of each conception is its paramount quality. To find his sense of colour deficient is to hear only the sounds and not what happens to them, to miss the individuality of each separate composition. There is an unmistakable and highly distinctive Brahmsian way of deploying colour—his use of woodwind and brass instruments is completely different from Wagner's, and the sound of his string writing is so personal that it became dangerously imitable by minor composers—but the important thing about it is that colour is deployed, not laid on for its own sake. Brahms was less interested in what he called *Effekt* than in organic growth, and Julius Harrison in *Brahms and His Four Symphonies* has shown how fascinatingly close is the relationship between orchestration and architecture in the symphonies. The First Symphony, for instance, shows a gradual brightening during its course from the dark strife of its opening movement to the warm brilliance of its last, and it is demonstrable that the orchestration contributes as much to this impression as do the harmony and tonality and the changing nature of the themes. In the woodwind department the clarinet gradually assumes leadership, usurping the more plangent oboe—except in the profoundly gloomy and mysterious introduction to the finale, where the oboe momentarily regains its sway. Brahms also uses the brass of the orchestra with notably strategic intent and success; in this same work, as also in the Fourth Symphony, we do not hear the trombones until the last movement. Harrison points out that in No. 1 the trombones play only 83 bars out of 1,262, while the first horn is given no principal theme until the finale. In the *Tragic Overture* the trombones are used with sparing but telling power, only emphasized by their omission from the final emphatic passage, which is thereby imbued with a sense of classical objectivity that is deeply impressive. This kind of artistry dominates Brahms's orchestral music, which must therefore seem uninteresting to anyone seeking nothing but surface colour; but it is the deepest, most demanding, and most rewarding type of artistry.

As in the concerti of Beethoven and Mozart, such an attitude to orchestration proves in Brahms to be peculiarly adapted to the more subtle aspects of the relation between orchestra and soloist. The classical concerto had achieved in Mozart's mature works for piano and orchestra an unsurpassable degree of organization; Beethoven had transcended them in scale of design and range of expression. The higher subtleties of such works inevitably escaped many subsequent composers; Mendelssohn had "abolished" the opening orchestral *tutti,* or *ritornello,* and if he did not believe it to be superfluous, many another lesser composer certainly did. Brahms saw that this easy avoidance of a magnificent artistic challenge was essentially debilitating and set himself to recover the depth and grandeur of the concerto idea. Like Mozart and Beethoven, he realized that the long introductory passage of the orchestra, far from being superfluous, was the means of sharpening and deepening the whole complex relationship of orchestra to solo, especially when the time came for recapitulation, where an entirely new and often revelatory distribution of themes, keys, instrumentation, and tensions was possible. Many of Brahms's contemporaries thought him reactionary on this account; but the result of this is that Brahms's concerti have withstood far greater wear and tear than many works thought, in their day, to outshine them.

At the other end of the scale Brahms was a masterly miniaturist, not only in many of his fine and varied songs, but also in his terse, cunningly wrought, intensely personal late piano works. As a song composer, he ranged from the complex and highly organized to the extremely simple, strophic type; his melodic invention is always original and direct, while the accompaniments are deeply illustrative without ever being merely picturesque. The late piano music, usually of small dimension but wide implication, is (as Schoenberg was to recognize) among the most concentrated attainments of its kind. It is generally expressive of a profound isolation of mind and heart and is therefore not readily approachable, while its apparent overall tone and mood may seem to the superficial ear monotonous. But each individual piece has a quiet and intense quality of its own that renders the occasional outburst of angry passion the more potent; the internal economy and subtlety of these works is extraordinary.

The range of Brahms is finally attested by his choral music. His strong melodic gift made him a natural vocal composer, and his choral writing combines the common-sense solidity of Handel's with a contrapuntal skill worthy of Bach—yet it achieves total independence. The *Deutsches Requiem,* one of the choral masterpieces of its period, shows all his characteristics in this field, together with an ability to integrate solo and *tutti* with the same kind of subtlety as in the concerti. The spaciousness and grandeur of its lines and the power of its construction place his underlying melancholy within the scope of a large, objective, nonreligious humane vision. Thus he is distinct from the self-regarding Romantic; his essential quality, perhaps, is stoicism.

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BRAHUI, a tribal confederacy of about 275,000 (1960s) in Baluchistan, West Pakistan. They are mostly nomadic goat herdsmen, distributed from the Bolan Pass through the Brahui Hills to Cape Monze on the Arabian Sea. The Brahui language is a far northwestern outlier of the Dravidian family of languages, all of whose other members are in peninsular India; it has borrowed heavily from Sindhi, but remains in unexplained isolation among Indo-Iranian dialects, to which it bears no genetic relationship.

The grammatical system discloses the secret of its parentage. The use of suffixes, most of which are traceable to the same source as Dravidian (in southern India), the essential forms of the personal pronouns and striking analogies in the pronominal terminations of the plural in the verb; in the formation of the casual, and, above all, in the organic negative conjugation, all show that the language has sprung from the same source as the Dravidian group. However, it has borrowed heavily from the vocabularies of such neighbouring tongues as Balochi, Persian, and Sindhi. *See* also Dravidian. (J. Wh.)

Physically the Brahui tribesmen resemble their Balochi and Pathan (*qq.v.*) neighbours, for the confederacy has been highly absorptive. The Brahui tribes are all Muslim by creed and Sunni by sect, Muslim rites being thickly overlaid upon social customs that are essentially Indian. Women are not strictly secluded.

The 23 Brahui tribes are organized along Balochi lines, owing a loose allegiance to the Brahui khan of Kalat, the "Fort," which has long been knit up with the confederacy's destinies. A group of seven or eight endogamous lineages form what is believed to be the original Brahui nucleus and constitute about one-eleventh of the Brahui population. These nuclear lineages claim descent, as do the Balochi tribesmen, from Mir Hamza, the Prophet's uncle, who according to orthodox Islamic tradition left no issue. First among the nuclear lineages stands the Ahmadzai, the ruling lineage, and last among them, the Rodeni, of semiservile descent. To this nucleus have been affiliated many indigenous and captive peoples, their lineages classed as Baloch, Pathan, Persian, Jat, and so on, according to the reputed origin of its ruling set. Thus the Pathan group among the Bangulzai comprises Rind-Balochi and Arab lineages. Even nuclear Brahui lineages are of mixed origin.

Documentary knowledge of Brahui history begins with the capture of Kalat by the Mughals and its recapture by the Brahui with Pathan aid, in the 15th to 16th century. Incessant warfare with Balochi and Jats ensued, but eventually, in the 17th century, Mir Ahmad, founder of the Ahmadzai lineage, welded or rewelded the various tribes into a confederacy. Under Nasir the Great, who took the title of khan, the confederacy attained its zenith in the 18th century (*see* Baluchistan: *History*). On that ruler's death in 1795 anarchy revived and the confederacy disintegrated, the Pathan elements taking a full share in its disruption, but closely followed by the Balochi and Persians. Modern Brahui history shows repeated fission.

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BRAID, JAMES (1795–1860), Scottish surgeon and scientific investigator of hypnotism, was born in Fifeshire, educated at Edinburgh and practised in Manchester. Braid's interest in mesmerism was aroused in 1841 when he attended several *conversazioni* of an itinerant mesmerist. Initially skeptical toward the phenomenon of mesmeric sleep, he began his own experiments; he became convinced that genuine sleep can be induced by a fixed stare at a bright inanimate object. In 1843 he published his *Neurypnology, or the Rationale of Nervous Sleep, Considered in Relation with Animal Magnetism,* introducing the term neurohypnotism or hypnosis and proving conclusively that hypnotic "phenomena are induced solely by an impression made on the nervous centers" without any fluid or other influence passing from operator to patient. By this means he hoped to "acquire a power of rapidly curing many functional disorders," otherwise deemed incurable and generally labeled "nervous complaints." He reported successful treatment of *tic douloureux,* paralysis, aphasia, rheumatism, headache, palpitation, skin diseases and other functional and organic diseases and advocated the use of hypnotism in surgery to alleviate anxiety and pain. At first his views met with violent opposition, but they were later taken up by Paul Broca, J. M. Charcot, A. A. Liébault and H. Bernheim and thus provided a major impetus to the development of the French school of neuropsychiatry. Braid died at Manchester on March 25, 1860. *See* also Hypnosis. (I. V.)

BRAID, JAMES (1870–1950), British golfer and one of the greatest players of his time, was born at Earlsferry, Fife, Scot., on Feb. 6, 1870. He learned golf as a caddie and wished to become a professional, but his parents apprenticed him to a joiner. In 1893 he became a club maker in a large department store in London and two years later achieved sudden fame by halving with the reigning champion, J. H. Taylor. In 1896 he became professional at the Romford golf club and quickly established himself as a player of note. He won the open championship five times: Muirfield (1901 and 1906); St. Andrews (1905 and 1910); Prestwick (1908); and the *News of the World* match-play tournament four times.

Braid, H. Vardon and Taylor were the dominating figures of the game in the early years of the 20th century and they were known as "the great triumvirate" (*see* GOLF: *Outstanding Players*). In 1905 Braid played with Sandy Herd a famous foursome over 72 holes against Vardon and Taylor, the latter pair winning by 13 and 12. He was professional at Walton Heath, Surrey, for over 45 years. Braid died in London on Nov. 27, 1950. (B. DN.)

BRĂILA (formerly IBRAILA), a Danubian port of southeast Rumania in the Galaţi region, lies in flat country on the west bank of the Danube, 106 mi. from its mouth at Sulina and 229 km. (142 mi.) N.E. of Bucharest. Pop. (1966) 138,587. Brăila is mostly a modern town, compactly built; its principal building is the cathedral of St. Michael. Electric streetcars intersect the town and link it with the salt Lake Sărat, 6 mi. S.W. Brăila is connected by rail with Ploeşti and Bucharest, and with Galati (20 mi. N.N.E.). It is the second largest port of Rumania, being accessible to seagoing ships and having a large grain and warehousing capacity.

Brăila is an important industrial centre, with metalworking, textile, clothing, footwear and food-processing factories. At Chişcani, 5 mi. S.S.W., pulp and paper are made from reeds. There are a state theatre and a museum of art.

Brăila is first mentioned in a document of 1368 issued by the prince of Walachia and permitting merchants of Braşov to transport their goods on the Danube through Brăila. In 1554 it was conquered by the Turks, who built five concentric walls around it. By the treaty of Adrianople following the Russo-Turkish war of 1828–29, Brăila was returned to Walachia. A little upstream of the city are remains of the piles of a bridge attributed by doubtful tradition to Darius (*c.* 500 B.C.).

BRAILLE, LOUIS (1809–1852), to whom the blind owe their alphabet, was born in Coupvray, France. At the age of three, while cutting leather in his father's shop, the knife slipped and plunged into his eye. Sympathetic ophthalmia and blindness followed.

In 1819 he went to Paris with a scholarship to attend the Institution National des Jeunes Aveugles, whose founder, Valentin Haüy, first discovered that the blind could decipher texts in embossed Roman letters. In 1821 Charles Barbier, an artillery captain, exhibited there an apparatus by which a message, coded in dots and dashes, was embossed on thin cardboard. At age 15 Braille worked out an adaptation that adequately met the needs of the sightless. After extending his six-dot code to musical notation, he published expositions of his system in 1829 and 1837.

Braille became a dedicated teacher in his school and a talented church organist. For the last 17 years of his life he was ill with tuberculosis. His remains, sent to Coupvray, were returned to Paris in 1952 to rest in the Pantheon.

See BLIND, TRAINING AND WELFARE OF: *Systems of Reading.*

See also J. Roblin, *The Reading Fingers (Les doigts qui lisent)*, Eng. trans. by R. G. Mandalian (1955). (J. E. LN.)

BRAIN. The brain is that part of the central nervous system that is lodged in the skull or, if the invertebrates are included in the definition, the head. This article deals almost exclusively with the brain of man; it does not include the invertebrates and considers the brain of the lower vertebrates only in so far as it can throw light on the structure of the human brain. The article is organized as follows:

- I. Anatomy of the Brain
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  - A. Vertebrate Evolution
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    - 3. Hindbrain
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I. ANATOMY OF THE BRAIN

The anatomy of the brain is of interest primarily because in the central nervous system, perhaps more than anywhere else, morphology sets certain easily seen limits to function. Nerve cells can do only one thing: send out rather uniform signals. For a given cell these signals will all be of roughly the same strength, determined by the amount of energy developed in that cell and having no clear relation to the energy of the impulse that releases that cell. This survey of the anatomy of the brain deals very briefly with the first stages of its development, then its comparative anatomy and, finally, the anatomy of the adult human brain.

A. DEVELOPMENT OF THE BRAIN

In all vertebrate embryos the central nervous system originates as an axial thickening of the ectoderm covering the dorsal surface of the embryonic area. This is the neural or medullary plate and is continuous on each side with the ectoderm that will become the epidermis. The edges of the neural plate soon become raised, so that the axial band is converted into a longitudinal groove. This is the medullary groove and already at its anterior end shows three enlargements that are separated by two constrictions. These indicate the site of the primary divisions of the embryonic brain, namely, the forebrain or prosencephalon; the midbrain or mesencephalon; and the hindbrain or rhombencephalon. There is also an indication on each side of the forebrain of the optic vesicle.

The medullary groove later becomes converted into a closed tube, which is named the medullary or neural canal, by the folding inward and union of its edges. The union begins in the region of the neck and extends headward and tailward. The lumen of this tube is dilated at the head to form the ventricles of the brain, while in the rest of its extent it remains narrow and forms the central canal of the spinal cord. As the margins of the medullary groove unite to form the medullary canal, a continuous lamina of epithelium grows outward on each side of the spinal cord and posterior part of the brain. This is the neural crest. It afterward becomes segmented and gives origin to the sensory ganglia on the posterior roots of the spinal nerves, the sensory fibres of the spinal nerves, and the ganglia and nerve fibres of the sympathetic system. It takes part in the formation of some of the ganglia and nerve fibres of the cranial nerves. The neural crest cells appear also to give rise to pigment cells, thus explaining in a simple way why so many animals are lighter on the belly than on the back. The hypoglossal (last cranial) nerve, which in the adult is a purely motor nerve for the muscles of the tongue, in the embryo has a posterior or sensory root with a rudimentary ganglion upon it (Froriep). This afterward disappears, but its temporary presence in the embryo indicates that the nerve was primarily composed of both motor and sensory fibres and that it is homologous with the spinal nerves. (*See* NERVOUS SYSTEM; EMBRYOLOGY AND DEVELOPMENT, ANIMAL: *Human Development*.)

1. Early Stages.—In the early stages of development the brain presents certain flexures which involve the longitudinal axis of the neural tube. The first of these is the cephalic flexure, which is a forward bend round the anterior end of the notochord. It is followed by the cervical flexure at the junction of the brain with the spinal cord, which is also in a forward direction. Between is the pontine flexure, which is in the reverse direction and does not involve the whole thickness of the neural tube.

The stage with three primary vesicles soon becomes modified by subdivision of the forebrain into an anterior telencephalon and a posterior diencephalon (including thalamencephalon); the hindbrain also divides into the metencephalon and myelencephalon. The telencephalon gives rise to the olfactory lobes and hemisphere vesicles. The thalamencephalon forms the region of the brain surrounding the posterior part of the third ventricle behind the foramen of Monro. It includes the thalamus proper, divisible into a sensory dorsal and a motor ventral part, the pineal organ and the habenula dorsally and the hypothalamus and the cerebral lobe of the pituitary ventrally. The metencephalon comprises the pons Varolii, part of the fourth ventricle and the cerebellum; the myelencephalon corresponds to the medulla oblongata.

In transverse section the developing medullary tube is seen to consist of left and right lateral plates, between which is the central canal of the spinal cord. The lateral plates are joined at their dorsal margins by a thin roof plate and along their ventral margins by a similar thin floor plate. These close in the central canal behind and in front. A cross section of the canal at this stage of development is diamond-shaped, with the dorsoventral diameter much longer than the transverse diameter. The wide angles on each side of the diamond correspond to a longitudinal groove on the inner surface of each lateral plate. This is the posterior median sulcus (sulcus limitans) and runs the whole length of the spinal cord. It is continued forward on the floor of the fourth ventricle, to the sides of the aqueduct of Sylvius in the midbrain. Its end in the thalamencephalon is not quite clear. The groove marks off the ventral or basal part of the brain and spinal cord, which gives origin to motor nerve fibres, from the dorsal or alar part, which receives the sensory fibres.

2. Further Differentiation.—The developing neural tube shows three important zones: an inner or germinal zone, a middle or mantle zone and an outer or marginal zone. The germinal zone is characterized by actively dividing nuclei. The middle zone forms the central gray matter of the cord and contains a large number of oval nuclei embedded in the supporting tissue. The marginal zone consists at first only of a fine network of supporting or neuroglial fibres. Later, it is traversed by white medullated fibres forming the columns of white matter.

These zones are present in the early stages throughout the whole extent of the neural tube, but the primary relations are considerably modified in the brain by the migration of nerve cells and nerve fibres from one zone into the other. Thus the inner zone forms the ependyma or lining membrane of the central canal of the spinal cord and ventricles of the brain. In certain places in the brain, however, the ependyma is invaginated into the cavities of the ventricles and modified so as to form the choroidal epithelium. Moreover, that part of the gray matter that forms the cortex of the cerebral hemispheres and of the cerebellum is situated on the surface of the brain, superficial to the white matter. This is brought about by the migration of cells from the mantle zone into the superficial strata of the marginal zone. White fibres may also invade the territory of the gray matter, as in the formation of the internal capsule. Portions of gray matter may thus be displaced from their original position, so that the primary position of the parts becomes obscured.

In the later stages of development the primary flexures of the brain become, to a large extent, straightened out, and the whole form of the brain becomes modified by the enlargement of the cerebral hemispheres.

3. Hindbrain and Roof Plate.—In the hindbrain a remarkable change occurs in the position of the lateral walls of the neural tube, whereby their dorsal margins formed by the alar laminae become widely separated. Each lateral plate is rotated outward through an angle of 90° by a hinge movement, as in opening a book. The surfaces originally directed toward the median plane thus become directed dorsally and now form the floor of the lozenge-shaped fourth ventricle. The sulcus limitans still separates the basal (motor) and the alar (sensory) region, but these, instead of being ventral and dorsal, are now internal and external.

The roof plate also becomes greatly modified, becoming thinned out and stretched so as to form a delicate epithelial lamina, which is blended with the overlying pia mater. A part of this membrane becomes infolded just behind the cerebellum to form the choroid plexus of the fourth ventricle. The anterior part of the roof plate with the adjoining portion of the alar lamina becomes thickened to form the cerebellum, which is thus connected with the sensory tracts and, more especially, with incoming impulses from the vestibular portion of the eighth cranial nerve. Median and lateral openings in the roof of the fourth ventricle are formed, secondarily, by a breaking down of the epithelial membrane. The cerebrospinal fluid is thus able to pass from the ventricles into the spaces of the subarachnoid tissue outside (see *Ventricles*, below).

4. Midbrain and Thalamencephalon.—The midbrain in a ten-millimetre human embryo is characterized by the relatively large size of its central canal and its prominent position on the surface of the brain. At a later stage, owing to the growth through it of tracts of nerve fibres from the cerebral hemispheres, cerebellum and pons Varolii, the walls of the canal become greatly increased in thickness, and the lumen becomes relatively small. Moreover, in the later months of fetal life, the midbrain becomes completely covered over and concealed by the backward growth of the corpus callosum and cerebral hemispheres.

The thalamencephalon appears to undergo less change from the primary form of the neural tube than either the midbrain or hindbrain. In the early stages of development the roof of the thalamencephalon is exposed on the superficial aspect of the brain. About the third month, however, the cerebral hemispheres, with the developing corpus callosum and fornix, grow backward over the thalamencephalon, mesencephalon and cerebellum, carrying with them a covering of pia mater. This fuses with the pia mater, covering the thalamencephalon so as to form a triangular fold, the velum interpositum, or tela chorioidea, from which the choroid plexuses of the third and lateral ventricles are formed.

The hemisphere vesicles are at first quite small and open by a relatively large aperture, the foramen of Monro, into the third ventricle. The latter is limited in front by a thin membrane, the lamina terminalis, so named because it at first forms the anterior end of the brain. Later the hemispheres grow forward on each side of it, and it is left at the bottom of the great longitudinal fissure. As the hemispheres enlarge forward, upward and backward, nerve fibres are developed between them, which cross in or near the lamina terminalis. These form the anterior commissure, the hippocampal commissure of the fornix, and the corpus callosum.

5. Development of the Pituitary Body.—The pituitary (or hypophysis) has two parts: an oral or anterior lobe, glandular in structure; and a cerebral or posterior lobe, composed of neuroglia. The organ is present in all vertebrate animals and is developed very early. Thus in the human embryo of four weeks the oral portion appears as a flattened, flask-shaped diverticulum, the pouch of Rathke, which arises from the ectoderm of the primitive mouth cavity or stomodeum. This comes in contact with the neural ectoderm, forming the floor of the third ventricle behind the optic decussation and in front of the anterior end of the notochord. Later the neural ectoderm gives rise to a hollow diverticulum, the posterior lobe, which is connected to the brain by a funnel-shaped stalk, the infundibulum. The infundibulum then becomes surrounded on the front and sides by the vesicular part of the pouch of Rathke. That part of the pouch that comes in contact with the cerebral lobe is called the paraneural part or pars intermedia.

The parts on each side which become applied to the infundibular part of the floor of the third ventricle are the lateral or tuberal lobes. The vesicular part of the pouch soon becomes cut off from the roof of the mouth cavity by the degeneration of its stalk. About the seventh or eighth week the vesicle becomes further modified by the outgrowth from it of numerous branching processes which invade the surrounding tissue. The processes are at first hollow and lined by epithelial cells. Later the mesodermal tissue between the processes becomes vascularized, and the lumina of the processes and the main central cavity gradually become obliterated. The cavity of the posterior lobe also disappears, with the exception of a small recess in the floor of the third ventricle, which corresponds to the attachment of the infundibulum. In the adult the interior of the posterior lobe is occupied by a loose network of supporting neuroglia and contains no nervous tissue, except fibres of the sympathetic system which accompany the vessels.

The meshes of the network contain a clear fluid. In the paraneural part or pars intermedia, the epithelium is frequently arranged in the form of closed vesicles containing colloid material, and this substance has sometimes been observed in the posterior lobe and in the region of the third ventricle, close to the infundibulum, more especially in those animals in which the lumen of the cerebral lobe persists and remains in continuity with the cavity of the ventricle. The origin of the pituitary gland presents one of the most interesting problems of comparative embryology, references to the literature on which will be found in any of the standard works on zoology and embryology mentioned in the bibliography. (*See* also Pituitary Gland.)

6. Pineal Organ or Epiphysis.—The pineal body of the human brain is a small conical structure that springs from the posterior part of the roof of the third ventricle and projects backward over the superior quadrigeminal bodies. It consists of rounded epithelial cells that are arranged in an alveolar manner. Between the alveoli or follicles is a supporting tissue enclosing thin-walled blood vessels and frequently containing also deposits of calcareous salts. These form small spherical bodies which show, on section, a concentric laminated structure. They are known as brain sand and in old subjects are commonly found also in the choroid plexuses, pia-arachnoid and other parts of the brain.

The pineal body of man is a vestigial organ which represents a more highly evolved apparatus in lower types of living vertebrates and probably a still more highly evolved apparatus in certain extinct reptiles, such as the *Ichthyosaurus*. In one living reptile, the tuatara (*Sphenodon*), the pineal apparatus consists of two distinct organs—a glandular organ, the epiphysis, which is the structure present in the human brain, and a sensory organ, the pineal eye; this is situated in the parietal foramen, a central aperture in the vault of the skull, immediately beneath the scales covering the surface of the head.

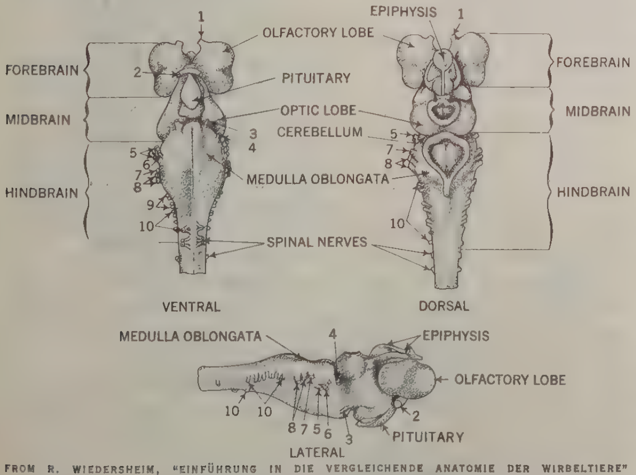

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FIG. 1.—BRAIN OF A LAMPREY (PETROMYZON): (1–10) CRANIAL NERVES

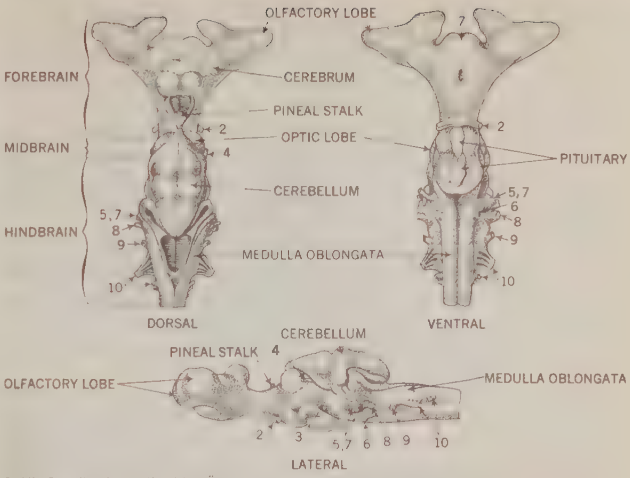

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FIG. 2.—BRAIN OF A SHARK (SCYLLIUM): (1–10) CRANIAL NERVES

In some of the lower vertebrate animals the pineal organ is bilateral, and it is believed that the ancestors of vertebrate animals possessed a pair of parietal eyes which may have been serially homologous with the paired vertebrate eyes. Transitional stages in the evolution of the pineal body from a bilateral to a mesial organ have been shown in amphibians.

B. Comparative Anatomy

In the lowest types of vertebrate animals the brain is tubular in form and resembles an early developmental stage of the brain in higher vertebrates. In the small lancelet or amphioxus (*q.v.*) the brain consists of a median cerebral vesicle, the cavity of which is continuous with the central canal of the spinal cord. In the larval stage an opening lined by ciliated epithelium, the anterior neuropore, lies at the bottom of a funnel-shaped depression, the olfactory pit. Viewed from the outside, there appears to be no distinction between brain and spinal cord. In front, at the pointed anterior end of the brain, is a median pigmented area. This is regarded as the rudiment of a median eye. A thickening of epithelium in the floor of the ventricle probably represents the infundibulum of the pituitary body. There are only two pairs of cranial nerves, both of which are sensory. It should be remembered that the lancelet lives in mud and hardly ever moves about.

1. Cyclostomes.—In the cyclostomes, of which the lamprey (*Petromyzon*) may be taken as an example, the brain is easily distinguished from the spinal cord. There is distinction into forebrain, midbrain and hindbrain. There are well-developed eyes with optic nerves ending in optic lobes (fig. 1). In the larva the fibres of the optic nerves, instead of crossing to the optic tract and lobe of the opposite side, as in higher vertebrates, appear to pass back to the optic lobe of the same side. It is probable, however, that in the later stages of development a decussation of some of the deeper fibres occurs in the floor of the fourth ventricle. The forebrain presents on each side two hollow vesicles, the olfactory lobe of large size and a rudimentary cerebral hemisphere behind. The two cerebral hemispheres are joined across the median plane by the lamina terminalis, in which there is a small anterior commissure.

On the dorsal aspect of the thalamencephalon are two oval masses, the habenular ganglia. The right of these is much larger than the left. There is an epiphysis and also an indication of an additional outgrowth in front of the pineal organ, the paraphysis. The pituitary body is formed from a single median pouch, the pituitary sac, which opens primarily on the ventral aspect of the head, between the olfactory sac in front and the primitive mouth behind.

Later the pituitary sac sends out small follicular processes that fuse with the infundibulum and form, with the latter, the compound pituitary gland. In the course of development the original openings of the pituitary and olfactory sacs are displaced from the ventral to the dorsal aspect of the head.

In the hindbrain a rudimentary cerebellum is present, which appears as a transverse bar at the anterior boundary of the roof of the fourth ventricle. The choroid plexuses are well developed and consist of three invaginations, an anterior from the roof of the third ventricle, a middle in relation with the midbrain, and a posterior from the roof of the fourth ventricle.

2. Fishes.—The Chondrichthyes, to which belong the sharks and the rays, are the lowest vertebrates that swim freely about in the water. Although the eyes are fully developed, smell is probably the dominant sense, since the olfactory bulbs and tracts are enormous and project as large hollow outgrowths from each side of the forebrain. There is also a remarkable development of the cerebellum (fig. 2). The cerebellar cortex is often highly convoluted. The cerebral hemispheres are much larger than in the lamprey, the corpus striatum is developed and a roof plate or pallium is present; but as yet there is no differentiation of cortical layers. There is only one pineal stalk. The fibres of the optic nerves cross one another as compact bundles.

The brain of the Teleostei, or fishes having a bony skeleton, is in some respects not so far advanced as that of the cartilaginous fishes. The cerebral hemispheres and olfactory lobes are small. The optic lobes are enormously developed, however, and the optic nerves cross one another completely.

In the mud fishes, or Dipnoi, the brain is elongated and tubular in form, the olfactory lobes large and the cerebellum small. The brain, as might be expected, resembles in some respects that of the Amphibia.

The cranial nerves and their nuclei are arranged in two columns: a dorsal or, in the fourth ventricle, lateral one; and a ventral or medial one. In the spinal cord the two roots unite and form together the peripheral nerve. In the brain they remain separate, the anterior root giving rise to the innervation of the mesoderm, the posterior root giving sensory and visceromotor innervation to the skin and the internal organs, including the muscles of the gill arches. But the cranial nerves were numbered before this was clearly understood. The anterior roots in higher forms are four in number: the 3rd pair or oculomotor, the 4th or trochlear, the 6th or abducens and the 12th or hypoglossal nerve. The posterior roots are the 5th or trigeminal, the 7th or facial, the 9th or glossopharyngeal, the 10th or vagus and the 11th or accessory nerve. The 1st or olfactory, the 2nd or optic and the 8th or acoustic are nerves that go to special sense organs and are neither anterior nor posterior roots.

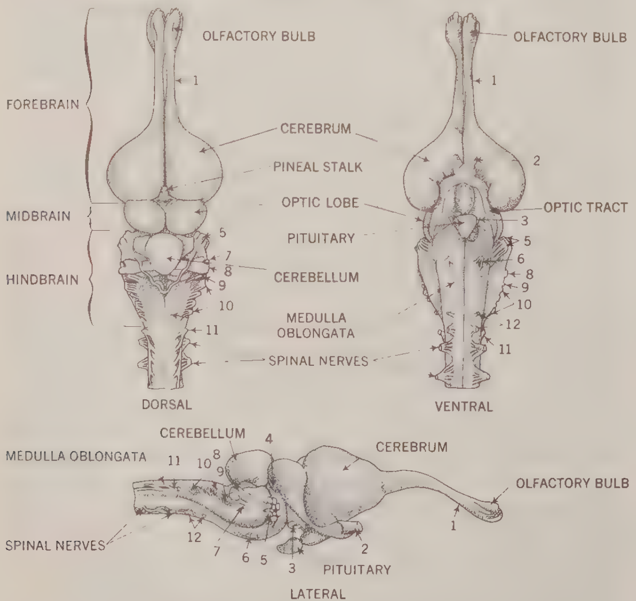

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FIG. 3.—BRAIN OF AN ALLIGATOR: (1–12) CRANIAL NERVES

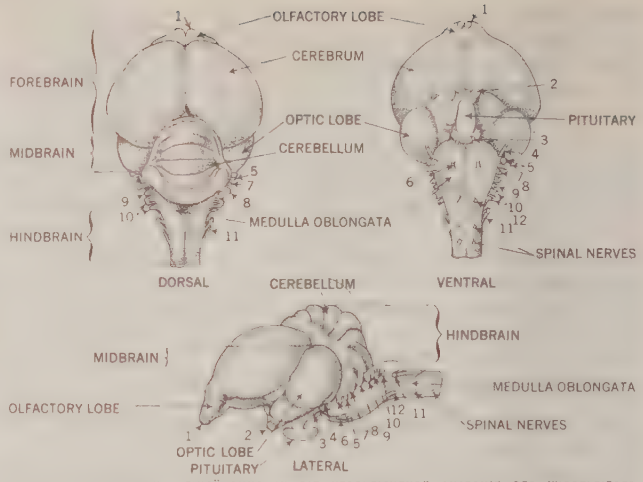

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FIG. 4.—BRAIN OF A PIGEON: (1–12) CRANIAL NERVES

3. Amphibians and Reptiles.—In the Amphibia the brain is tubular and does not show any distinct advance on the type characteristic of fishes; in some respects, *e.g.*, the development of the cerebellum, it is distinctly inferior to that of *Scyllium.* The olfactory lobes are large and in the frog's brain are fused in the median plane. In the lamina terminalis there is an anterior or ventral commissure and a dorsal or hippocampal commissure. The formation of the latter corresponds to the appearance of a small layer of cells in the superficial stratum of the median wall of the pallium. This is regarded as the first indication of the hippocampal cortex. The epiphysis that is present in the larva disappears in the adult animal. There is a well-developed infundibulum and hypophysis. The optic tracts and lobes are of large size. The cerebellum appears as a small transverse bar in the anterior part of the roof of the fourth ventricle and closely resembles that of the human embryo at the fourth week.

In the Reptilia (fig. 3) the cerebral hemispheres are more highly differentiated. The mesial surface of each hemisphere shows an upper hippocampal zone, a lower olfactory tubercle and an intermediate part, the paraterminal body or precommissural area. On the upper part of the outer or lateral surface is a limited area, termed by G. Elliot Smith the neopallium. This is the forerunner of the neocortex, which forms the main part of the cerebral hemispheres in the higher mammalia. Below the neopallium is the pyriform lobe, which is olfactory in function and corresponds to the uncus of the human brain. The corpus striatum is large, and there is an indication of differentiation into caudate nucleus, globus pallidus and putamen. In the Lacertilia the pineal organ is more highly developed than in any other living vertebrate animal. There is, however, no evidence of its use as an organ of sight.

4. Birds.—In birds (fig. 4) the cerebral hemispheres, optic lobes and cerebellum are large. The surface of the cerebral hemispheres is smooth, and their bulk depends largely on the great size of the corpus striatum. The cerebellum consists of a large central lobe or vermis, crossed by a series of parallel fissures, and on each side a small but well-defined flocculus. The olfactory lobes are extremely small, and, judging from the early development and large size of the optic vesicles and the optic nerves and tracts, vision is the dominant sense.

5. Monotremes.—In the lowest Mammalia, represented by the duckbilled platypuses and the spiny anteaters, the cerebral hemispheres are well developed. They extend forward over the olfactory lobes and backward over the thalamencephalon, midbrain and cerebellum. Convolutions and fissures appear. There are a dorsal and a ventral commissure, fimbria and gyrus dentatus. The cerebellum is well developed, presenting numerous folia and a conspicuous flocculus. In the spiny anteater, which is nocturnal in its habits, the optic nerves are extremely small, but there is an enormous development of the olfactory bulbs and tubercles.

6. Marsupials and Insectivores.—In the Marsupialia the type of brain varies much, apparently according to the habits of the different species. Thus in the Tasmanian devil (*Sarcophilus*), described by G. Elliot Smith as an "offal eating animal," there is an enormous development of the olfactory bulbs and the region of the brain termed rhinencephalon; in kangaroos (Macropodidae) there is a great development of the neopallium and cerebellum.

The Insectivora are remarkable for the very large size of their olfactory organs and for the fact that they possess a corpus callosum. Most of the lower mammals are macrosmatic; *i.e.*, have a well-developed olfactory organ. In the mole the optic nerves and tracts and the superior corpora quadrigemina are poorly developed. The influence on the brain of change of habit in two members of the same family, the jumping shrew and the tree shrew, is striking.

7. Higher Mammals.—The surface of the brain in mammalian animals varies greatly with regard to the convolutionary pattern. In some the hemispheres are smooth, *e.g.*, the manatee, the lesser anteater and the marmoset; in others highly convoluted, *e.g.*, whales, dolphins and certain ungulates, such as the elephant; others are intermediate in this respect. The degree of convolution is partly dependent on the size of the body. As a rule large animals have highly convoluted brains, small animals smooth brains. There is also a definite relation between the number of white fibres in the centre of the hemispheres and the number of nerve cells in the gray cortex on the surface.

In some animals, *e.g.*, the Cetacea, with a highly convoluted pattern, the gray cortex is very thin. In the higher types of animals it is usually thicker and much more highly differentiated. Primates are microsmatic; *i.e.*, have a poorly developed organ of smell. The brain of the chimpanzee closely resembles the convolutionary pattern of the human brain. In most apes there is an extension forward of the striate (visual) and peristriate areas of the cortex on the outer side of the occipital lobe. This encroaches on and overlaps the parietal lobe and occipitoparietal fissure. It thus produces a transverse or lunate sulcus. This is the simian fissure or affenspalte and is sometimes represented in the human subject by a small and variable fissure which usually lies some distance behind, and external to, the external parieto-occipital fissure and is not continuous with it. The human brain is distinguished anatomically from that of the higher apes by its large size and great development of the parietal regions. Mentally, man is distinguished from the apes by the faculty of speech and by much greater powers of reasoning, concentration and appreciation. (*See* MAMMAL; PRIMATES.)

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C. ANATOMY OF THE ADULT HUMAN BRAIN

1. General Structure.—The lowest part of the brain, the medulla oblongata, is continuous through the foramen magnum with the spinal cord. The brain and spinal cord constitute the central nervous system, whereas the nerves passing to and from the central nervous system form the peripheral cerebrospinal system. (*See* also NERVOUS SYSTEM; SPINAL CORD.) The nervous system also includes certain nerve centres and nerve fibres that, without our conscious knowledge of the processes concerned, control the vital functions of the body, such as circulation of the blood and respiration. This system, since it acts to a large extent independently of the will, has been termed the autonomic system. It includes the sympathetic and parasympathetic systems. Through communicating branches the brain is capable of influencing organs that are supplied by the autonomic system; *e.g.*, the salivary glands and heart, both of which may be acted on by fear, hunger, etc. Ordinarily, however, the functions of the internal organs are carried out without the person's being conscious of the processes involved.

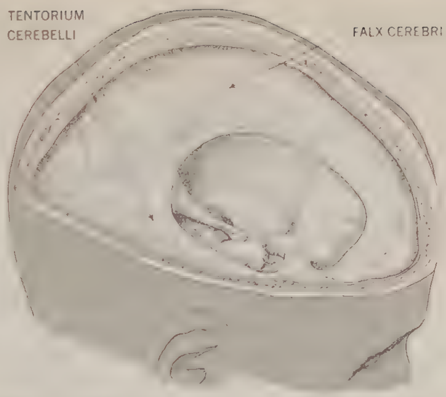

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FIG. 5.—SAGITTAL VIEW OF HUMAN BRAINPAN SHOWING MEMBRANOUS PARTITIONS BETWEEN HALVES OF THE BRAIN

The halves of the brain are separated by membranous partitions (fig. 5) that are continuous with the three membranes covering the substance of the brain. If the membranes are removed, the brain's surface is seen to be moist and of a grayish-white colour. It is characterized by sinuous foldings of the superficial stratum or cortex. These are the gyri or convolutions, and they are separated by grooves or sulci. The main part of the brain is subdivided by a deep longitudinal fissure into right and left hemispheres. The hemispheres are connected by transverse bands of nerve fibres called commissures. The largest of these crosses the middle of the great longitudinal fissure and is called the corpus callosum. In addition to the hemispheres and cerebellum, the brain comprises the interbrain or thalamencephalon, the midbrain or mesencephalon, the pons Varolii, which forms a transverse bridge between the two cerebellar hemispheres, and finally the medulla oblongata, which is situated below the pons and cerebellum and connects these with the spinal cord.

2. Membranes of the Brain.—These are an outer, tough, fibrous layer, the dura mater; a thin, intermediate, weblike tissue, the arachnoid; and a soft, vascular inner covering, the pia mater. (*See* also MENINGES AND CEREBROSPINAL FLUID.)

The dura mater lines the cranial cavity. On its outer surface are meningeal arteries and veins that serve for the nutrition of the bone. If the dura mater is torn in an injury to the skull, an effusion of blood may occur between the dura mater and the bone, which may, by exerting pressure on the underlying brain, cause paralysis of the opposite side of the body. The inner surface of the membrane which is in relation with the brain is smooth and moist. The dura mater also forms partitions between the hemispheres of the brain and cerebellum. These septa are folds of the dura mater and consist of two layers, blended where they touch but separated along the attached borders of the septa to form venous channels or sinuses, by which blood and also excess of cerebrospinal fluid is drained from the brain into the great veins of the neck, which carry it back toward the heart.

The secretion from the pituitary gland is also carried away into the general blood stream by small venules, which open into the neighbouring cavernous and other venous sinuses. Absorption of the cerebrospinal fluid is carried out, to a large extent, by small villous processes of the arachnoid membrane, which project into the venous sinuses and spaces of the dura mater and are most numerous in the neighbourhood of the sagittal sinus. If this absorption is prevented or retarded, the intracranial pressure of the cerebrospinal fluid rises, and one form of hydrocephalus (*q.v.*) results. In old age the arachnoid villi enlarge to form Pacchionian bodies. Between the dura mater and the subjacent arachnoid membrane is an interval called the subdural space. It contains a small quantity of fluid that serves to lubricate the smooth inner surface of the dura mater.

Beneath the dura mater is the arachnoid membrane, which, although thin, is not permeable to fluids. It is separated from the pia mater by the subarachnoid space. This is traversed by a network of delicate fibrous bands. The meshes of this network are filled by the subarachnoid cerebrospinal fluid, while the larger thin-walled cerebral arteries and veins covering the surface of the brain lie in the thin bands of fibrous tissue forming the net.

The pia mater is the delicate vascular membrane which forms the immediate investment of the brain and dips down into the fissures between the convolutions. It contains the smaller arterioles and venules which supply the subjacent cortex of the brain. A large triangular fold of pia mater (velum interpositum) is included in the great transverse fissure lying between the corpus callosum and fornix above and the roof of the third ventricle and optic thalami below. This pyramidal fold contains the two great cerebral veins of Galen, which drain the blood from the interior of the brain. Vascular fringes at the margin of the fold project into the lateral ventricles, and similar fringes project from the under surface of the fold into the third ventricle. These fringes are the choroid plexuses of the lateral and third ventricles, and a similar choroid plexus is found in the roof of the fourth ventricle. They are covered by a secretory layer, called the choroidal epithelium, which secretes the cerebrospinal fluid. In the lower part of the roof of the fourth ventricle are three openings in the arachnoid membrane: a median, the foramen of Magendie; and two lateral, the foramina of Luschka. These form a communication between the cerebrospinal fluid in the ventricles of the brain and that contained in the subarachnoid space. Obliteration of these openings by meningitis produces an obstructive hydrocephalus, in which the accumulation of fluid is entirely intraventricular.

3. Ventricles.—These are cavities containing fluid situated in the substance of the brain and lined by a thin membrane, the ependyma. The true ventricles are four in number, namely, the right and left lateral ventricles, which are contained in the cerebral hemispheres; the third ventricle, situated in the thalamencephalon; and the fourth ventricle, in the hindbrain. Each lateral ventricle is connected with the third ventricle by a small opening, the interventricular foramen of Monro; and the third ventricle is joined to the fourth by a narrow channel, the aqueduct of Sylvius in the midbrain. The fourth ventricle communicates below with the central canal of the spinal cord and with the subarachnoid space by the foramina of Magendie and Luschka.

The cerebrospinal fluid, which is contained in the ventricles and subarachnoid space, acts as a mechanical support to the brain and spinal cord; it also takes the part of the tissue fluid and lymph found in other parts of the body. The blood is supplied to the brain by two paired arteries: the two internal carotids and the two vertebral arteries. These are in communication with each other at the base of the brain, where they form the so-called circle of Willis, which, however, in about 25% of all cases is incomplete. The details do not matter too much, but it should be pointed out that the venous return is arranged not alongside the arteries as almost everywhere else in the body but through a system of dural sinuses that go to the jugular foramen and from there to the internal jugular veins. (*See* Arteries; Veins.)

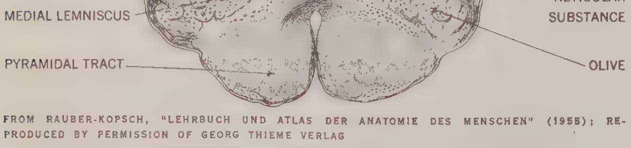

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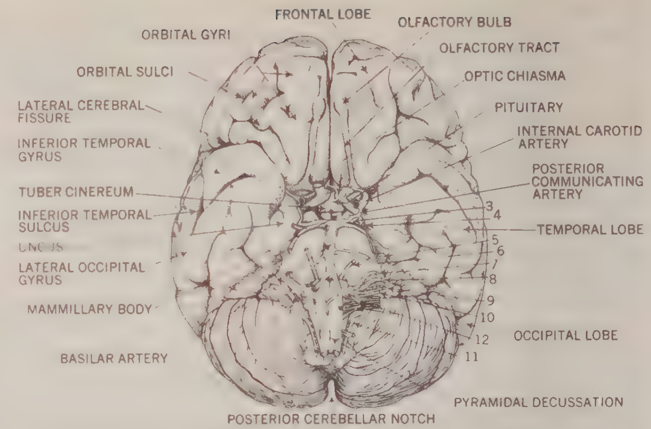
FIG. 6.—CROSS SECTION THROUGH MEDULLA OBLONGATA



FROM RAUBER-KOPSCH, "LEHRBUCH UND ATLAS DER ANATOMIE DES MENSCHEN" (1955); REPRODUCED BY PERMISSION OF GEORG THIEME VERLAG

FIG. 7.—BASE OF BRAIN

4. Medulla Oblongata.—This is situated in the lower and posterior part of the cranial cavity (fig. 6). It appears to be a direct continuation upward of the spinal cord but differs from this in the arrangement of the fibres composing the nerve tracts and in the disposition of the gray matter. It contains the important vital centres known as the cardiac, vasomotor and respiratory centres. These are situated in the lower part of the floor of the fourth ventricle. Longitudinal bundles of nerve fibres connect the medulla oblongata with the pons Varolii, and two diverging bundles of fibres called restiform bodies join it to the cerebellum.

The principal longitudinal tracts which connect the pons with the medulla on each side are: (1) the pyramidal tract, (2) the medial longitudinal bundle; and (3) the medial lemniscus or fillet.

Pyramidal Tracts.—The pyramidal tracts consist of motor fibres, each of which descends from the motor area of the cerebral cortex through the internal capsule, midbrain and pons to the anterior part of the medulla. Here they form two parallel strands, one on each side of a median vertical groove. In the lower part of the medulla oblongata the greater number of the fibres of the pyramidal tract cross over to the opposite side of the spinal cord, where they form a bundle of descending fibres called the crossed pyramidal tract. The remaining fibres are continued downward on the same side of the cord as the direct pyramidal tract. Eventually these fibres also cross to the opposite side. (*See* Spinal Cord.) The crossing of the motor nerve fibres in the medulla oblongata is called the decussation of the pyramids (fig. 7); and since, with few exceptions, all motor fibres, and also sensory fibres, cross to the opposite side, each cerebral hemisphere dominates the muscles of and receives sensory impulses from the opposite side of the body.

Medial Longitudinal Bundles.—These are paired tracts of nerve fibres which have their cells of origin in the vestibular nuclei of the brain stem, and end in the nuclei of the muscles of the eyes and those for the neck muscles of the same and the opposite side. By means of these tracts the position of the eyes and the head can be adjusted to each other, and coordinated in such a way that the eyes remain fixed on a given object, regardless of the position of the head.

Medial Fillets (*Lemnisci*).—Each medial fillet is a longitudinal tract of ascending sensory fibres lying close to the median plane between the pyramidal tract and the medial longitudinal bundle. The fibres of the right and left tracts cross the median plane, forming the sensory decussation. This lies above the level of the motor or pyramidal decussation.

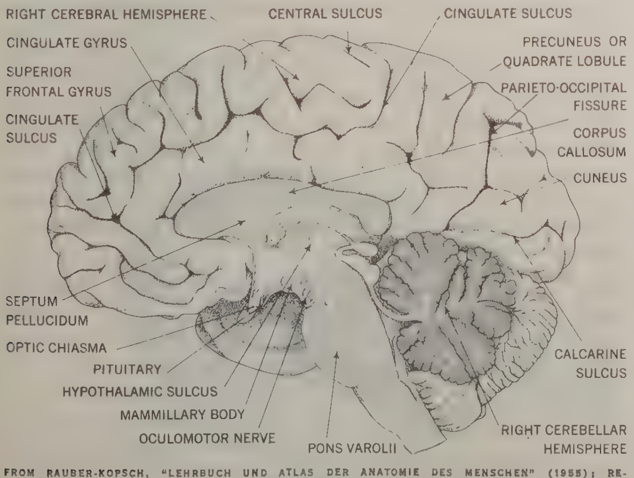
The sensory impulses coming from the spinal cord end in cell-stations in the medulla: the gracile and cuneate nuclei. It is from these that the superficial arcuate fibres, which pass to the cerebellum, and the deep arcuate fibres (medial fillets) take origin. The latter thus form one link or relay in the main sensory tract to the cortex.

Immediately lateral to the pyramidal tract on the anterior aspect of the medulla is an oval swelling, the olive. The olive lies over a folded lamina of gray matter in the substance of the medulla; this is the inferior olive. It is connected with the opposite cerebellar hemisphere by fibres that cross the middle line and reach the cerebellum by means of the restiform body. The superficial origin of the cranial nerves from the 3rd to the 12th is shown in fig. 7; the nuclei from which the motor fibres originate and those in which the sensory fibres terminate lie in the substance of the medulla and pons. Like the spinal nerves, they are connected by nerve tracts with the opposite hemisphere.

5. Pons Varolii.—This area lies between the medulla oblongata and midbrain on the ventral side (fig. 8). It forms, by its posterior surface, the upper half of the floor of the fourth ventricle. It contains the nuclei of origin or termination of the 5th, 6th, 7th and 8th cranial nerves. A conspicuous band of transverse fibres lies superficially and crosses beneath or ventral to the pyramidal fibres, which pass through the pons from the internal capsule and midbrain to the medulla oblongata. Some of the transverse fibres, however, lie more deeply and intersect the longitudinal fibres of the pyramidal tract. Most of the transverse fibres arise from nuclei of the pons which are connected with the cortex of the frontal and parietotemporal lobes of the cerebrum on the same side and, crossing the mid-line, eventually reach the cortex of the opposite cerebellar hemisphere. The most important longitudinal tracts of nerve fibres traversing the pons are the pyramidal tracts, the longitudinal bundles and the ascending sensory fibres of the medial and lateral fillets. The lateral fillet is the main auditory tract which ascends to the midbrain.

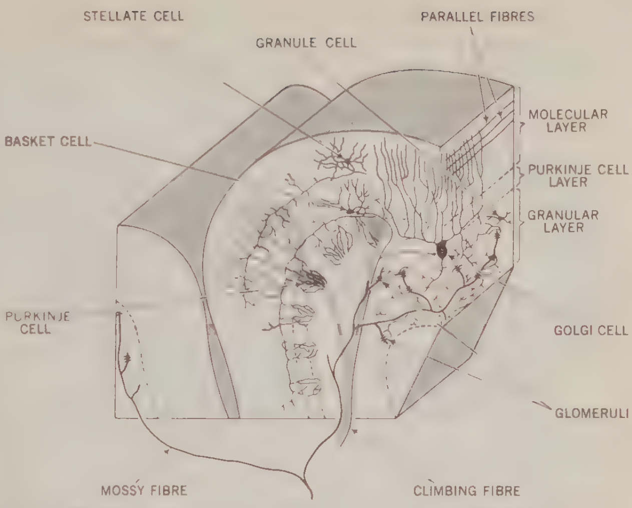
6. Cerebellum.—This consists of a central part, known as the vermis, and two lateral hemispheres (fig. 8). Each hemisphere is connected with the brain stem by three peduncles: (1) the inferior or restiform body to the medulla; (2) the middle or brachium pontis; (3) the superior or brachium conjunctivum. The last-named joins the cerebellum to the midbrain and conveys efferent fibres, one bundle leaving the cerebellum and ascending to the contralateral red nucleus and to the thalamus, another bundle going finally to the reticular substance of the medulla oblongata.

The cerebellum receives impulses from the equilibratory organ in the middle ear, from muscle spindles, from the exteroceptors of the skin, from the eye and from the ear (acoustic organ), as well as from the cerebral cortex. These impulses reach the gray matter of the cortex of the cerebellum and are believed to pass from there to the dentate nucleus, a convoluted lamina of gray matter situated in the substance of each cerebellar hemisphere. From this a relay of fibres ascends to the opposite red nucleus and thalamus (*see* below for midbrain). The superficial surface of the cerebellum differs from that of the cerebral hemispheres. In place of convolutions, the vermis and hemispheres of the cerebellum are crossed by numerous transverse fissures, which mark off a series of folds or folia. The general arrangement of these is seen in a median section through the vermis, which presents a branched appearance called the arbor vitae. The surface of the cerebellar hemispheres and central lobe is subdivided into lobes and lobules by deep fissures, a full description of which must be sought in textbooks of anatomy.



FROM RAUBER-KOPSCH, "LEHRBUCH UND ATLAS DER ANATOMIE DES MENSCHEN" (1955); REPRODUCED BY PERMISSION OF GEORG THIEME VERLAG

FIG. 8.—MEDIAN SECTION THROUGH BRAIN



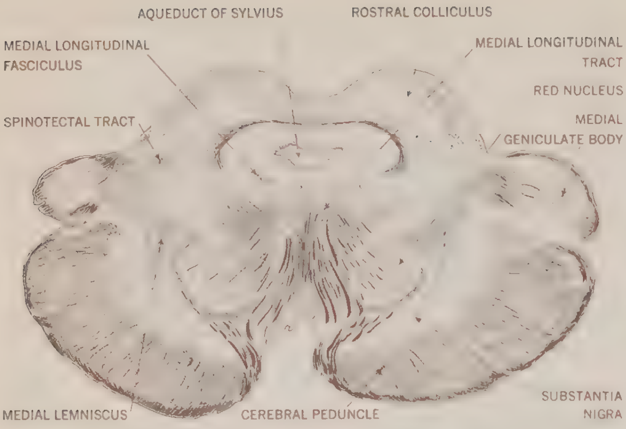
FROM J. ECCLES, R. LLINAS, AND K. SASAKI, "INTRACELLULARLY RECORDED RESPONSES OF THE CEREBELLAR PURKINJE CELLS," EXPERIMENTAL BRAIN RESEARCH, 1966

FIG. 9.—SECTION OF THE CEREBELLUM SHOWING THE EXTENSIVE BRANCHING OF VARIOUS NERVE CELLS

The cortex of the cerebellum consists of a superficial stratum, the molecular layer; an intermediate layer, which contains the cell bodies of branched Purkinje cells (fig. 9); and an inner deep stratum, the granular layer, which rests upon the central white matter. The latter is formed by medullated nerve fibres, which course to and from the gray matter. The Purkinje cells are remarkable for their large size and extensive connections. The cell bodies are pear-shaped and arranged in a single layer. From the outer end of each cell processes branch out in the molecular layer.

These processes (or projections) are the dendrites, and the branching takes place chiefly in a plane at right angles to the longitudinal axis of the folium in which it lies. The dendrites of the Purkinje cells are intersected at right angles by parallel fibres that run in the direction of the folium. These fibres are derived from axons of the granule cells in the inner stratum of the cortex, which pass outward and divide in the molecular layer in a T-shaped manner into right and left branches. The bodies of the Purkinje cells, moreover, are surrounded by a network of fibres that originate from basket cells in the molecular stratum; and the Purkinje dendrites are also accompanied by delicate climbing afferent nerve fibres from the white matter.

Although areas of the cerebellar cortex cannot be mapped out by response of particular groups of muscles to electrical stimulation, it is possible on morphological grounds, by means of experimental work and by the tracing of tracts of nerve fibres entering the cerebellum, to locate areas of the cortex according to the fibres which they receive from particular parts. Thus it is generally admitted that the head and neck are represented in the anterior part of the vermis, the trunk in the posterior part and the limbs in the apical region of the vermis and hemispheres. References to literature on cerebellar localization will be found in


AQUEDUCT OF SYLVIUS
ROSTRAL COLLICULUS
MEDIAL LONGITUDINAL FASCICULUS
MEDIAL LONGITUDINAL TRACT
RED NUCLEUS
SPINOTECTAL TRACT
MEDIAL GENICULATE BODY
SUBSTANTIA NIGRA
MEDIAL LEMNISCUS
CEREBRAL PEDUNCLE

FROM RAUBER KOPSCH, "LEHRBUCH UND ATLAS DER ANATOMIE DES MENSCHEN" (1955); REPRODUCED BY PERMISSION OF GEORG THIEME VERLAG

FIG. 10.—SECTION THROUGH UPPER PART OF MIDBRAIN

C. J. Herrick, *An Introduction to Neurology* (1927); H. Woollard, *Recent Advances in Anatomy* (1927); and Jansen and Brodal, *Aspects of Cerebellar Anatomy* (1954).

7. The Midbrain.—The midbrain (mesencephalon) connects the pons and cerebellum with the forebrain (fig. 10). It is traversed by the aqueduct of Sylvius. The part that lies above the aqueduct, called the roof plate or tectum, is subdivided by a cruciform sulcus into four rounded swellings. These are the colliculi or corpora quadrigemina. The upper pair of these bodies receives nerve fibres from the retina, which reach them through the optic tracts. They are concerned in the regulation of the movements of the eye and in the pupillary reflexes. The lower pair serves as a cell station in the path of the auditory impulses which pass from the cochlea to the cortex of the temporal lobe. The gray matter in the roof of the aqueduct receives an important tract of nerve fibres from the spinal cord, known as the spinotectal.

A similar bundle, the spinothalamic tract, also traverses the midbrain. Both tracts convey the more primitive sensations of pain, heat and cold to the receptive centres in the brain. These have been described by Head as protopathic sensations, to distinguish them from the finer and more recently evolved sensations of touch, which he terms epicritic. The latter ascend in the posterior columns of the spinal cord to the gracile and cuneate nuclei. From these a relay of nerve fibres ascends through the medulla oblongata and, crossing in this to the opposite side of the brain, passes as the medial fillet through the pons and midbrain to the thalamus. From the thalamus another relay of fibres carries the sensory impulses to the cortex of the brain. These fibres diverge as they traverse the white matter of the brain, thus forming part of the corona radiata.

The most ventral part of the midbrain forms the crura cerebri. These are two diverging limbs which ascend as it were from the pons Varolii to the right and left cerebral hemispheres. They are partly the pyramidal tract that descends from the motor area of the cerebral cortex to the opposite side of the spinal cord and partly the cortico-pontine fibres which pass from the frontal and temporal lobes to the pons. Behind or dorsal to the crura is a lamina of pigmented nerve cells (substantia nigra) that separates the pes pedunculi from the tegmentum. The latter consists of two symmetrical halves connected by a median raphe. This is traversed by decussating fibres, the greater number being the cerebellar fibres already mentioned as issuing from the dentate nucleus, traveling by the superior peduncle to the midbrain and then crossing to the red nucleus of the opposite side and to the thalamus.

From the red nucleus a tract of nerve fibres descends to the spinal cord, where it forms connections with the motor cells in the gray matter of the anterior cornua. (*See* SPINAL CORD.) This is the rubrospinal tract of Monakow. Large in lower forms, it dwindles into an insignificant strand of a few fibres in man, showing that the kind of control exercised by the cerebral cortex changes in the course of mammalian evolution. The red nucleus is also connected with the central ganglia of the brain, in the first place with the inferior olive. By means of these connections, it is believed that the cerebral hemispheres control the more reflex movements carried out by the spinal cord, such as balancing movements and the maintenance of posture.

In the tegmental part of the midbrain are also situated the longitudinal association tracts, known as the dorsal and medial longitudinal bundles; the fountain decussation, which connects nuclei in the superior quadrigeminal body of one side with the nuclei of cranial nerves of the opposite side of the brain; and, finally, the nuclei and roots of origin of the 3rd, 4th and part of the 5th cranial nerves in the gray matter surrounding the aqueduct of Sylvius. (*See* NERVE.)

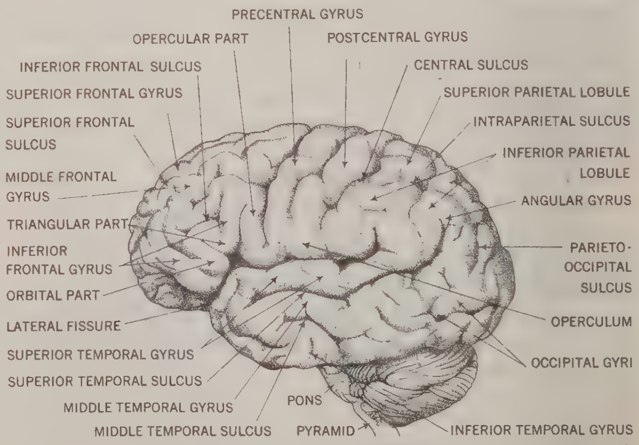
8. Cerebral Hemispheres.—One of the most distinctive features of the human brain is the large size of the hemispheres and the high degree of specialization in the microscopic structure of the cortex. The surface of each hemisphere is subdivided, for descriptive purposes, into lobes and lobules. Certain fissures and lines which are arbitrarily drawn between these are employed for demarcating the boundaries of these areas. The names of the principal fissures and lobes are indicated in figs. 11 and 12, and it will be necessary only to draw attention to certain of the more important ones. Thus the central fissure, or fissure of Rolando, is situated on the lateral surface and separates the frontal from the parietal lobe. The lateral fissure or fissure of Sylvius marks off the temporal lobe from the parietal and frontal lobes. On the median surface are the callosomarginal, parieto-occipital and calcarine fissures, which limit the frontal, limbic, parietal and occipital lobes.

The central, or Rolandian, fissure marks the posterior limit of the important motor area of the cortex. Electrical stimulation of particular parts of this area produces definite movements of groups of muscles, the action of which is normally initiated and controlled by the part stimulated. Injury to the same part causes paralysis of the corresponding muscles.

The cortex of the occipital lobe which surrounds the posterior part of the calcarine fissure is the visuosensory area for reception of visual impulses from the retina. The visuosensory area is surrounded by a marginal zone which extends on to the outer aspect of the occipital lobe, termed the visuopsychic area.

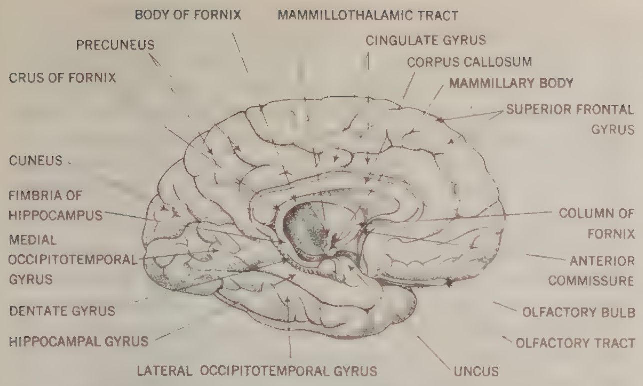
The middle part of the first temporal gyrus and the adjacent gyri on the lower lip of the fissure of Sylvius are concerned with hearing. The auditory area of the brain receives sensory impulses by way of the auditory radiation from the medial geniculate body of the same side. These, the lower auditory centres, are connected with the opposite ear by means of the lateral fillet.

The front part of the hippocampal gyrus, with its hooklike end, the uncus, is the higher cortical centre for the sense of smell.


PRECENTRAL GYRUS
OPERCULAR PART
POSTCENTRAL GYRUS
INFERIOR FRONTAL SULCUS
CENTRAL SULCUS
SUPERIOR FRONTAL GYRUS
SUPERIOR PARIETAL LOBULE
SUPERIOR FRONTAL SULCUS
INTRAPARIETAL SULCUS
INFERIOR PARIETAL LOBULE
MIDDLE FRONTAL GYRUS
ANGULAR GYRUS
TRIANGULAR PART
INFERIOR FRONTAL GYRUS
PARIETO-OCCIPITAL SULCUS
ORBITAL PART
LATERAL FISSURE
OPERCULUM
SUPERIOR TEMPORAL GYRUS
OCCIPITAL GYRI
SUPERIOR TEMPORAL SULCUS
PONS
MIDDLE TEMPORAL GYRUS
MIDDLE TEMPORAL SULCUS
PYRAMID
INFERIOR TEMPORAL GYRUS

FROM RAUBER-KOPSCH, "LEHRBUCH UND ATLAS DER ANATOMIE DES MENSCHEN" (1955); REPRODUCED BY PERMISSION OF GEORG THIEME VERLAG

FIG. 11.—SOME GYRI AND SULCI OF LEFT CEREBRAL HEMISPHERE


BODY OF FORNIX
MAMMILLOTHALAMIC TRACT
PRECUNEUS
CINGULATE GYRUS
CORPUS CALLOSUM
CRUS OF FORNIX
MAMMILLARY BODY
SUPERIOR FRONTAL GYRUS
CUNEUS
FIMBRIA OF HIPPOCAMPUS
COLUMN OF FORNIX
MEDIAL OCCIPITOTEMPORAL GYRUS
ANTERIOR COMMISSURE
DENTATE GYRUS
OLFACTORY BULB
HIPPOCAMPAL GYRUS
OLFACTORY TRACT
LATERAL OCCIPITOTEMPORAL GYRUS
UNCUS

FROM RAUBER-KOPSCH, "LEHRBUCH UND ATLAS DER ANATOMIE DES MENSCHEN" (1955); REPRODUCED BY PERMISSION OF GEORG THIEME VERLAG

FIG. 12.—MEDIAL SIDE OF LEFT CEREBRAL HEMISPHERE

This is the most primitive of the special senses. It is closely associated with the sense of taste and is both relatively and absolutely more highly developed in lower types of vertebrate animals than in man. That part of the brain which is concerned in the sense of smell, and also in certain complex emotional responses, is called the rhinencephalon. In addition to these, there is a large area behind the central fissure that extends forward onto the motor area. This is the cutaneous sensory, or tactile, area.

The areas of cerebral cortex lying between the special and cutaneous sensory areas are believed to function as association centres between the different senses and as centres in which the memory of associated sensations is stored. The prefrontal region is connected by association fibres with all the various sensory and motor areas and, more especially, with that part of the adjacent motor area which is concerned with the movements of the eyes. It is therefore believed that this part of the cortex may control skilled movements which are dependent on impulses reaching the brain from the eyes and which require close attention and a knowledge or memory of past experiences—for instance, such movements as those of the lips and tongue, or of the hand, which have given man the powers of speech and of writing. If the upper and lower lips of the fissure of Sylvius are separated, a triangular area of submerged cortex will be exposed. This is the island of Reil, or insula. It lies over the outer aspect of the corpus striatum, and the lips of the fissure which overlap it are called the opercula insulae. In the human fetal brain, and the brains of most animals, part of this area of the cortex is exposed.

The basal ganglia are masses of gray matter embedded in the cerebral hemispheres. They include the optic thalami and the caudate and lenticular nuclei. The optic thalamus is a receptive centre for primary sensory impulses, and an important cell station in the path of sensory messages to the cerebral cortex. The caudate and lenticular nuclei, with the white matter which surrounds the lenticular nucleus, form the corpus striatum. The white fibres lying to the inner side of the lenticular nucleus are called the internal capsule; those to its outer side form the external capsule. The former consists of sensory fibres passing to the cortex, motor fibres of the pyramidal tract passing from it, and association fibres passing between the nuclei. (*See* fig. 13.)

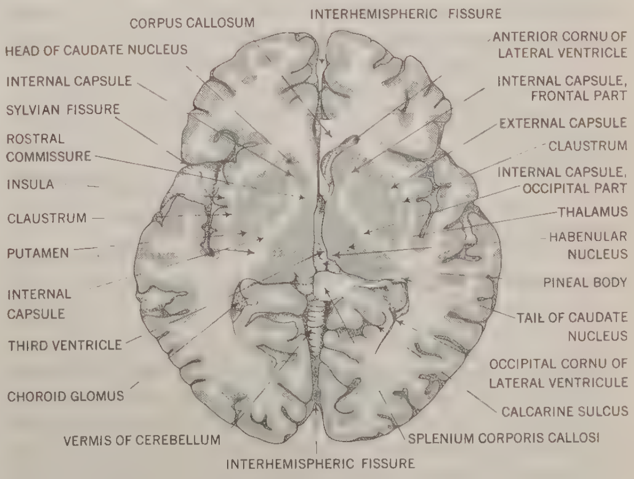
9. Cerebral Cortex.—The cortex is the stratum of gray matter that covers the central white matter of the hemispheres. It consists of nerve cells, nerve fibres, blood vessels and a supporting tissue, the neuroglia. It exhibits a definite stratification into layers of nerve cells and nerve fibres. In sections of the fresh brain, the main strata are easily recognizable by the unaided eye, and more especially so in the visual cortex, or area striata. Various zones may be distinguished in this way, and it is found that the naked eye appearances correspond closely with the finer details revealed by microscopic preparations.

The superficial lamina, or outer fibre layer, is largely composed of nerve fibres running tangentially to or parallel with the surface. Many of these fibres are branches of the peripheral processes of small and large pyramidal cells contained in the subjacent strata of the cortex; others are the terminal branches of nerve fibres passing into the cortex from the white matter. These are called corticipetal fibres and originate from nerve cells in the central ganglia or from other parts of the cerebral cortex. The nerve fibres of the superficial lamina, and other strata in which the fibres are arranged tangentially, serve as association fibres, connecting different areas of the cortex with one another. They also connect fibres conveying sensory impulses reaching the cortex from the central ganglia or other parts with the cells which give rise to the efferent or outgoing impulses. Certain of these efferent, corticifugal fibres spring from the basal ends of the large pyramidal cells of Betz, present in the motor region of the cortex and other smaller pyramidal cells. Some efferent fibres remain on the same side as their origin and pass to distant parts of the cerebral cortex, while others cross, by the corpus callosum, to the cortex of the opposite cerebral hemisphere.

In animals the degree of lamination and differentiation of the nerve cells in the cortex appears to correspond with the stage of evolution attained by the particular species. The cortex is thicker and more highly evolved in man and the higher types of mammals than in lower forms. In the development of the cortex, stratification begins about the sixth month of fetal life, when the convolutions first appear, and differentiation continues not only during the later months of fetal life but for a considerable period after birth. The more superficial strata containing the pyramidal cells are developed latest.

10. Weight of the Brain.—The weight of the brain varies with age, stature, body weight, sex and race. It is also influenced by congestion of the blood vessels, degenerative changes and atrophy. At birth the brain weighs approximately 380 g. and is 12.4% of the body weight. The entire brain, with the pia-arachnoid, of an adult British male weighs approximately 1,409 g., or 49.6 oz.; that of a female, 1,263 g., or 44.5 oz. The average stature and body weight of the female, however, are less than those of the male, and when these factors are allowed for, the size and weight of the brain in the two sexes are approximately equal. The influence of age on brain weight is considerable. The growth of the brain is very rapid during the first three years but slightly less rapid up to the 7th year, when it is not far off its full weight. After this the increase is very gradual, its prime being usually attained in males by the 20th year and in females somewhat earlier. From this period onward, in both sexes, there is a continuous diminution in the average brain weight of approximately 1 g. per year.

Tall persons have heavier brains than short persons, but, relative to their height, short persons have larger heads and brains than tall persons. Many men of conspicuous ability have had


CORPUS CALLOSUM
INTERHEMISPHERIC FISSURE
HEAD OF CAUDATE NUCLEUS
ANTERIOR CORNU OF LATERAL VENTRICLE
INTERNAL CAPSULE
INTERNAL CAPSULE, FRONTAL PART
SYLVIAN FISSURE
EXTERNAL CAPSULE
ROSTRAL COMMISSURE
CLAUSTRUM
INSULA
INTERNAL CAPSULE, OCCIPITAL PART
CLAUSTRUM
THALAMUS
PUTAMEN
HABENULAR NUCLEUS
PINEAL BODY
INTERNAL CAPSULE
TAIL OF CAUDATE NUCLEUS
THIRD VENTRICLE
OCCIPITAL CORNU OF LATERAL VENTRICULE
CHOROID GLOMUS
CALCARINE SULCUS
VERMIS OF CEREBELLUM
SPLENIUM CORPORIS CALLOSI
INTERHEMISPHERIC FISSURE

FROM RAUBER-KOPSCH, "LEHRBUCH UND ATLAS DER ANATOMIE DES MENSCHEN" (1955); REPRODUCED BY PERMISSION OF GEORG THIEME VERLAG

FIG. 13.—SECTION THROUGH BRAIN (SEEN FROM ABOVE): RIGHT HALF THROUGH THE LEVEL OF THE INTERVENTRICULAR FORAMEN; LEFT HALF THROUGH THE LEVEL OF THE ROSTRAL COMMISSURE

brains of large size, *e.g.*, Georges Cuvier, 1,830 g., but on the other hand the brain of Anatole France, who died at the age of 80, weighed, without the membranes, only 1,017 g.; by adding 60 g. for the weight of the membranes and 61 g. to allow for shrinkage due to age, his brain may be estimated to have weighed, at the age of 20, no more than about 1,138 g. Averages calculated from groups, *e.g.*, scholarship winners and persons of average and below average ability, show statistically that there is only a very slight correlation between large size of head and a high intelligence.

(R. J. G.; G. v. B.)

II. PHYSIOLOGY OF THE BRAIN

If by physiology of the brain is meant the study of the biological function of that organ, the state of exact knowledge regarding it is still extremely inadequate, although there exists a vast body of detailed fact. Inferences as to function drawn from morphological and phylogenetic data are therefore a permissible and welcome help, although often of the nature of suggestion rather than demonstration. It is with the vertebrate brain that the following account is concerned.

The brain is that part of the nervous system that is constructed upon and evolved alongside the distance receptors. The importance of this is that it means ability on the part of the animal to react to an object when still distant from it and allows an interval for preparatory reactive steps; this can go far to influence the success of the animal's behaviour in regard to that object. The reactions initiated and guided by the distance receptors are all steps toward final adjustments, which latter are consummations often of critical importance for the existence of the animal (*e.g.*, attainment of food) or of its species (*e.g.*, fertilization). This time interval and its series of steps, along with the vicissitudes of relation between things of changing position reacting one on another at a distance, conspire to give to the distance receptor reflexes a multiformity and a complexity unparalleled by the reflexes initiated from other receptors. This interval affords much more copious opportunity for adjustment and side connection as occasion demands. It gives freer play for the affixing of new-conditioned, *i.e.*, individually acquired, reflexes to the primal inborn reflexes. Further, the time interval allows opportunity for variations of behaviour to be failures and yet recovered from and, conversely, allows greater chance for successful reaction variations to be selectively preserved.

A. Vertebrate Evolution

As we pass from lower vertebrates to higher, we find, broadly taken, a progressive increase in the relative size of the brain. This fact stands related to two features which characterize the vertebrate evolution and seemingly also that of other phyla as well. One of these features is that, broadly speaking, the course of vertebrate evolution has tended to produce a more and more unified individual, an individual of greater functional solidarity, although still consisting of individually living cell units. Consistently with the two main biological requisites of the individual animal life, namely, its preservation and that of its species, the closer functional welding of the parts of the animal individual into an integrated whole seems, as we look along the vista of geological time and of geographical spread, to have been a steady outcome of evolution.

The other feature is not unrelated to the foregoing one. It is that evolution, though with checkered history, has resulted in animal forms possessing successively greater dominance over their environment. Organisms are commonly spoken of as "lower" and "higher." The lower are usually the simpler, the higher the more complex; but the lower need not the less perfectly fulfill their primary biological requisites: preservation of self and species. There are brachiopods that have without visible change maintained themselves in and upon their environment from the era of the earliest fossil-bearing rocks till today, and they are lower animals. Such commerce with and maintenance in the environment must be as admirably adjusted as any imaginable so far as concerns persistence of life. Yet, in the course of time, evolution has produced animal forms which pursue a far richer and more manifold commerce with the environment, and some of these dominate the environment more variously and extensively than others, including their own ancestry, have done. In this sense they are higher forms. The earliest animal forms have included none of these highest, and some of the very latest are also the very highest forms achieved. As judged by dominance of the environment, man, although quite a recent form, is the highest as yet. The key to this evolutionary feature is furnished largely by the evolutionary history of the brain and its functions.

1. Increased Integration.—A factor, and in some respects a decisive one, both in the accomplishment of greater functional solidarity of the animal and of its higher mastery over the environment, is the progressive development in the nervous system of a dominant part. The organization of the central nervous system is thus enhanced as an integrator of the animal in its life of external relation. The integration combines, into great unitary harmonies, reactions originally scattered and local and semi-independent acts. It organizes the several segments and segmental regions into a well-knit individual. The establishment in the central nerve cord of, so to say, a headquarters station for receipt of calls from many directions and for dealing through subsidiary parts of the nervous system with the motor machinery of the animal, as a whole, imbues the organism with individuality of a higher kind. It is this that the advent of the brain foretells. The progressive development of the brain increasingly secures advantages.

The success seems partly a matter of mere increase of centralization. The receptor apparatus of the head acquires increased co-ordinative guidance of the body. The body tends to become a locomotor and, later, a secondary prehensile train and a digestive appanage attached to the head, with, as inalienable possession, the reproductive organs. The brain in this respect merely takes with further specialized success the general role assigned to the nervous system from its earliest appearance and onward throughout evolutionary history, namely, the welding of the body's component parts into one consolidated mechanism facing as a united entity the changeful world about it. The work of this kind done for the "higher" animal by its brain presents the acme of animal integrative achievement. Hence is it that each of us, though made up of myriads of cell lives individually feeding and breathing, and of manifoldly differing activities, constituting scores of organs, yet appears to himself a single entity, a unity experiencing and acting as one individual. That the particular body system which is specialized for integration, and whose sole function is integration, and that that portion of it where integrative function is at its highest should be the seat of mind, even from the dim mental beginning, and that mind should remain there localized and despite all mental growth stay restricted in seat there along millions of years, on into ourselves today, indicate the scope and crowning importance of nervous integration and the brain.

2. Control of Environment.—In regard to attainment of wider mastery over the environment, no less than in respect of organizing the individual, phylogenetic development of the brain has played a decisive part. The more numerous and extensive and the better co-ordinated the responses made by a creature to the actions of the world around upon its receptors, the more completely will the bundle of reflexes (which from one standpoint the creature in its life of external relation is) figure the complexity of the environment and meet widely and successfully its situations. And at the root of the success of the brain as an integrator there lies something more than is represented in its expressing merely a more highly organized centralization.

Over and over again in the evolution of the brain there is instanced the importance, for the process of integration, of connecting together nerve structures that might or do react concurrently but are originally unconnected. The simultaneous components of a "reflex-figure" (C. S. Sherrington, 1906) tend to stamp in a neural pattern. The functional "reflex-figure" with its simultaneously reacting parts proceeds along with (as its structural counterpart) a neural pattern which may become innate or be an individual acquirement; *e.g.*, mammalian cortex.

A keystone of the principle of integration is that the concurrent activity of related parts results in more than the simple sum of the activity of the separate component parts. Thus, in psychical integration, the single touch gives experience of itself alone. But a double simultaneous touch, *e.g.,* compasses, gives experience of two touches and, which is new, an untouched space between. The integration results in more than the mere sum of the components. Again, the uniocular field gives experience of some amount of "depth"; but when in combination with the other uniocular field to a binocular, there is yielded such an enhancement of the third dimension as amounts to a new result, the "depth" of stereoscopic vision. And in the vertebrate after advent of the brain the animal's reactive behaviour shows in increased measure the important quality of modifiability by experience, using this last term without of necessity any psychological connotation. Late in vertebrate development in a restricted number of forms, all mammalian and nearly related one to another, and relatively very recently evolved, this modifiability of behaviour has become greatly more effective. Its highest outcome appears perhaps as the rational guidance of human conduct.

It is not of course that either the fuller integration of the individual animal or the higher animal's wider dominance of the environment is the result entirely of the brain or of the cerebral adjunct "mind." Contributory to the latter result has been the mechanism (partly nervous) for ensuring a constant temperature environment for the tissues of the body, enabling the individual's activity to be uninterrupted by season and largely independent of latitude; also contributory has been the gestation arrangement which protects the young within the mother until a relatively late stage, providing exceptional prenatal care for the offspring. Nevertheless the extreme importance of the contribution by the brain is shown by the degree of dominance over the environment obtained by man as compared with that of other, even the highest other, placental mammals.

The vertebrate brain consists of a hindbrain, midbrain and forebrain.

3. Hindbrain.—The hindbrain, as traced upward from the lamprey, shows two main functional divisions. Of these, one, the basal, closely resembles the spinal cord of which it is the continuation in the posterior head segments. In air-breathing vertebrates this basal portion contains a centre regulating the movements which ventilate the lungs. This mechanism presents the interesting physiological feature that while "reflex" in the sense of being driven and controlled by nervous impulses arriving at it by well-recognized afferent nerves, it is also activated and partly regulated by stimuli arising autochthonously within it. This intrinsic stimulation is perhaps generated and is certainly influenced by the chemical condition (degree of acidity) of the blood. Another centre in this basal part of the hindbrain is, in higher vertebrates, one which influences the general circulation of the blood, by regulating the contraction of the muscles of the arterial tubes and to some extent of the heart itself. There lie also in this region reflex centres which maintain postural contraction of the extensor muscles of the limbs and trunk in response to passive stretch of these muscles. In the erect attitude of the animal these muscles are subjected by the weight of superincumbent parts to stretch, and they are termed antigravity muscles; this hindbrain region, therefore, executes a crude reflex standing, traces of which can be executed even by the isolated spinal cord itself (dog). Further forward still this part of the hindbrain receives the nervous impulse from the labyrinth organs and enables still more perfect reflexes of standing.

Cerebellum.—The hindbrain has further an important roof portion, the cerebellum, so called because in man it seems, on gross inspection, a small replica of the great cerebral hemispheres in front. The cerebellum has its cradle, ontogenetically and phylogenetically, in the primary receiving stations of the receptive nerve from the labyrinth, an organ largely controlling the postures of the head in regard to the vertical (line of gravity). The activity of the primitive cerebellum rests further on nerve tracts from the spinal cord. It acts on the muscles of the body. Traced up from the fish through amphibians and reptiles to birds, the relative size of the cerebellum differs in even nearly allied groups but bears evident proportion to range and power of skeletomuscular motility. In forms that crawl and creep it is small, but in the great swimmers and fliers it is large, even very large. With the mammalian series, however, a steady progress in cerebellar size occurs along with ascension to higher forms and culminates in the ape and man. Two large lateral developments are added to the pre-existent, unpaired median portion. Each of these lateral additions is functionally an annex of the new mammalian neopallium of the contralateral cerebral hemisphere, and with this latter go considerable developments in the median (paleo) cerebellum also. The surface sheet of the cerebellum has a peculiar and characteristic minute structure, found in both the paleocerebellum and the neocerebellum, although the history of the two seems so different and though the genesis of the neocerebellum is separated by many millions of years from that of the paleocerebellum. To all appearances the neural chains of the cerebellum are a collateral path that, as regards those of the paleocerebellum, belongs to the afferent limbs of reflex arcs actuating skeletal movements but, as regards those of the neocerebellum, belongs to the efferent central path of "volitional" movements.

The excitability of the cerebellar surface by electricity was once denied, but later studies confirmed that considerable areas of the surface are truly excitable by electrical stimuli. The excitable field is paleocerebellar and causes inhibitory relaxation of certain active postures; *e.g.,* of extension-abduction of limb. Destruction of the paleocerebellar region, which receives in mammals proprioceptive spinal tracts, causes exaggeration of the stretch reflexes of the limb extensors. Disease with cerebellar defect in man produces its most obvious detectable results in the field of willed muscular acts. The accuracy of execution of the movement is impaired by overshoot, abruptness of start and stop, ill-sustained contraction and undue liability to fatigue. Cerebellar ataxia seems to contain the following three factors: (1) diminished fineness of postural adjustment; (2) excessive intensity of postural activity; and (3) complication of the two foregoing by voluntary efforts at correction.

Function of the Cerebellum.—Acute unilateral damage of the cerebellum in man brings as characteristic symptoms: (1) the tendency to fall sideways toward the side of injury, especially if the eyes are closed; (2) the hand in reaching toward a point goes too far or stops too short; (3) in alternating movements the limb on the side of the lesion cannot alternate its phases with normal quickness and accuracy—it starts late and ends late for each phase; (4) with eyes shut the limb tends unconsciously to slip from an adducted into an abducted posture; and (5) the position of the limb is often misperceived, its degree of abduction being underestimated. There is, however, no impairment of skin sensations or of superficial or deep pain sensation. Strangely enough, congenital absence, total or almost so, of the cerebellum has been found in persons who have lived their lives without suspicion of any nervous defect. How the defect is compensated remains unanswered.

Obviously the function of the cerebellum is still obscure, although it is a large organ, weighing in man more than the entire spinal cord. Proprioceptive recepts seem at the base of paleocerebellar function and suggest for it an adjusting co-operation in the execution of muscular acts, the acts themselves being initiated and directed by centres other than the paleocerebellum, probably mainly those of the midbrain. The neocerebellar function may be inferred to be similar in character to that of the paleocerebellum but to be adjuvant to movements of a newer physiological order (voluntary), initiated and directed by the neopallium (cerebral cortex). The neopallium in activating these movements probably activates collaterally the associated neocerebellar co-operation. The status of the cerebellum in the motor acts seems merely that of an executive instrument of them; the purpose and object of them are none of its affair. Cerebellar reactions are unconscious. The destruction of the cerebellum entails no loss of sensation, although cerebellar disturbance may occasion some proprioceptive misperception.

4. Midbrain.—The midbrain, like the hindbrain, is made up of centres intrinsically its own, as well as of conducting tracts merely passing through it to connect centres extrinsic to it. Its main intrinsic apparatus is collected in its roof. This receives a great afferent path from the retina and also from the receptive centres of the hindbrain and spinal cord. It distributes efferent paths to neighbouring motor stations, including those of the eye muscles; many of these paths decussate. It sends also some longer paths forward to the forebrain and backward into the spinal cord. It has also rich intrinsic interconnections. By means of its midbrain the mammal, even after destruction of the forebrain, is able to execute and maintain the erect posture and with better adjusted muscular tone than by means of the hindbrain alone. It is able further to assume the erect posture from other positions passively imposed upon it. It can right itself. The mere motor execution of these reflexes is a matter of high complexity. Maintenance of standing involves duly adjusted simultaneous activation of many hundreds of thousands of motor units. The righting reflexes themselves are chain reflexes. In a chain reflex the result of a foregoing reflex's execution is to evoke execution of the next succeeding one. This means due and successive activations of appropriate different great combinations of motor units reaching at last the "standing complex," which forms an equilibrium, and, until disturbed, an end point. (*See* also EQUILIBRIUM, ANIMAL.)

The cat retaining the midbrain but deprived of the forebrain reacts to sounds, although without giving indication of the direction whence they come. The midbrain is in fact a large exchange where messages from the retina are associated with those from various other receptive nerves of the head and, via the spinal tracts, from the body (especially skin). In responding to these messages the midbrain uses efferent paths by which it can operate upon motor centres, especially of the eyes and mouth and also of the neck and body. Severe impairments of motility and of normal posture are therefore produced by injury of the midbrain roof. Although relatively large in lower vertebrates, the midbrain becomes relatively dwarfed in the mammalian brain. There is some evidence that in the course of vertebrate evolution along the mammalian branch the intrinsic importance of the midbrain as a dominating centre becomes smaller, not only relatively but absolutely. The supreme control of behaviour becomes located progressively more forward, passing from the midbrain (most fishes) to the thalamus and corpus striatum (reptiles and birds) and then to the cerebral cortex (mammals).

5. Forebrain.—In the forebrain four main constituents are strikingly distinguishable. They are the thalamus, olfactory lobe, corpus striatum and pallium. The latter three belong to the endbrain, so called because it is the actual terminal piece of the nerve cord itself.

Thalamus.—Throughout the vertebrate series the thalamus is a structure for correlating messages relayed up from receiving stations corresponding with all the various classes of receptor organs of both head and body; eminently so with the retinal, whence the term optic thalamus. Besides providing machinery for interconnecting these and bringing their recepts to bear on the motor centres of the midbrain and hindbrain, it is itself a relay station for transmissions to the corpus striatum. Whereas in mammalia the neopallium is large, the thalamus becomes a relay station for routes thither, and on an enormous scale. In lower mammals it is subdivided into regions (nuclei) each preponderantly representative of some specific set of receptors (retinal, auditory, tactual-proprioceptive, etc.) and each in give-and-take connection with especially some one field of the neopallium (cerebral cortex). In higher apes and man the subdivisions become more complex still. The thalamus of lower vertebrates certainly mediates the simpler types of modification of behaviour by trial-and-error learning; after removal of the whole forebrain the frog, for instance, is incapable of acquiring a very simple maze adjustment. But the feeding chain reflex remains, the retinal reflex orients the frog to the fly and, if the fly moves again, the simultaneous spring and snap reflex follows, to be followed, if successful, by the swallow reflex. The thalamus is of itself quite incompetent in the hen for the instinctive behaviour of the maternal uprearing of the chick.

In close association with the thalamus is an underlying structure, the hypothalamus, among whose ascribed functions is nervous regulation of the mechanism (vascular, glandular, etc.) by which in animals of constant temperature (birds, mammals) the body temperature is maintained steady despite environmental changes, a result contributing enormously to evolutionary success. In addition to this so to say essentially vegetative function, the hypothalamic region is concerned with visceral nerve relays, putting them in touch with taste and smell (from in front) relays. It is therefore relatively large in lower vertebrates, while the thalamus, analogous with it but in an exteroceptive and somatic rather than a visceral field, gains on it in higher vertebrates. In the bird the thalamic forebrain independently of the cerebral hemispheres seems to operate large reflex reactions to injurious agents and to hunger, thirst and temperature and possibly elaborates mental concomitants of these. But even in the highest mammals tonic activities of the sympathetic, essentially a visceral, system are traceable to this region. The nexus between sympathetic and visceral reactions on the one hand and affective and emotional mental experience on the other makes the close relation between thalamus and hypothalamus the more significant.

The dog or cat deprived of the forebrain except the thalamus does not react even when hungry to food placed before it. The muzzle has to be dipped into the food or the food put into the mouth for the feeding to occur. Food doctored with quinine, etc., is rejected. Pain stimuli to skin, etc., evoke biting, barking, miaowing and withdrawal of the threatened part. Yet in all this defensive behaviour there may be little or no indication of the locality of the offending stimulus. The animal, it has been inferred, can experience pain; it is not, however, able to acquire the simplest conditioned reflex. Its behaviour is confined to the stereotyped inborn reflexes. Its reflex behaviour is modifiable, however, to the extent that having hurt one foot it limps upon three legs until the hurt foot is healed. Its reactions, indicative of pain, may possibly be pseudoaffective reflexes without psychical adjunct. But there is evidence from clinical studies that pain is among the reactions of the thalamus. Affective and emotional disturbances are recognized as part of the syndrome of thalamic disease. The inference is therefore that the cerebral seat of mind does in some measure include—and so to say overlap upon—the thalamus, even in higher mammals. (*See* also THALAMUS.)

Olfactory Lobe and Corpus Striatum.—Of the three great components of the endbrain (cerebral hemisphere) one is the olfactory lobe, the reflex centre for the organ of smell, whose afferent nerve is so to say the segmental nerve for this region. Another is the corpus striatum, a large correlating centre, of easily recognizable beginnings in fish and of further development in reptilia. In birds it becomes the largest element of the hemisphere, whereas in mammals although large it is relatively dwarfed by the development of the pallium, especially the neopallium of higher mammals. Birds, therefore, offer best opportunity for detecting striatal function, the more so perhaps since in them the olfactory region is greatly reduced. In the pigeon, destruction of the hemispheres other than the corpus striatum leaves the feeding, mating and rearing reflex acts, as well as walking and flying with avoidance of obstacles, intact but open to occur with less discrimination of stimuli. Conditioned reflexes can be acquired and attached to the innate ones: feeding or avoidance. But if the corpus striatum is destroyed, the hen loses irrecoverably her maternal behaviour of incubating and rearing. So, similarly, the hawk caged with mice turns its gaze toward them when they move, but on their ceasing to move reaction ceases on the part of the bird. Neither does their movement excite attack upon them. The bird will starve in presence of its natural prey. It seems clear that in birds the corpus striatum operates complex though stereotyped behaviour and provides in some measure acquisition of individual modification (by experience) of such behaviour.

Passing to the lower mammals, the corpus striatum is relatively smaller than in birds. Conformably with mammalian ancestry some of the corpus striatum is ancient and olfactory and probably serves higher correlations of smell with taste and touch for locomotor and head reflexes involved in feeding. Another part, also ancient, receives exteroceptive and proprioceptive tracts (from the thalamus) but no olfactory; it operates movements through an emissive path to the midbrain. To these old parts there is a new addition of undetermined function. The cat, with neopallium lost but corpus striatum (and archipallium) retained, localized the direction of sounds. In man destructive disease within the corpus striatum is thought responsible for the syndrome of Parkinson's disease, characterized by tremor and tonic spasm.

Pallium (*Cerebral Cortex*).—In fish and many amphibians the pallium is nonexistent or present only in traces. It exists clearly though rudimentarily in reptiles. In view of the great importance ultimately assumed by the pallium it is well to remember that, in entire absence of a pallium, not only is complex instinctive behaviour but also modification of innate behaviour by individual experience clearly evidenced in fishes and lower amphibians, not to speak of Invertebrata.

From early reptilian stock came, it is held, the mammalian stock, as did, independently and somewhat later in geological time, the birds. In the course of bird evolution the pallium has progressed little or not at all, perhaps in correspondence with the avian lack of olfactory development, the pallium tracing its origin partly to nerve centres for smell. In mammals on the other hand the pallium taken over with primitive potentialities has proceeded to large and ultimately in some forms (apes and man) enormous development. Hence a progressive divergence might be expected between the courses of development of behaviour in birds and mammals, respectively. The progress of bird behaviour to its highest types might be expected to show little qualitative difference from behaviour of the paleencephalic type. Comparison of birds with bony fishes reveals in both groups a great diversity of specialized forms with specialized behaviour evolved by hereditary organization, behaviour highly and rigidly stereotyped and fixed in character and little imbued with individual plasticity. In this respect both groups resemble the insects. The fish, however, reveals more individual modifiability, *e.g.*, docility, than does the insect; and the bird on the average leads individually a more diversified life and has more power for conditioned molding of innate instinctive behaviour than has the fish. Yet, there is a similarity of the behaviour of the two. Nothing essentially new in behaviour, not even in instinctive type, sunders the later group from the earlier.

Mammalian behaviour, on the other hand, in its course of evolution reveals attainment of certain additional new types of reaction, types different perhaps even radically from anything paleencephalic. Indications of this are the replacement in some respects of "trial-and-error" learning by methods of "seeing through" or of "stopping to think" about a situation. Another is the "tooldom," if one may so call it, of man. And there is the specific human behaviour involving concepts and symbolic thinking and employing complex speech. Of all this the development of the pallium is the correlative.

Neopallium.—The pallium that the mammalian stock derived directly from its reptilian ancestry is an associating mechanism for recepts relayed to it from olfactory organs on the one hand and receptive organs of the mouth and muzzle on the other. This, called the archipallium, therefore promotes in some way the behaviour reactions in regard to feeding, including the food finding. No sooner, however, has the mammalian career of the pallium been entered on than a further formation adds itself to the archipallium. This is the neopallium, a correlation mechanism of still more decisive and capital importance, destined in man to exceed in size the total rest of the central nervous system. In man it is the seat of all that is exclusively human in the mind. It is a structure in which are brought together paths from less comprehensive correlating centres; *e.g.*, those of the thalamus. The archipallium correlates recepts from the olfactory distance receptor with others from the skin, mucous membrane and muscles of the mouth region. The neopallium working on a grander scale brings together recepts from all the various species of receptors, distance receptors and others alike.

But it is never reached by any receptive nerve immediately; it is reached only through relay systems that climb to it via successive correlating mechanisms. The recept patterns that enter the neopallium (cerebral cortex) are therefore always greatly changed from those furnished to the first receiving stations by the groups of receptor nerves themselves. Yet, as is clear in the more primitive mammals, just as the thalamus shows some subdivision into regions individually concerned with recepts predominantly of one kind of source, retinal, auditory, cutaneous, etc., so in the neopallium connected with the underlying thalamus there are individual territories which receive patterns composed predominantly of recepts traceable to one kind—be it this or that—of receptive source. There is thus some localization of function in the neopallium in correlation with some at least of the sets of receptor organs, or, psychologically put, some at least of the modalities of sense. Vision is an instance.

6. Developmental Stages.—It is of interest and a help toward broad evaluation of the place of the brain in the scheme of life to trace, so far as possible, the steps in biological history that were specially momentous in favouring or determining the vertebrate brain's evolution onward to its capital development in man.

One of these steps is judged to have been the emancipation from an aquatic existence achieved partially by amphibians with conversion of paired fins into limbs and development of lungs for air breathing. The body's greater need for support in air than in water made of the limb a jointed motor prop for locomotion with movement of diverse direction and with fingers and toes for clasping and other use. The limb and the evolving nervous system conspired so to say to draw advantage from this. The conquest of the land completed by the reptiles was accompanied by relative increase of the forebrain. The land may be regarded as a habitat of more varied difficulty and opportunity. Yet, launched from that stock, the primitive mammal was completely equipped for a land existence. Its forebrain as judged from primitive existent forms was able, and grew more so, to learn with fewer repetitions and better retention; not only so, but its warm constant body temperature provided for cerebral and other activities uninterrupted by seasonal abeyance. One great branch of this stock, developing a mechanism (placenta) of nutrition and protection for the young within the mother's body (ultimately in the human case nine months long), entered into active and successful competition with other land forms and, indeed, upon great competition within itself. We learn, by comparison of the fossil members of this great group with its present members of similar kind, that even with regard to allied forms the cerebral neopallium has become relatively much larger since the Early Tertiary period. That is to say that in this group the modern individual has relatively more neopallium than had its ancient ancestor of like form and body bulk.

7. From Subhuman to Human.—The ancestry proper of man is thought traceable to some shrewlike placental that became arboreal in habit. Modes of arboreal life put a premium on movements of varied range and accurate adjustment of both limbs and body and also on sight. The evolving of a limb as a tool for uses additional to locomotion gives opportunity for limb and brain to interact. Physical opportunities beget mental opportunities, and conversely. Fruits picked and insects caught will be handled and examined under combined touch, muscular sense and sight. The hand became a testing organ additional to and of greater range than the snout. Some lemurlike type arose, followed by some monkeylike type. The brains corresponding with these are known, and their increased scope of reaction and behaviour can be judged. Parts of the brain concerned with sight and manual dexterity increase greatly in transition from the lemurs up to the ape. The freeing of arm and hand from exclusively locomotor use and their employment for grasping and presenting objects to the eyes and mouth, along with correlative change of the visual axes to parallelism, greatly amplifying and enhancing stereoscopic vision, are thought to have been of great moment for advance toward the human stage of brain. A core of three-dimensional space neighbouring upon and centred at the animal then became visually, tactually and proprioceptively explorable by and familiar to experience on a scale of accuracy hitherto unapproached in animal life. Correlated with this is perhaps the curiosity characteristic of monkeys. The free hand itches to be employed. Later some form belonging to the ape group, though not any existent ape, with anthropoid characters, came to live less in the trees and indeed far more on the ground, probably on the grasslands. With this went a greater attainment of the erect position, a more complete freeing of the arm and hand as a universal tool and a loftier point of vantage for the stereoscopic gaze. So an immediately subhuman and then, less than 500,000 years ago, a human brain was reached.

B. EXPERIMENTAL INVESTIGATIONS

1. Lessons of Animal Behaviour.—Lloyd Morgan showed that the newly hatched chick pecks at things of all sorts, as well as food, and that it learns to feed by profiting from the experience of the gustatory results of its random pecking. For this behaviour in the bird the corpus striatum in absence of the pallium suffices; it forms an instance of a modifiable behaviour in which one (a pleasurable) result stamps in the step which led to it, while another (an unpleasurable) result eradicates itself by stamping out an act which led to it. Similarly, the dog, caught by too hot a morsel, fights shy of a next one. In the case of the dog, more than the corpus striatum is at work; the pallium is necessary. Those who study the functions of the pallium look largely to animal behaviour as their key. The behaviour tests consist chiefly in training or learning of one kind or another: a simple form of maze with alternative paths, one leading to food and another not, or one evoking an electric shock and the other not; food that can be reached only by opening the tilt latch or other fastening of a spring; or the learning by experience that some stimulus, *e.g.*, a sound, signals the coming of food or some other event with which in the animal's training it has been regularly associated. Such observations touch somewhat the same topics as do many of the anecdotes of sportsmen and animal lovers. They have the difference, however, that laboratory observers control carefully the conditions surrounding an observation, simplify its factors, exclude extraneous variables, describe the resultant behaviour as objectively as possible and arrange the experiments so as to permit quantitative statement.

In a good deal of this work it is customary to apply the term reflex to the acts of the normal animal; *e.g.*, dog. Previously the application of the term reflex in physiology and in medicine was to reactions, through the nervous system, that in man were known to be, or that in animals there was cogent reason to believe were, unaccompanied by mental experience. The extension of the term reflex to such an act on the part of one's dog as its coming when called by name may be taken to mean not that the observer denies that mental action attaches to the dog's behaviour but that the observer explicitly disregards it and is studying the behaviour solely as neuromuscular bodily reaction, hoping thus to study the brain, much on the lines along which the spinal cord may be studied.

2. Reflexes.—All purely spinal and hindbrain and midbrain reflexes of the placental mammal seem to be innate. They are transmitted by heredity and are the common property of the species, often of the genus. They include not only such simple acts as mastication, swallowing, the blink reflex, the knee jerk, the scratch reflex, crude sexual acts, etc., but also standing, stepping, the falling cat's righting reflex, etc. They may develop only in maturity, but they are innate. Built up into chain reflexes, they form the basis of much instinctive behaviour.

Besides this type of reflex reaction the individual animal is able to develop other responses operating through its central nervous system. Thus, when the skin of the foot is subjected to a hurtful electric shock, retraction of the foot ensues. If along with or just preceding this some other stimulus, *e.g.*, a sound, is given, then after a number of regular repetitions of this concurrence, the sound itself evokes the retraction of the foot. The response to such an associated stimulus is called an associated or conditioned or individual reflex. The associated reflex is (in the dog) a response for which the neopallium is a *sine qua non.* In entire absence of the neopallium (cerebral cortex) the dog is incapable of acquiring any such responses and loses any such as it has already acquired. A dog's normal everyday behaviour is largely composed of such responses which the common happenings and experiences of its life as an individual from puppyhood onward have taught it. By loss of the pallium this stock of reactions is woefully reduced; it cannot maintain even its base existence. Its behaviour is cut down to a few rigidly fixed reactions. This is exemplified by Pavlov's decorticated dogs, which were not able even to feed unless food was placed in the mouth, and by J. G. Dusser de Barenne's cats, although one of those, in which the archipallium had been spared, still found its food by smell and fed itself.

By means of the pallium any agent which acts on a receptor can by training become a signal evoking a particular movement or a secretion. The training required is that the agent act several times concurrently with the act of movement or secretion, or immediately before it or, which is much less favourable, just after it. The movement or secretion to which the extraneous stimulus becomes attached as a signal is called the ground act or unconditioned reflex. In using the latter term it must be remembered that the protective movement in response to a hurtful stimulus is not itself entirely a reflex in the usual physiological sense of that term.

It is true that in the protective ground act there is a kernel of reaction evocable even when only the spinal cord remains, and it is therefore purely reflex. But to this in the protective act evoked by a similar stimulus in the intact animal there is much added. In this latter case cerebral and cortical reactions are superadded to the reflex. The ground act is therefore a behaviour response far more complex than that which is usually denoted physiologically a reflex. If we face the full biological situation, it includes, instead of merely a pure physiological reflex, a large psychical reaction as well. It must, so to say, reverberate through wide regions of the pallium (cerebral cortex). Similarly, the secretion of the saliva in response to food in the mouth has been greatly used as a ground act (Pavlov), and in terming it an unconditioned reflex it must be remembered that although secretion of saliva can after severe curtailment of the nervous system be obtained as a pure reflex, it yet, as obtained in the feeding response of the intact animal, is but one component of an immense reaction with emotional and other mental accompaniments inevitably involving wide regions of the pallium. These ground acts as reactions to the essential stimulus, *e.g.*, food in the mouth for salivation, are innate inherited reactions, although possessing cortical extensions. The attaching of them to other stimuli, by training in the individual, constitutes the so-called conditioned reflex of Pavlov and the individually acquired reflex of Beritoff and also involves the pallium.

At commencement of the acquiring of an individual reflex, the response tends to be evoked not only by exact repetition of the particular stimulus but also by other stimuli broadly resembling it though not necessarily very closely. The individual reflex is said then to be in the generalized stage. Further training brings greater precision, in the sense that the response occurs only to more precise repetitions of the specific stimulus. This process is differentiation. By this means it has been ascertained that the brain of the dog can discriminate between notes only one-eighth of a tone apart and can hear notes of much higher pitch than the highest audible to man. It exhibits discrimination between figure patterns of relatively slight difference; *e.g.*, a thicker and a thinner capital T. It fails, however, to discriminate colours, although well discriminating different luminosities.

The individually acquired reflex is termed a deferred reflex when the beginning of the conditioned stimulus considerably precedes that of the ground response, although continued until that of the ground response has begun. The individual reflex so acquired brings its effect, *e.g.*, salivation, only after the conditioned stimulus has endured for a time practically corresponding with that employed in the repetitions giving the training. The name trace reflex is given to individual reflexes in which the conditioned stimulus is allowed to lapse before the stimulus for the ground response begins. The trace reflex differentiates its stimulus relatively slowly and poorly; it is also less durable. It is noteworthy that although pain stimuli have inborn defensive reflexes at command, such stimuli are difficult for induction of individual acquired reflexes—the training is long and uncertain, although sometimes successful. This suggests paucity of pain-receiving afferent connections with the cortex in spite of probable wealth of connections with the thalamus.

If some unusual stimulus is employed concurrently with an established conditioned stimulus and in face of this concurrence the ground stimulus is omitted, the individual acquired reflex occurs only weakly or not at all. The stronger this foreign stimulus, the greater its inhibitory effect. This inhibitory result wears off under repetition of the same foreign stimulus. It was shown in Pavlov's laboratory that the degree of inhibition exerted by the foreign stimulus is directly proportional to the intensity of the investigatory reflex that it excites. By investigatory reflex (Beritoff's orientation reflex—the reaction agrees with Head's "vigilance") is denoted an attitudinizing of the head, which is excited by all sorts of stimuli but on repetition of the same stimulus rapidly tends to die out. It may accompany various individual reflexes. It is destroyed by destruction of the pallium. It has been noted that incidental activity of a natural innate skin reflex (*e.g.*, the scratch reflex) may suffice to inhibit an acquired reflex belonging to quite another distant skin region (*e.g.*, of forefoot).

3. The Cerebral Cortex.—The effect of variously situated partial destructions of the cerebral cortex upon acquired reflexes was studied by Pavlov. The destruction of no one single even large field of cortex precludes totally or permanently all acquisition of individual reflexes. Pavlov regarded this as conclusive against the teaching that one special field for association exists in the cortex. The extirpation of a part of the cortex of whatever region temporarily upsets the conditioned reflexes, and with selective disturbance of them. After bilateral removal of the occipital region (visual) the dog never again directs its movements by sight and fails to distinguish size and distance of objects. Full and bilateral destruction of this region in man and monkey causes total blindness; but the dog after removal of even greater portions of both occipital regions still discriminates light from dark, and good conditioned reflexes are acquired with light difference as a stimulus. Bilateral removal of the temporal lobes (acoustic) precludes acquired reflexes to sounds, but only for a time; conditioned reflexes to single sounds, and even with some discrimination of tone sequences, can later be established. Yet after loss of the temporal lobes dogs cease permanently to respond to their names. Bilateral destruction of the parietal and motor area regions is found to especially impair acquired reflexes trained on touch and proprioception, respectively, and especially those in the limbs. After bilateral removal of the frontal lobes, formerly acquired visual and auditory conditioned reflexes return, and new ones can be established soon after the operation. There ensues a persistent supersensitivity of the skin.

In sum, localized damage to cortical areas affects acquired reflexes selectively according to the species of receptor of their stimulus (psychologically, their sense modality) and to the topographical seat of the lesion in the field of the cortex. Pavlov concluded that the motor area of the cortex is merely the area of proprioceptive receptors. He denied to the cortex any special association area. "The cerebral cortex should be regarded as the essential organ for the maintenance and establishment of conditioned reflexes." It may be added, on the basis of older experiments, that total destruction of the pallium of only one hemisphere in the dog impairs its behaviour relatively little.

Instinctive behaviour was defined by Lloyd-Morgan as "that which is, on its first occurrence (in the individual) independent of prior experience; which tends to the well-being of the individual and the preservation of the race; which is similarly performed by all the members of the same more or less restricted group of animals, and which may be subject to subsequent modification under guidance of experience." It is an innate behaviour trend which a certain more or less complex group of stimuli of external and internal origin can call forth.

The experiments of Ceni showed that in the hen the train of behaviour corresponding with incubatory and maternal rearing of the young is not obviously disturbed by destruction of the whole pallium. In the bitch, on the contrary, not only does complete destruction of the pallium cause all maternal instinctive behaviour to disappear but also bilateral destruction, even when confined to the frontal region, does so. Inherited behaviour, as well as individual acquired behaviour, is therefore laid up in the cerebral cortex of the dog.

The observations on the dog may be compared with those on the rat by Lashley in regard to ability to learn and retention of learned behaviour, *e.g.*, for a maze or the entrance fastening to a food box, and the effect upon them of pallial destructions. With learning of a simple maze, acquisition occurs at normal rate after bilateral destruction of any one-third of the cortex, and similarly is retained. With a test in which two alleys to food are offered, one lighted, the other dark, the food being attainable always by the lighted and never by the dark one, bilateral destruction of the occipital third (visual) of the pallium abrogates totally the successful behaviour already learned but offers no impediment to acquiring it as quickly as in the original training. With a more complex test for entrance to a food box the learned solution of it and its reacquisition are disturbed, but not completely abolished, by bilateral destruction of either the frontal or occipital regions.

Turning from mammals lower than the dog to others higher, the older experiments on the monkey, while showing greater impairment of motor behaviour than in the dog, gave evidence of considerable powers of recuperation. In monkeys the destruction of the precentral gyrus, the motor area of both hemispheres, the animals having previously been trained in habits of manipulation, revealed, on subsidence of the temporary paralysis, perfect retention of these habits, as demonstrated by Lashley. Nor did even the paralysis recur on destruction of the corpus striatum subsequent to recovery from the diplegia. Even in the manlike apes the temporary arm paralysis caused by destruction of the cortical excitable area for the arm produces no permanent impairment of individually acquired motor habits executable by that arm. The peeling and other manipulations in eating a banana, the taking and holding of a cup of water to drink from and the learned handshake with a visitor are all recovered. Further, the recovery is not frustrated or undone by additional removal of the arm area of the opposite hemisphere or of the postcentral gyrus of the same side.

But these are relatively restricted lesions, and in the manlike apes, as in man, objective study solely by means of motor behaviour apart from speech of the effects of damage to this or that field of the neopallium (cerebral cortex) becomes less and less adequate to the complexity of the phenomena if all reference to psychical accompaniment is omitted. The fully developed pallium is mainly so to say a mental organ. To a spectator otherwise unacquainted with the play, *Hamlet* in dumb show would convey but meagrely that play's contents. The experiments of Thorndike and others showed that lower mammals give little evidence for their possession of images in the form of ideas; or in their learning of mazes, door fastenings, etc., of doing so even by imitation. There is, it is found, some power of imitation, though not so much as has been generally supposed, in monkeys, and a questionable existence of image ideas. A situation before which a cat is helpless will be grasped by a monkey. A chimpanzee will solve a situation by making use of some object present at hand as an implement; will recall the position of an object it has seen placed in hiding a day previously; will in some cases fetch an object, remembered though out of sight, to serve as an implement suitable for solving a newly arisen situation; and has been observed to pause in a waiting attitude, trying, as it were, to "see" how to attain indirectly an objective unattainable directly, somewhat as a man stops to think. It is inferred that the manlike apes form and retain memory images not essentially dissimilar from man's memory images.

It would seem that no gross lesion of the neopallium occurs without inflicting a certain degree of lasting disturbance upon mental reactions. It may be that that impairment will, by improved analysis of the conditions, be found to be essentially of the same kind for all regions of the pallium. Be that as it may, it is already certain that disturbances predominantly in this or that sphere of sense are related regularly to spatially separate areas of the human cortex and that impairment of the performance of willed movements by the muscles, especially of limbs and face, in the opposite side, results from damage of a particular pallial region, the precentral gyrus in man just as in the ape, and more severely. Speech *per se*, without any paralysis of the motor mechanisms of its production, is affected very commonly by injury of the cerebral cortex. The manner and degree of the disturbance of speech so produced differ greatly in differently placed structural lesions. The study of these lesions, although difficult, affords perhaps the best opportunity for analytic examination of the mental functions attaching to the neopallium in man. They form a theme too large and also too special to be entered upon adequately here.

4. The "Motor" Cortex.—Electrical stimulation, so useful a physiological agent in the case of nerve trunks and many of the nerve centres, fails in its application to most parts of the surface of the pallium, especially in the higher animal forms. From certain of the areas of the cortex, however, it does, and especially in the highest forms, evoke motor responses with regularity. The main such area occupies in ape and man the "precentral convolution" and is called the motor area. The movements evoked occur in the crossed half of the body. The particular muscular field yielding the motor response differs for different parts of this area, and for each such part is fairly constant. Thus flexion of the arm will be excitable from one set of points; the extension of the arm from another set; opening of the jaw from one set; movement of the tongue from another; and so on.

One characteristic of these movements is that they tend to spread. Thus when the point for the thumb is stimulated, the movement will begin in the thumb, then under continuance of the stimulus may spread to the fingers, then to the wrist, the elbow and shoulder, and even to the face and leg as well, so that the musculature of one entire side of the body may thus be simultaneously convulsed. This spread is called the march, because it resembles a feature, termed, by Hughlings Jackson, the march, in the epileptic seizure. Strong and prolonged stimulation of a motor cortical point is apt to be followed by a clonic (convulsive) spasm resembling that of the true epileptic seizure. The representation of certain fields of the musculature of the body is more liberal than that of others. Variety of movement rather than power of movement seems to determine the extent of the cortex. The cortical area for the thumb (gorilla and chimpanzee) is larger than those for the whole of the abdomen and chest combined. The cortical area for the tongue (anthropoids) is larger than that for the whole of the neck. Only in very few cases is the movement bilateral, *i.e.*, both right and left, from unilateral cortical stimulation. One of these rare instances is that of the vocal cords, which bilaterally adduct (phonation). Another is that of the eyelids, which blink for both eyes. A condition for obtaining the motor responses from this motor field of the pallium is that the narcosis under which the animal is necessarily placed at the time of experimenting must not be too deep. It is known from observations in man by surgeons (Harvey Cushing and others) that no pain or indeed other sensation attaches to electric stimulation of the motor cortex. All that is felt, even in the fully conscious person, is some perception of the movement which is evoked. If the narcosis goes beyond inducing sleep of a natural depth, no visible response to stimulation, however strong, is obtainable from the pallium, although spinal reflexes, *e.g.*, the knee jerk, are still readily elicitable by their appropriate stimuli.

It was at one time thought that the response on application of electrical currents to this cerebral surface was due to stimulation, not of the cortex itself, but of bundles of nerve fibres under the cortex. The distinction if existent would not be of much significance, because such fibres must issue from the cortex; that it is, however, some element in the cortex itself which is excited may be regarded as established. Probably the element in question is a large nerve cell, a number of which are scattered throughout this excitable field. Each such large cell sends a long threadlike fibre down far beyond the confines of the forebrain itself. These cells get severally into touch with the primary motor nerve cells in the various segments of the head and body. They form together a direct path, the pyramidal tract, from the motor cortex to the spinal cord, etc.

When this excitable field of the cortex was first investigated, it was thought by some that it might prove to be as the immediate starting place of willed movement. The immediate and severe paralysis of willed movement, which, in man and the monkey, results from destruction of this excitable field of the cortex, supported such a view. But there follows in short time a remarkable restitution of the willed movements, even in the manlike apes. And this is not due to vicarious functions on the part of the corresponding area of the opposite half of the pallium or of the underlying corpus striatum. The inference is that fields of the cortex other than the so-called motor ones, and routes other than the pyramidal tract, are capable of carrying out willed acts.

That the movements excited from the motor cortex are produced via the fibres of the pyramidal tract seems clear; they are precluded by severance of that tract below the cortex. But that they resemble truly closely willed acts of movement is unlikely on several grounds:

1. Severance of the afferent spinal roots supplying a limb, although it does not impair the motor supply of the muscles, etc., in the least, disturbs the willed movements of the limb very greatly indeed, rendering them so inaccurate and wild as to be worse than useless. The animal, *e.g.*, monkey, soon relinquishes use of the "deafferented" limb altogether. Electrical stimulation of the field of the motor cortex corresponding with the "deafferented" limb nevertheless evokes in it all the movements normally so elicitable, and with no detected departure from the normal. The willed movements are grossly disturbed; yet the motor responses of the motor cortex remain practically unaffected.

2. Degeneration experiments show that the spinal terminals of the fibres (pyramidal tract) from the motor cortex are actually scattered among the ultimate motor cells themselves. The motor cortex presumably, therefore, makes direct synaptic junction with the final motor cell that directly innervates the muscle. This simplicity of connection of the motor cortex with the muscle could hardly provide for the complexity of a willed movement. But it accords with the further fact that under stimulation of the motor cortex the rate of rhythm of response of the muscle follows the rhythmic stimulation of the cortex even up to 180 per second. Also the time interval between delivery of the electrical stimulus to the motor cortex and the response by the muscle is much less than the latent period for many spinal reflexes.

3. Recent observations indicate that the electrical and myographic behaviour of the muscles under motor cortex stimulation denotes conflict of excitatory with inhibitory influence, simultaneously exerted on the same muscle. The clonic afteraction so characteristic of motor cortex excitation seems traceable to alternating excitation and inhibition. All this renders it unlikely that the motor cortex and the pyramidal tract descending from it to play upon the motor nerve cells yield of themselves, at least when excited artificially, *i.e.*, electrically in experiment, movements truly resembling willed movements.

Two patients of Cushing offered opportunity while in a fully conscious state for elicitation of movements of the right hand by electrical stimulation of the motor cortex. As reported from their own introspection, the reaction was attended by no sensation other than a secondary awareness of changed position of hand and fingers. With the anthropoid ape an impressive observation repeatedly noted is the seeming entire ignorance on the part of the animal, on its awakening from a motor cortex ablation experiment, of any disability precluding its performance of its willed acts as usual. Surprise at the failure of the limb to execute what is intended seems indubitably the animal's mental attitude, and not merely for the first few minutes but for many hours. The animal is slow to realize the limb's inability. It is often many hours before repeated and various failures to execute ordinary acts for climbing, feeding, satisfying its curiosity, etc., gradually impress upon the animal that the usual services are no longer to be expected from the limb. Even after this lesson seems to have been learned, an emergency will call forth a new attempt and surprise at failure as though the former experience has been for the moment again forgotten. The impression conveyed is that the forerunning idea of the act intended is present and as definitely and promptly developed as usual. The surprise seems to argue unfulfilled expectation and defect in the motor execution rather than in the mental execution of the act.

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C. THE BRAIN STEM

In the developing body of man the embryonic central nervous system, coursing the length of the back, undergoes differentiation at its anterior end into the brain, in relation to which the head is formed, while the remainder becomes the spinal cord, associated with the trunk and its contained viscera and the extremities. The original part of this differentiating brain becomes the brain stem, and, as the term stem suggests, it bears two blossoms which, budding from its lateral and dorsal aspects, flower into the cerebral hemispheres and cerebellum. These so overgrow and cover their stalk that, when the adult brain is removed from the cranium, nothing of its initial component is seen until, viewed from the under side, a lumpy column about as large as a man's thumb from tip to wrist, and not greatly different in shape, can be distinguished as the brain stem.

The brain stem is thus interposed between and interconnected with the more differentiated parts of the brain on the one hand and the spinal cord on the other, and it bears certain similarities to each of these structures. By means of its entering and exiting nerves, the spinal cord is concerned very largely with gathering sensory impressions from and effecting motor behaviour in what were originally serially arranged segments of skin or muscles of the body. The skin of the head and the muscles of the eyeball and tongue are likewise supplied with nerves from the brain stem. In addition, sensory endings and muscles developed around the nasal, oral and pharyngeal cavities and their derivatives are also supplied by brain stem nerves. Lastly, the specialized sense organs, the ear, eye and olfactory receptors, which develop in the head, are innervated by nerves connecting with the brain stem. These nerves of the head are collectively designated as cranial.

Next, when, by a development called encephalization, the two great superstructures of the brain, the cerebral hemispheres and cerebellum, gained dominance over the performance of most of the remainder of the nervous system, it became necessary to provide these ascendant structures with knowledge of what was transpiring in the body below them and to develop channels over which their influences might reach lower outflows. As a consequence, ascending pathways from the cord continue upward through the brain stem and are joined there by others, conveying afferent messages from the head, to pass or be relayed to the cerebellum or cerebral hemispheres. Similarly, pathways from these latter structures descend into the brain stem, in part to terminate in relation to its motor outflows, in part to continue uninterruptedly through it toward motor outflows from the cord and in part to reach these cranial or spinal outflows indirectly after relay by collections of brain stem neurons. The brain stem therefore resembles the spinal cord, of which it is the rostral continuation, both in supplying nerves to the periphery and in accommodating ascending pathways to and exiting connections from the cerebral hemispheres and cerebellum.

The development called encephalization, which carried the cerebellum and, to a greater degree, the cerebral hemispheres to such heights of structural complexity and functional achievement, led the brain stem also to assume a dominating and integrating role over lower-lying outflows from the nervous system—in general, those innervating the viscera, or skeletal structures related to viscera—which preserve the internal environment of the body in a state of optimum activity; in addition, and less clearly perceived, this development also led the brain stem to assume the role of maintaining a state of optimum activity within the interior of the central nervous system itself, both in the spinal cord below it and in the cerebral hemispheres above.

The account below concerns itself with each of these aspects of the brain stem and will consider: (1) the commoner reflexes mediated by the cranial nerves; (2) features of sensory conduction to and motor outflow from the cerebral hemispheres and cerebellum, of particular relation to the brain stem; (3) the role of the brain stem in regulating the internal environment of the body; and (4) a most important function of the brain stem (and the least understood), its capacity for maintaining the activity of the remainder of the central nervous system at an optimum level.

1. Brain Stem Reflexes.—A reflex is a relatively invariable and stereotyped response to a specific stimulus, the subservient neural connections of which appear to have become built into the nervous system for the beneficial result which their activity contributes to the organism's well-being. Those reflexes mediated by the brain stem and its cranial nerves are concerned with adjusting the related musculature for optimum performance of the body's distance receptors, the eye and the ear, with orienting parts of the body in spatial relation to the head and with managing the complicated acts involved in ingesting food. They may be considered in that order.

Eye and Ear.—Of the reflexes related to the eye, conjugate deviation of the eyeballs, often combined with turning of the head, better to perceive some interesting aspect in the field of vision, is in progress almost constantly during our waking moments. Alterations for near vision are also frequent and involve contraction both of muscles converging the eyeballs and of intraocular muscles which render the central part of the lens more convex; the latter maneuver, called accommodation, serves to focus light rays on the retina. Associated with it is a constriction of the pupil cutting off light from the periphery of the lens, whose shape is not changed so greatly. The light reflex is a constriction of the pupillary aperture also evoked, as the term implies, by visual stimulation. It is obviously purposeful in reducing excessive illumination of the retina, just as is stopping down the aperture of a camera in photographing a brilliantly lighted scene. An Argyll-Robertson pupil (extremely contracted and fixed to light but constricting in accommodation to various distances) is a frequently encountered sign in neural syphilis, for the brain stem path of the light reflex is unusually susceptible to injury by the spirochete of this disease.

More intense light evokes a reflex blinking of the lids, but the corneal reflex, a blink caused by stimulation of the cornea by touch or by drying, is more important both for protection and because loss of lachrymal secretion by frequent wiping of this structure leads to its injury, the cornea being the last portion of the body surface of terrestrial animals still to require a watery environment.

Two reflexes related to the ear are evoked by auditory stimulation. One directs the pinnal concavity or, in man, the entire head toward the source of a sound and appears designed to capture the maximal intensity of sound stimuli. The other, the auditory reflex, involves the two smallest muscles of the body, buried in the middle ear, the tensor tympani and stapedius, whose contraction reduces undue movement of the ossicular chain to loud sounds. In its damping action to loud sound, the auditory reflex is analogous to the pupillo-constrictor reflex of the eye to bright light.

Also located in the ear is the vestibular organ (of whose existence many are unaware because its afferent impulses are consciously perceived only when excessive, and then but vaguely, as vertigo), which initiates reflexes involving: (1) the muscles which orient the eyeballs in effective positions for vision when the head is moved; and (2) muscles of the trunk and extremities which hold the body in a definite spatial relationship to the force of gravity, which we call being right side up in the world. The most easily examined of these vestibular reflexes is nystagmus, a repetitive deviation of the eyeballs designed to keep them abreast of the rotating head. It may be evoked by spinning in a chair or by irrigating the external ear with hot or cold water, thus creating convection currents in the fluid-filled canals of the vestibular organ, simulating those induced by rotation. Prolonged repetitive stimulation of the balancing part of the vestibular organ, as by the pitching of a ship at sea, evokes a battery of visceral alterations not normally induced by vestibular nerve impulses, accompanied by sensations of nausea and distress—an incapacitating syndrome described as motion sickness.

Food Ingestion.—Reflexes associated with the nasal and oral cavities are broadly concerned with conveying solid and liquid food into the gastrointestinal tract and with expelling these or other foreign objects from the closely adjacent air passages, into which they sometimes inadvertently become directed. The first of these objectives is accomplished by the swallowing reflex, in which stimulation of the back of the mouth cavity evokes sequential contractions of the muscles of the lips, jaw, tongue, pharynx and part of the neck, propelling food or liquid into the esophagus. Ingested material is prevented from regurgitating into the nose, during swallowing, by a tensing of the soft palate and from entering the larynx, by a drawing up of this latter structure beneath the back of the tongue, so that the swallowed material cascades past it. Impairment or absence of swallowing from injury to its reflex arc, called dysphagia, is a frequent symptom of poliomyelitic involvement of the brain stem, its danger lying in the tendency to aspirate both ingested fluids and salivary and mucosal secretions, with the consequent development of pulmonary edema or pneumonia.

Reflexes expelling material from the nasopharynx are of two sorts—those in which the local musculature tries to accomplish this act unaided, as in gagging or choking, and those in which the respiratory musculature is also invoked to contribute a blast of expired air to the process, as in sneezing or coughing. Swelling of the mucosa in allergies or infections of the nasopharynx causes persistent stimulation of its receptor endings, which makes recurrent sneezing or coughing—actually perfectly normal reflexes—associated in many persons' minds with processes of disease.

Related to these last reflexes are vomiting and hiccoughing, the latter appearing to be a repeated but halfhearted and ineffective effort to vomit; both reflexes involve cramplike contractions of the abdominal and thoracic respiratory musculature—in particular, the diaphragm—designed to empty the stomach by regurgitation. Because hiccoughing is personally annoying and publicly ludicrous, the attempt is usually made to stop it by various maneuvers, many with a sound physiological basis, designed to augment the activity of the brain stem respiratory centre, with the hope that it will regain normal control of the diaphragm. In cases of prolonged and intractable hiccoughing, surgical crushing of the phrenic nerve, innervating the diaphragm, has sometimes been necessary to relieve an exhausted patient.

All these various stereotyped acts are managed by neural connections within the brain stem which underlie some of the reflex functions of this part of the nervous system—the management of the distance receptors located in the head, the most important being the eye, the maintenance of equilibrium, the ingestion of nutriment and the protection of the respiratory and alimentary passages from harmful agents.

2. Sensory Conduction Through the Brain Stem.—This account is limited to brief mention of three general aspects of sensation of particular relation to the brain stem.

First, afferent nerve impulses gathered from all parts of the body and conducted to the cerebral hemispheres are somehow transmuted there into consciously perceived sensations, in which the intermittent features of nerve conduction fuse into the familiar picture of the world we see, hear and feel about us. Though the nature of this transmutation is not understood, it is clear that the delivery of afferent impulses to the hemispheres is prerequisite to it; for, if a receiving area of the hemisphere is destroyed, or if the afferent pathway to it is interrupted at some lower level, the modality of sensation it subserves becomes lost to consciousness. Because paths conducting afferent messages toward the hemispheres are topographically distinct from one another, sensations can be lost singly. It has proved possible in patients with intractable pain, who can no longer be relieved with drugs, for the surgeon, by an appropriately placed incision either in the spinal cord or in the brain stem, to interrupt that pathway mediating impulses from pain receptors and thus eliminate pain sensations from consciousness, while preserving other afferent pathways and leaving unaffected the sensations which they mediate.

Next, if the central course of any single sensory pathway is examined, it will be found that its component nerve fibres, mediating impulses from different portions of the receptor field, whether for vision, hearing, pain or touch, possess a definite spatial relationship to one another. This relationship is preserved in the relay of these impulses from the anterior end of the brain stem to the various sensory areas of the cerebral hemispheres. This orderly arrangement of conducting elements, an obtrusive structural feature of afferent pathways at each level of the central nervous system, may be without functional significance. It seems likely, however, that it underlies the orientation which objects are seen to bear to one another in the field of vision, or the orderly relation which sounds of different pitch hold to one another in audition or the sense of localization which normally is attached to painful or tactile impressions.

Lastly, another general feature of afferent conduction through the brain stem is the feeling quality which sensations often possess. Except in poetic persons, many sensations are perceived with no reaction but indifference, but the most phlegmatic can recall some dramatic instance when perception was accompanied by a warm suffusion of pleasure or by a shuddering chill of unpleasantness. Because lesions in or near the anterior end of the brain stem are sometimes followed by states collectively called the thalamic syndrome, in which the most prosaic sensations are accompanied by intense and unmerited feelings of pleasure or unpleasantness, it has been suggested that this region is particularly concerned with endowing sensation with these qualities.

Afferent conduction through the brain stem has thus been considered from the points of view of the conscious perception of sensation, the orientation of perceived objects in sensory fields and the feeling which may be attached to sensation. The importance of side branches or collaterals, which turn from the long sensory paths as they ascend through the brain stem into the central reticular formation of this structure, is considered below.

3. Motor Conduction Through the Brain Stem.—The activity of skeletal musculature, whose contraction holds body parts in position or moves them about, is integrated at both upper and lower levels of the nervous system, and the stereotyped contraction of some of the head muscles in cranial reflexes has already been considered. The finer, more labile and adaptive contractions of skeletal muscle, particularly in voluntary movement, are managed by a motor area in the cerebral hemispheres from which the pyramidal tract descends on each side through the brain stem to pass, with crossing, directly to the levels of motor outflow whose discharge it initiates.

A part of this pyramidal projection, concerned with voluntary contraction of the head musculature, terminates in relation to the brain stem cells of origin of the cranial motor nerves and is designated as the corticobulbar system. Though corticobulbar connections subserve a number of functions, the most important of which is speech, relatively little is known of their neural organization. After corticobulbar fibres are given off, the remainder of the pyramidal projection descends into the cord for voluntary contraction of the muscles of the body, in particular those manipulating the distal portions of the extremities. Injury to the motor area of the hemispheres or to its descending pyramidal tract, as frequently occurs at the junction of the brain stem and hemispheres in a stroke or apoplectic attack, is followed by a paralysis of voluntary movement.

Not all of the cerebral influence upon movement is exerted directly, viz., over the pyramidal tract, however. A significant part reaches lower outflows over a series of shorter paths, some of the constituent relays of which are provided by collections of brain stem neurons. Because this group of motor connections lies outside the pyramidal projection, it is termed the extrapyramidal system. This latter system is able to initiate contraction of a postural nature, involving chiefly muscles of the trunk or proximal parts of the extremities. It serves also in managing grosser types of movements, such as those of progression. One of the major functions of the extrapyramidal system is, however, that of modifying activity initiated from other neural sources and already in progress. Because different components of this system respectively augment or reduce motion, their injury is followed either by depression or exaggeration of motor activity. Other symptoms that may follow injury to the extrapyramidal system are those of involuntary movement, as tremor, the basis of which is also little understood.

Important modulating influences on motion are also exerted by the cerebellum and are mediated by connections passing either upward, via the brain stem, to the cerebral hemispheres or downward, over brain stem relays which are apparently identical with those of the extrapyramidal system, to lower motor outflows. The brain stem thus plays an important part in motor conduction both from the cerebral hemispheres and from the cerebellum. Its role in this regard is discussed in more detail below.

4. Regulation of the Internal Environment.—In serving local reflexes and providing relays for pathways to and from other levels, the brain stem is analogous to the spinal cord. In exerting a dominating and regulating influence over collections of lower outflows concerned with certain general functions of the body, it resembles the cerebral hemispheres. The hemispheres are broadly involved with preserving optimum relations of the body with the external world, and, to a degree, the brain stem is comparably concerned with managing a number of the processes which maintain the internal environment of the body in an optimum condition. Parts of the brain stem so concerned are its anterior and posterior extremities, the first of which may now be considered.

Anterior Portion.—The anterior portion of the brain stem, overlying the pituitary or master gland of the endocrine system, sends connections to this gland which control the liberation of pituitary hormones and so exert widespread influences throughout the body. A second group of efferent connections from the anterior brain stem descends, with relays, to the spinal cord to terminate in relation both to outflows for skeletal muscle and, in larger part, to outflows of the autonomic nervous system, innervating smooth muscle and exocrine glands throughout the body. By exciting parts of the autonomic system in varying combinations, or throwing the whole system into activity at once, this second outflow from the anterior part of the brain stem may likewise alter body states profoundly.

Variations in the osmotic tension of blood circulating through the rostral brain stem cause its neurons to discharge, innervating the neurohypophysis and stimulating secretion of that gland's hormones. One of these, antidiuretic in action, passes in the blood stream to the kidney, where it facilitates the reabsorption of water from the kidney tubules. About 170 l. of water filter from man's blood every 24 hours and start down the kidney tubules toward the bladder. With the aid of a normal complement of an antidiuretic hormone from the neurohypophysis, about 169 l. of this water are, fortunately, reabsorbed into the blood stream before leaving the kidney, and only the remaining litre, conveying waste materials in solution, continues to the bladder and is thence voided as urine.

If the anterior end of the brain stem is injured, or if its path to the pituitary is interrupted, the neurohypophysis becomes paralyzed and atrophic, so that the secretion of its antidiuretic hormone fails. Reabsorption of body water from the kidney is then incomplete, and in record cases as many as 40 l. may be lost daily and passed as urine, so that were not a compensating quantity of water drunk, the body would rapidly become dehydrated. This disturbing syndrome is called diabetes insipidus, for its excess urine is not sweet as it is in the commoner diabetes mellitus. Administration of an extracted antidiuretic hormone, called pituitrin, constitutes as specific a therapy for diabetes insipidus as does that of insulin for diabetes mellitus.

Although the secretion of the anterior lobe of the pituitary appears to be somewhat more autonomous, appropriate injury to the anterior brain stem causes deficiency in production of gonadotropic hormones, with consequent atrophy of the sex glands, regression of secondary sexual characteristics and loss of potency. Brain stem injuries causing deficiencies in the sexual sphere are often associated with the development of pronounced obesity, the etiology of which is unsettled. The combined disorder is referred to clinically as adiposogenital dystrophy, or Fröhlich's syndrome, after the person who first recognized its pathological basis and so inaugurated a long series of studies of this part of the nervous system. A contrasting disturbance, the precocious onset of puberty, which may result from involvement of the anterior brain stem, depends either upon overactivity of the mechanism just considered or upon malfunction of the pineal gland, connected with the dorsal, rather than the ventral, aspect of this level of the neuraxis.

Research has indicated that the anterior brain stem is involved in the increased secretion of the adrenocorticotropic hormone (ACTH) from the anterior lobe of the pituitary in response to stress stimulation. Regulation of the adrenal cortex thus appears to be under the control of the brain. Stress stimuli have been found to cause increased discharge of the anterior brain stem, and direct stimulation of this structure has been shown to increase ACTH secretion. Conversely, after injury to the anterior brain stem, stress is no longer capable of leading to increased pituitary-adrenal activity. Because of the scarcity of the neural innervation of the anterior lobe, it was suggested that a humoral substance is elaborated in the anterior brain stem and conducted to the gland by way of vascular channels surrounding the infundibular stalk.

By way of its connections with autonomic outflows, the anterior brain stem is similarly able to regulate or widely alter conditions in the interior of the body. Excitation of this neural part evokes a mass discharge of the sympathetic portion of the autonomic system, with rise in blood pressure, increase in heart rate, cessation of gastrointestinal peristalsis, erection of hair, sweating, etc. A discerning person will recognize that these alterations constitute some of the objective changes of emotional excitement, known to be executed by this and other parts of the brain stem with the purpose of mobilizing the body's energies for dealing with an existing or anticipated emergency.

Many of the changes just mentioned are also those which are employed in preserving a relatively stable internal body temperature in the face of wide variations in environmental conditions. Heat, produced in the body, as in a stove, by oxidative reactions, is conserved by peripheral vasoconstriction and erection of the hair (particularly in fur-bearing animals), reducing the body's irradiation; when necessary, heat conservation is also augmented by shivering. It is dispelled by increased irradiation, consequent to peripheral vasodilation, and by the evaporation of an augmented sweat secretion. These opposing processes (heat retention and heat release) are regulated by two antagonistic thermal mechanisms in the anterior part of the brain stem, influenced by alterations in the temperature of the blood circulating through the brain stem.

These neural systems by which the brain stem preserves a constant body temperature normally exhibit the precision and efficiency of the operation of a thermostat, but, like their mechanical counterpart, they may sometimes undergo derangement. Circulating toxins or breakdown products, incident to infection, paralyze that neural mechanism dispelling body heat and periodically excite the other, initiating heat production and conservation. The patient then shivers and exhibits peripheral vasoconstriction, and although he subjectively experiences a chill, his internal temperature rises to fever height. Elevated body temperature together with increase in the count of white blood cells, enemies of foreign agents in the body, thus constitute the two most reliable diagnostic signs of infection.

The role of the rostral brain stem in the regulation of internal body processes is, then, attested by its control of the endocrine factors involved in water metabolism, reproductive function and adrenocortical activity, and by its management, exerted over neural channels, particularly those of the autonomic system, of the activities concerned in emotional excitement and in the preservation of a constant body temperature.

Posterior Portion.—Somewhat similarly, the caudal (tailward) part of the brain stem is concerned with managing internal processes, even more vital in nature, which clear the blood of carbon dioxide, provide it with a fresh supply of oxygen and circulate it throughout the body. These respiratory and cardiovascular mechanisms of the caudal brain stem may next be considered.

The thoracic and abdominal musculature whose contraction expands the chest cavity, permitting air to flow into the lungs to carry oxygen to and carbon dioxide from the blood flowing through the exposed pulmonary capillaries, is initiated by lower brain stem neurons, the efferent fibres of which descend to the spinal outflows of the inspiratory muscles. These brain stem neurons are constantly being excited by a multiplicity of factors, associated with oxygen deficiency in their circulation. The rhythmicity of respiration is affected by the periodic prevention of inspiration, both by inhibitory afferent impulses initiated by lung stretch during inspiration and conveyed to the lower brain stem by cranial afferent nerves, and by central inspiratory-inhibitory or expiratory connections. In respiration more forceful than that of ordinary quiet breathing, the active contraction of expiratory muscles is added to the relaxation of inspiratory ones in expelling air.

Though the motor nerve supply to the respiratory muscles proceeds entirely from the cord, spinal neural levels are, by themselves, incapable of maintaining respiration. Participation of the brain stem mechanisms mentioned is essential for this activity. In the execution of criminals by hanging, the brain stem in effect is severed from the cord, and death is thus caused by asphyxia. In cases of poliomyelitic injury to the neurons either in the cord or brain stem, with consequent respiratory paralysis, life may sometimes be preserved by artificial respiration in an iron lung.

The lower brain stem also contains regulating collections of neurons whose efferent fibres influence autonomic outflows, from both the brain stem and cord, concerned with the rate of beat of the heart, and those autonomic outflows from the cord which innervate smooth muscle in the walls of arterial blood vessels, the contraction of which constricts their lumina and so maintains an optimum pressure in the circulatory system, enabling blood, pumped from the heart, to be conveyed to all parts of the body.

Two receptor organs, informing the lower brain stem of both the pressure and the chemical composition of circulating blood, by way of cranial afferent nerves, play an important part in the regulation of cardiovascular activity by this brain stem mechanism. The first of these is strategically located in the arch of the aorta, where it can test the blood just leaving the heart and starting on its way to all parts of the body. Because the body is apparently so particularly concerned in maintaining an optimum circulation through the cerebral hemispheres of the brain, another, similar receptor is found in the wall of the internal carotid arteries, supplying blood to these structures. Injury to the brain stem cardiovascular mechanism, or interruption of its connections to autonomic outflows, is followed by vasomotor collapse and fall of blood pressure. Resultant circulatory disturbances, if unrelieved, are fatal.

5. Regulation of the Central Nervous System.—Somewhat analogous to the role of the brain stem in managing the functions of other organs within the body is its role in maintaining an optimum state of activity within the interior of the central nervous system. Injury to the rostral brain stem is followed by deterioration of function of the cerebral hemispheres, and injury to more caudal parts results in impairment of activity within the spinal cord.

It is perfectly clear that the conscious perception of sensation, the voluntary control of motion, and other features which characterize the activity of the cerebral hemispheres in what is called the waking state are somehow dependent in an essential manner upon the functional integrity of the anterior brain stem. Injury to this region in man is followed by states varying in intensity from degrees of somnolence to coma. In the most severe states, though the patient's respiration and circulation are preserved and he may be nourished and kept free of infection for years, he has no more rapport with the external world than is exhibited by a vegetable. Developments in electroencephalography have revealed pronounced differences in the spontaneous electrical activity of the cerebral cortex in wakefulness and sleep. In the latter state the electrical record is composed largely of high, slow waves and is described as being synchronized. During wakefulness, in contrast, the electroencephalogram (EEG) is made up of low-voltage, fast activity. Direct stimulation of the central core of the brain stem will reproduce the normal waking record. Injury to the cephalic part of the brain stem in experimental animals is followed by chronic somnolence and a synchronized EEG. After such injury, afferent stimulation is no longer capable of arousing the subject to wakefulness. Many side connections or collateral branches from ascending sensory paths have been shown to turn into the central core of the brain stem and to exert their arousing influences indirectly by modifying its activity. Structurally, the portion of the brain stem involved is a reticular formation, and research has identified the existence of an ascending reticular activating system concerned with regulation of the background activity of the cerebral cortex.

Though the lower brain stem's influence upon the spinal cord is not so specific and is abetted by both the cerebral hemispheres and the cerebellum, it is important in preserving the normal function of this part of the nervous system. Transection of the cord from the brain, even at thoracic levels, leaving respiratory and vasomotor activity unimpaired, is followed, in the isolated cord segments, by a specifically neural depression called spinal shock. In this condition, spinal reflexes for a period can no longer be evoked by afferent stimulation and, even when recovered, may exhibit abnormality. Though other factors may be concerned, spinal shock depends in part upon loss of excitatory influences descending to the cord over pyramidal and extrapyramidal connections, to the latter of which the brain stem makes contributions.

In addition to exerting ascending influences upon the cerebral cortex, the central reticular formation of the brain stem has been shown to give rise to descending connections to motor outflows from the spinal cord. The more cephalic of these augment or facilitate spinal motor discharge, while the more caudal region exerts an inhibitory or reducing action. An imbalance in these extrapyramidal motor connections is thought to be responsible for spasticity, in which condition inhibitory influences are no longer active, while facilitatory ones are preserved and exert an augmented effect since they are no longer opposed. The involuntary movements of other types of extrapyramidal disease may also have their basis in malfunction of these descending connections from the brain stem.

In addition to serving cranial reflexes, participating in sensory and motor conduction and managing a number of internal body processes, the brain stem is concerned also with maintaining an optimum state of activity within the remainder of the central nervous system. (H. W. M.)

D. Nutrition of the Brain

A basic principle was stated by Joseph Barcroft as follows: "There is no instance in which it can be proved that an organ increases its activity, under physiological conditions, without also increasing its demand for oxygen." (Joseph Barcroft, *The Respiratory Function of the Blood,* The Macmillan Company, 1914.) Although this principle was formulated long before Barcroft's time, he was the first to demonstrate its general validity by direct measurements of the amounts of oxygen consumed by different organs (leg, muscle, heart, kidney, salivary gland, pancreas, liver) under different conditions of activity. Subsequent work abundantly confirmed his findings. Its validity as far as the brain is concerned, strongly suggested by evidence accumulated between World Wars I and II, was finally proved in 1944–45. Representative values for various organs are shown in Table I.

The oxygen requirement of the brain even at rest is high. Man's brain comprises only about 2% of his body weight, yet it uses

Table I.—*Oxygen Consumption*
(c.c. per 100 g. of tissue per minute)

Organ	At rest	Stimulated	Stimulus
Leg muscle (cat)	0.3	8.0	Nerve (electric)
Kidney (dog)	0.9	11.0	Caffeine (diuresis)
Salivary gland (cat)	3.0	10.0	Nerve (electric)
Pancreas (dog)	3.0	10.0	Secretin
Brain (monkey)	3.7	6.5	Picrotoxin (convulsion)
Brain (man)	3.3	?	—
Heart (dog)	8.0	16.0	Epinephrine

approximately 25% of all the oxygen taken up by his body under conditions of complete mental and physical rest. The purpose underlying the oxygen consumption by the brain undoubtedly is the same as in any other living system, viz., to provide energy to be used in doing work (*see* DIET AND DIETETICS). Yet, as Otto Warburg, a pioneer in studies of brain metabolism, pointed out in 1912, nerve cells do no work that is measurable in mechanical or chemical units, since they do not contract, move, divide or grow, nor do they secrete substances. Nevertheless, the brain obviously needs oxygen, as indicated by: (1) its extraordinarily high oxygen consumption; (2) its vulnerability to deprivation of oxygen; (3) the fact that functional activity of the brain runs parallel to its oxygen consumption, exhibiting cerebral depression from anesthesia, diabetic coma, insulin shock, brain tumours, etc.

The foodstuffs and oxygen necessary to meet the requirements of the brain can reach it only by way of the blood. There are no important exceptions to the rule that an increase in the functional activity of any organ entails a simultaneous increase in the amount of blood which it receives. It is noteworthy, however, that the way in which this compensation is brought about differs markedly from organ to organ. In the case of the skeletal muscles, increased activity is associated with both an increase in the amount of blood expelled by the heart and a widening of the blood vessels supplying the exercising muscles, brought about largely by reflexes acting through regulating centres in the brain stem. In the case of the salivary glands, increased secretion of saliva is elicited by nerve impulses carried by special nerves, and these impulses also cause dilation of the blood vessels supplying the gland. In the brain, however, although nerves are known to be able to mediate either constriction or dilation of blood vessels, these effects are much weaker than those seen in other tissues, and there is general agreement that nerve control plays no important part in the normal regulation of the cerebral circulation. The most plausible idea is that the blood vessels of the brain possess the unusual property of tending to constrict if left to themselves and that this tendency is constantly opposed by the dilating action of the products of cell metabolism either arising in the brain itself or carried to it in the blood from other tissues. Any increase or decrease in the oxygen consumption of the brain would then be associated with a corresponding change in the calibre of its blood vessels (therefore in the volume of blood flowing through them) because the amount of vessel-dilating material had changed. Increase or decrease in the concentration of such material in the blood reaching the brain would have similar effects on cerebral blood flow.

The evidence in favour of this conception is of two main types: (1) All the characteristic products of nerve metabolism tested (increased carbon dioxide, decreased oxygen, acids, potassium salts, acetylcholine, phosphates, heat) have been found to dilate cerebral blood vessels. (2) Increase in the carbon dioxide or decrease in the oxygen content of the blood reaching the brain (by inhalation of appropriate gas mixtures) causes dilation of cerebral blood vessels and increase in cerebral blood flow, while decrease in carbon dioxide (by overbreathing) or increase in oxygen has the opposite effect. Table II shows representative effects of this type in normal young men at physical and mental rest.

The figures listed in the first column are probably fairly accurate approximations of the amounts of blood that flow through the brain of a normal young adult male at physical and mental rest and under normal environmental conditions. They represent about 20% of the total output of the heart. This confirms the conclusion—already derived from the fact that the brain, comprising only 2% of the body weight, accounts for approximately 25% of all the body's oxygen consumption even at rest—that the cerebral circulation occupies a very special place in human physiology. The changes in cerebral blood flow indicated in the table were brought about without any significant changes in blood pressure or cardiac output, and it is probable that the ordinary adjustments of the cerebral circulation to the changing requirements of the brain do not necessitate corresponding changes in the general circulation. When the latter is depressed by such influences as hemorrhage, shock or drugs, cerebral blood flow will follow this change apparently quite passively. When the general circulation is stimulated (as by blood transfusions or drugs), cerebral blood flow will be increased. No drugs have been shown to be able to produce a change in cerebral blood flow opposite to a change in general blood pressure, and in this respect the cerebral circulation is unique. Even the coronary vessels in the heart, which resemble the cerebrals in being obedient to changes in general blood pressure and in lacking important control by vasoconstrictor or vasodilator nerves, can be strongly constricted by extract of the posterior lobe of the pituitary gland, but this has no direct effect on the cerebral circulation. Spasm of cerebral vessels has long been suspected to be the cause of certain conditions, such as convulsions, temporary depression or loss of consciousness, memory or speech, transitory disturbances of vision, etc., but the cause of the spasm, or indeed the fact of its occurrence, has not been clearly shown. The only agency shown to be capable of causing an important degree of constriction of cerebral vessels is hyperventilation, which can produce mental confusion or even complete unconsciousness in normal persons and can elicit a typical convulsion in persons with latent epilepsy. Diminution in cerebral blood flow produced by constriction of cerebral vessels is probably a partial cause of these conditions.

TABLE II.—*Cerebral Blood Flow*
(c.c. per minute)

Cause of change	Before	During	Per cent change
Voluntary hyperventilation .	980	658	—32
Passive hyperventilation . .	924	564	—36
Increased carbon dioxide . .	966	1694	+75
Decreased oxygen . . .	980	1330	+36
Increased oxygen. . . .	938	826	—12

The commonest and most important derangements of the cerebral circulation are produced by either a decrease in the arterial blood pressure or an impediment to flow in the cerebral vessels themselves. The former can be caused by an appropriate decrease in any of the three main factors concerned in the regulation of blood pressure; namely, efficiency of the heart, resistance of the blood vessels and volume or viscosity of the circulating blood. The latter may be caused by obstruction (embolism) of cerebral arteries by a clot carried by the blood from another part of the body (usually the heart), by formation of a clot in a cerebral artery or vein (thrombosis) or by actual rupture, with hemorrhage into the brain substance. In all such cases the part of the brain supplied by the involved vessel or vessels loses its functions, and from the consequent symptoms it is usually possible to locate the lesion with considerable precision. The loss of function is a result of the fact that the distribution of the arteries in the brain does not overlap significantly. Therefore there is no alternative source of supply of blood when one terminal artery is occluded, and the tissue supplied not only loses its function but also undergoes disintegration.

Another source of interference with the cerebral circulation lies in the peculiar location of the brain inside a rigid container, the skull. Since the contents of the container are incompressible and the container is practically indistensible, it follows that an increase in the volume of any of the cranial contents will lead to an increase in pressure involving all of them and will be reflected in an increase in pressure of the cerebrospinal fluid. This pressure operates on the blood vessels, as well as on other cranial contents, and when it rises to a level higher than the pressure inside the vessels, the latter collapse and flow of blood through them ceases. A change of this type in the vessels supplying the vasomotor centre in the brain stem causes increased activity there and thus brings about a rise in blood pressure. When the rise is sufficient to overcome the abnormal pressure on the outside of the vessels, flow of blood through them is restored. Thus the arterial blood pressure characteristically rises in cases of high intracranial pressure whether the latter depends on an intracranial hemorrhage or a tumour, on interference with drainage of the cerebrospinal fluid, on swelling of the brain itself (as in uremia or eclampsia) or on inflammatory disease (encephalitis, meningitis). If this rise in blood pressure did not occur, all functions of the brain would cease as soon as the cerebrospinal pressure exceeded the normal pressure in the cerebral veins and capillaries, and death would occur from failure of respiration and circulation at a much earlier stage of these diseases.

Among the unusual features of the cerebral circulation, the anatomical arrangements deserve emphasis. Instead of depending on a single artery to supply most of the blood and a single vein to bring it back to the heart, the brain gets its blood from four major arteries and is drained by three separate sets of veins. Any two of the arteries and any one of the veins could meet the needs of the brain if time were given for adjustment, and even one artery is enough to supply the vital centres of the brain stem and thus prevent failure of circulation and respiration. The arteries (the two internal carotids and the two vertebrals) join at the base of the brain to form a circle (the circle of Willis) from which arterial branches are given off to course either through the brain substance or over its surface in the pia mater. The carotid arteries run in the neck and can be occluded by deep pressure, but the vertebrals arise in the chest and soon enter the vertebral column, where they are protected from pressure or injury short of disruption of the spine itself. The cerebral veins follow the arteries but meet not in a circle but in a number of wide thin-walled sinuses, from which blood leaves by way of the two large internal jugular veins, a variable network of veins at the base of the skull, and large sinuses inside the vertebral canal. Even if the entire venous return from the upper part of the body is obstructed (as by thrombosis of the superior vena cava), there is no serious impediment to the drainage of the cerebral circulation.

No definite statement has been made about the exact relation between deficient blood supply and functional activity of brain cells. Both stimulation and depression have been described—stimulation in the case of the vasomotor centre responding to high intracranial tension, or an epileptic seizure precipitated by hyperventilation; depression in the case of mental confusion or unconsciousness from severe hyperventilation, or failure of all brain functions as the final effect of cerebral anemia. The last-named is the inevitable result if the diminution in blood supply is sufficiently severe and lasts a sufficient time, and there is no doubt whatever on this score. The possibility of stimulant effects preceding the depression depends on the part of the brain under consideration. The cortical cells concerned with consciousness, judgment, memory, etc., apparently are depressed only while the vasomotor centre is characteristically stimulated strongly. There probably are many variations between these extremes, but the information available at mid-20th century did not warrant definite statements.

See Meninges and Cerebrospinal Fluid; Nerve; Nerve Conduction; Nervous System; Nervous System, Diseases of; Neurology, Comparative; Spinal Cord; *see* also references under "Brain" in the Index.

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BRAIN, SURGERY OF: *see* Nervous System, Surgery of.

BRAINERD, DAVID (1718–1747), American Protestant missionary to the Indians in Connecticut, New York, Pennsylvania and New Jersey, was born April 20, 1718, at Haddam, Conn. His great-grandfather, a Puritan minister, had emigrated from England. Orphaned at 14, Brainerd studied under tutors and entered Yale college, New Haven, in Sept. 1739. He was expelled, for minor offenses, in his junior year. Brainerd was ordained as a Presbyterian minister on June 12, 1744, at Newark, N.J. As a missionary, he was employed by the Honourable Society in Scotland for Propagating Christian Knowledge. He preached through an interpreter, Moses Tinda Tautamy, working among the Delawares, the Six Nations, the Senakes (probably Senecas) and Tutelas. He rode horseback along the Susquehanna and Delaware rivers, camping at night, his only home a cabin at the forks of the Delaware. He kept a journal for the Scottish society, and a diary. Brainerd spent much time at Crossweeksung (now Crosswicks), N.J.; and visited New Haven and Hartford, Conn.; New York; Elizabeth and Princeton, N.J.; and Juniata and Philadelphia, Pa. He contracted tuberculosis and was nursed for 19 weeks at the home of Jonathan Edwards at Northampton, Mass., by Edwards' daughter, Jerusha, to whom he was engaged to be married. He died Oct. 9, 1747. Brainerd is known both for his missionary work and his diary and journals.

See Jonathan Edwards, *The Life and Diary of David Brainerd*, ed. by Philip E. Howard, Jr. (1955). (P. E. H.)

BRAIN-FEVER BIRD (*Cuculus varius*), an Asian hawk cuckoo superficially resembling the old world sparrow hawk (*Accipiter nisus*). It takes its name from the suggested effect of its repetitious cry. Like the European cuckoo (*q.v.*), it lays its eggs in the nests of other birds, the usual hosts being babblers (*q.v.*). (G. F. Ss.)

BRAINTREE AND BOCKING, an urban district (since 1934) of Essex, Eng., is 15 mi. W. of Colchester and 41 mi. N.E. of London by road. Pop. (1961) 20,600. Area 10.6 sq.mi. The town lies between the Brain and the Pant (or Blackwater) rivers, on the Roman highway, Stane street. Braintree is the market town for a large agricultural area, and Bocking has many 16th- to 18th-century houses. Both have 13th-century churches. The manufacture of crepe and silk, introduced by Huguenot refugees in the 17th century, gradually superseded the older wool cloth industry. Steel windows, tools, plastics and rayon are also manufactured.

BRAINWASHING, a colloquial term variously used to describe the systematic efforts of Communists to persuade nonbelievers to accept Communist allegiance, commands and/or doctrine; more generally applied to any technique designed to manipulate human thought or action against the desire, will or knowledge of the individual (*see* Psychology, Social). Brainwashing (*Hsi Nao*) is most appropriately used in reference to Chinese Communist thought reform or ideological remolding (*Szu Hsing Kai Tsao*), a program of political indoctrination based on the conception that persons who have not been educated in a Communist society have incorrect "bourgeois" attitudes and beliefs, and must be "re-educated" before they can take their place in such a society.

History.—During the growth of Chinese Communism (1921–48) thought reform was used to integrate new members into the movement and to strengthen the commitment to the Communist cause of the old rank and file as well as the elite of the party. Following the conquest of the Chinese mainland (1949), the Communists attempted to reform Chinese intellectuals, peasants, soldiers and all others who, because of their class origins or past behaviour, were not considered politically reliable. This group included Europeans and Americans who were imprisoned by the Communists and whose confessions and apparent conversions to Communism first brought widespread attention to thought reform. During the Korean war (1950–53) United Nations prisoners of war were subjected to a less intensive program of reform, but greater emphasis was placed in this program on obtaining propaganda material than on political re-education.

Process.—The techniques of thought reform vary with the target group and the circumstances, but the basic approach is the same whether used in a prison, a revolutionary college, a factory or a Communist cell. By controlling the physical and social environment an attempt is made to destroy loyalties to any non-Communist groups or individuals, to demonstrate to the individual that his attitudes and patterns of thinking are incorrect and must be changed, and to develop loyalty and unquestioning obedience to the Communist party.

In the political prison, for example, the following techniques were used: (1) isolation from former associates, sources of information and daily routines; (2) an exacting prison regimen that required absolute obedience and humility (eating, sleeping, washing, eliminating, etc., according to strict schedule, doing nothing without permission of the guard, keeping head bowed and eyes downcast in the presence of the guard, etc.); (3) physical pressures ranging from deprivation of food and sleep to manacling as punishment for nonco-operation; (4) creation of an atmosphere in which redemption and freedom were completely contingent on successful reform; (5) social pressures, such as prolonged interrogations and "struggle meetings," in which attempts were made by more advanced cell members to persuade the less reformed members by any means from cajoling and harassment to humiliation and revilement; and (6) daily study groups in which Communist doctrine was learned—basic conclusions were presented in lectures and readings and were followed by group discussions in which each member was required to show how these conclusions could be derived from Communist premises and how they applied to himself (mutual criticism and self-criticism were an essential part of such group discussion).

In this setting prison officials and cell mates exerted unremitting pressure on the prisoner to make him re-evaluate his past from the Communist point of view, to recognize his guilt and to confess his crimes. Crimes were defined as actions or thoughts which in any manner could harm the Communist cause. The confession had to be built around actual events, and the sincerity of it had to be demonstrated by willingness to include in it denunciations of parents, friends and other close associates. When, and if, the prisoner had recognized his guilt (*i.e.*, accepted the Communist interpretations of his actions), had made a satisfactory confession and had demonstrated his change in attitude and point of view, he was brought to trial, convicted of the crimes to which he had confessed and given a lenient sentence because he had reformed. This entire procedure took from one-half to four or more years.

Analysis.—On the psychological level this process involves the removal of social and perceptual supports; the weakening of the ego by physical pressures; the coercion of guilt-provoking behaviour that then requires rationalization; the destruction of the person's self-image by humiliation and revilement; the rebuilding of this self-image through the positive personal relationships that develop in the enforced intimacy of the cell despite the ever-present atmosphere of hostility; a shift in perceptual and semantic frame of reference resulting from the desire to identify with the point of view of the cell mates and the need to rationalize coerced behaviour; and the elaboration of this new frame of reference through the intensive group study program. The depth and permanence of these changes in attitude and point of view depend on the personality of the individual, his degree of motivation to be reformed and the degree to which the environment continues to coerce his behaviour and support his new frame of reference. In persons who were expelled or escaped from the Chinese mainland the effects were transitory; in those who took their place in Chinese Communist society the effects were probably more permanent.

Thought reform contains elements which are evident in Chinese culture (emphasis on interpersonal sensitivity, learning by rote and self-cultivation); in methods of extracting confessions well known in the Papal Inquisition (13th century) and elaborated through the centuries, especially by the Russian secret police; in methods of organizing corrective prisons, mental hospitals and other institutions for producing value change; in methods used by religious sects, fraternal orders, political elites or primitive societies for converting or initiating new members. Thought reform techniques are consistent with psychological principles but were not explicitly derived from such principles.

See also KOREAN WAR.

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BRAKE. A means for controlling the speed of a movement or of totally arresting it. Most brakes utilize friction, although braking may be obtained by compressing a gas in a cylinder or by using an electric motor as a generator where the energy generated may be returned as electricity to a distributing system or dissipated as heat from resistors. Most friction brakes act on revolving elements, as wheels or drums, but slipper brakes pressing on flat surfaces are applied as for rail cars, mechanically or magnetically operated, and a pincer of caliper type grips each flank of a rack in some of the mountain railways and in elevators (lifts). A rope also serves for the application of a brake device in a few cases. The various arrangements used for clutches (*see* CLUTCH) are also usable for brakes when one member, having been made stationary, is engaged by the other. The eddy current coupling readily serves as a brake.

Band Brakes.—A highly effective braking action can be obtained by the coiling of a rope around a drum, as may be seen at any docks, a man holding the free end of the rope, and allowing it to slip gradually. The sustaining friction developed between rope and drum follows the law of belting so that a large arc of contact results in a high ratio of tension on the load end of the rope to the sustaining end. The more convenient application of this idea, a flexible steel band, is employed on winches, hoists, haulage and winding engines, cranes and motor vehicles. In order to increase the frictional effort and reduce heating, some kind of lining has to be fitted, such as wood, leather, asbestos or one of the special compositions. The band fits externally in all ordinary examples, but when access of dirt, moisture and grit must be prevented, an internal expanding type has the preference, the band being made of an expandable ring, with a pivotal freedom. By the multiplication of force with a lever, plus the frictional effect of the band embracing a large diameter, a man by exercising moderate force at a handle or treadle can hold a load of several tons and pay it out slowly or quickly by regulating his pressure. Fig. 1 may be noted to explain the essential features, the lever having its eye pivoted on a short shaft around which one end of the band is looped, while the other end is pinned a little way along the lever, being consequently pulled taut as the pedal is depressed. A balance weight at the tail end frees the band when the foot releases the lever. The band brake gives a large braking torque for the actuating force applied and in this respect is one of the most efficient brakes available. For rotation in one direction, greatest effectiveness is obtained when the tight side of the band is anchored at the lever pivot; effectiveness is not so great for operation of the drum in the opposite direction. By proper selection of the pivot point a band brake may be made self-locking for one direction of rotation and free running in the opposite direction. Such brakes are known as differential band brakes and are used on hand-operated hoists to prevent unintentional lowering of the load.

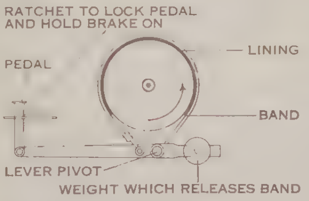
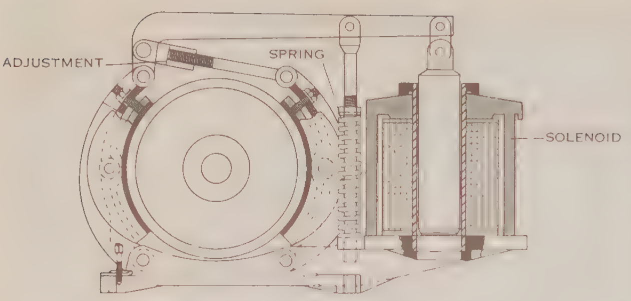

RATCHET TO LOCK PEDAL AND HOLD BRAKE ON
LINING
PEDAL
BAND
LEVER PIVOT
WEIGHT WHICH RELEASES BAND

FIG. 1.—SIMPLE BAND OR STRAP BRAKE

Although of high mechanical effectiveness, the band brake requires careful adjustment and has poor heat dissipating capacity, hence is not suitable for continuous operation.

Block Brakes.—A simple type of braking is obtained by pressing a block against the periphery of a rotating drum. To increase the braking capacity and at the same time greatly reduce the forces on the drum bearings, two diametrically opposed blocks are frequently used. The blocks are attached to posts pivoted to the frame and are forced against the drum as the posts are pulled together through a multiplying leverage. Such a brake used in a crane is shown in fig. 2. The blocks are held against the drum by the force from the spring multiplied through the linkage. Current supplied to the operating motor connected to the drum shaft flows through the coils of the solenoid, thus producing a flux to pull the solenoid plunger down and compress the spring, thereby releasing the brake to allow the motor to turn the drum. If the current fails, the spring applies the brake and prevents the load from being lowered. Block brakes with drums 12 or more feet in diameter are in use on mine hoists.

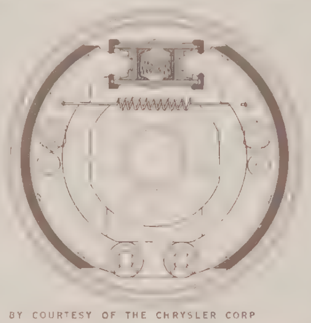
Motorcar Brakes.—Shoe brakes are commonly used. In them rigid shoes are pressed outward against the inside of a drum by a



BY COURTESY OF THE CLEVELAND CRANE AND ENGINEERING CO

FIG. 2.—CRANE BLOCK BRAKE ACTUATED BY SOLENOID

linkage and cam or by a hydraulic cylinder acting directly on the ends of the shoes. In fig. 3 for clockwise rotation the friction on the shoe surface helps to engage the right shoe more tightly, so that it is self-energizing, whereas the friction tends to lessen the pressure on the left shoe. The self-energized shoe is called the leading shoe; and the shoe with diminished energy, the trailing shoe. The trailing shoe requires about three times the tip operating force of the leading shoe. To give this greater force, some actuating cylinders have the piston for the trailing shoe larger than for the leading shoe. Temperatures caused by high energy generation in vehicles at high speed cause fade, or loss of braking power due to temperature expansion. Trailing shoes are less affected by fade than leading shoes. In order to obtain the desired ratio of front to rear wheel braking, some European designs use two trailing shoes with a servo unit or power assistance to increase the actuating force. United States practice sometimes uses two leading shoes to take full advantage of their self-energizing characteristic. English practice is to use two leading shoes on the front wheels and a trailing and leading shoe on the rear wheels, or leading and trailing on both front and rear.



BY COURTESY OF THE CHRYSLER CORP

FIG. 3.—HYDRAULIC AUTOMOBILE BRAKE

Entrance under pressure of fluid into the cylinder forces pistons apart and rotating shoes around their lower pivots, bringing friction surfaces into contact with the brake drum. When fluid pressure is released, the long spring pulls shoes out of contact

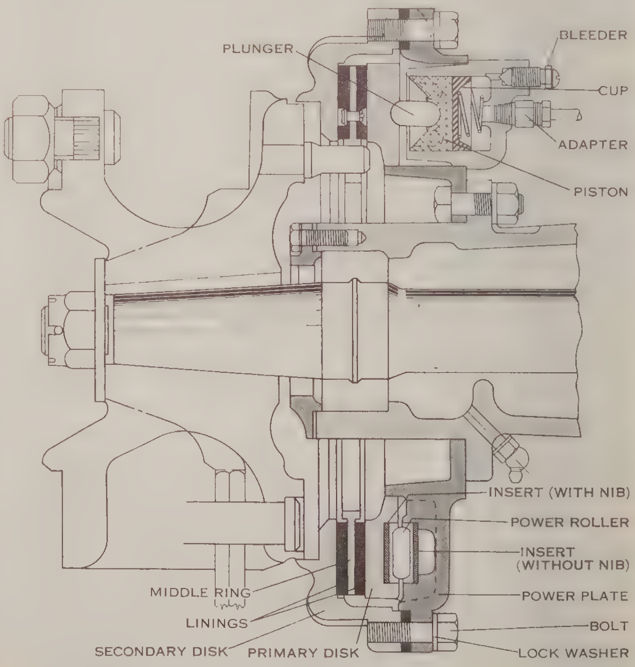
Disk brakes of the caliper type operate in the open in small and sport cars. A small friction area is applied through a pincer linkage to each face of a rotating disk. As the exposed surface is large and plane heat dissipation is good, no temperature expansion problems exist.

Enclosed disk brakes utilize friction contact around the outer surface of two faces of a disk squeezed between pressure plates or single surfaces of two disks separated so as to bear on the inside end surfaces of a drum. The arc of friction material contact may be 360° or less. Smaller contact area results in greater energy per unit of contact area but also greater free disk area to dissipate heat. A proper balance is necessary. Thermal and mechanical distortions are less than in the drum of a shoe brake. Disk brakes may be made self-energizing. The Lambert hydraulically operated tractor brake shown in fig. 4 is automatically self-energizing. Hydraulic fluid from the master cylinder acting on two cylinders (one shown) forces the primary disk against the rotating, friction-lined middle ring, which then contacts the secondary disk. The rotating disk imparts a slight rotary motion to the primary disk causing the power rollers to ride up the ramp of the power insert, thus increasing the pressure between the plates. A British-designed brake uses a vacuum booster instead of a self-energizing device. European use of self-energization is less than in the U.S. Automotive brakes may be actuated by rod, cable, hydraulic pressure, high-pressure air, vacuum or electrically energized magnets. Most used is the hydraulic system whereby force applied to the brake pedal moves a piston in a master cylinder from which the pressure is transmitted by the fluid through tubes to one or two actuating cylinders in each wheel brake. The pedal force may be used to control a vacuum cylinder which applies the principal force to the master cylinder. (*See* AUTOMOBILE: *The Chassis: Brakes.*)

In regions with long, steep grades the main brakes are relieved by auxiliary brakes, such as drum or disk brakes, on the transmission shaft, hydraulic retarders, or by using the driving motor as a compressor. In European exhaust brakes a valve is used to close off the exhaust line so that the engine acts as a compressor on the exhaust as well as the compression stroke. Fuel is cut off and induction air enters freely.

Railroad Brakes.—Air brakes, commonly used on railroads and required by law in the United States, consist of a compressor, pneumatic valves and regulators with the necessary pipes, reservoirs and accessories, with levers, rods and other rigging to transmit the forces to the brake shoes, which bear directly on the rim of the wheels. The simple air brake was superseded by automatic action so that the brakes would be applied upon release of air from the system—either when intentionally released by a control valve or accidentally by a broken pipe or burst hose. This automatic action is obtained by having in each car an auxiliary storage tank containing air of sufficient quantity and pressure to brake that car, and a triple valve to which are connected the brake pipe, auxiliary reservoir and brake cylinder. When pressure is reduced in the brake pipe by air escaping to atmosphere, the higher pressure from the auxiliary reservoir causes the triple valve on each car to admit air under pressure to the brake cylinder to apply the brake shoes. The brake is released by admitting high-pressure air from the main reservoir on the locomotive to the brake pipe until pressure is above that maintained in the auxiliary tanks. The triple valve parts are returned to their original positions and a release spring returns the piston (or diaphragm) to its original position, releasing the brakes.

The quick action automatic brake (AB), invented by George Westinghouse (*q.v.*), is the minimum standard required on freight cars introduced on United States roads from 1945. The triple valve is modified so that a quick reduction in pressure in the brake pipe establishes direct communication to the brake cylinder. The brake pipe is vented at each car and the pressure increased on each brake cylinder giving increased braking effort. The brake



BY COURTESY OF AUTO SPECIALTIES MANUFACTURING COMPANY

FIG. 4.—HYDRAULIC TRACTOR BRAKE WITH SELF-ENERGIZING DISK

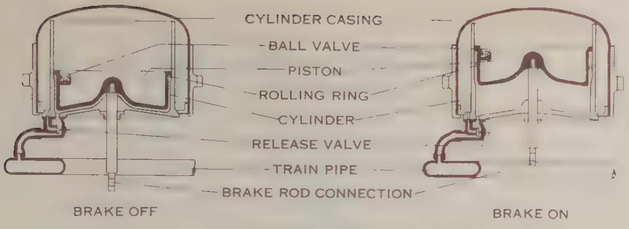


FIG. 5.—VACUUM AUTOMATIC BRAKE

force that can be applied to the wheels without locking them decreases as the speed decreases. To stop from high speed in the shortest time it is desirable to reduce the braking force when stopping rather than to keep it constant, as in the AB system. This effect is achieved in the high speed control (HSC) system, which is an electropneumatic brake superimposed on an automatic brake so that the cars are braked quickly and smoothly by either system.

HSC uses a modified triple valve with a governor and electropneumatic control to reduce the braking force in three stages: 60, 40 and 25 m.p.h., thus giving four speed zones with ratios of braking force to weight of wheel on the rail of 250%, 200%, 150% and 100%, respectively. At a ratio of 150% the wheels would lock and slide on the rails at low speed. The electropneumatic device consists of an equalizing portion for controlling the pneumatic service, the release and the automatic charging of the reservoirs; a portion for quick supply of high pressure for transmitting quick action to successive cars; and an electric system to operate switches, magnets, etc. A Decelostat is used to reduce automatically the braking force on wheels that tend to lock and slide.

The vacuum automatic brake is dependent on atmospheric pressure for its action, the brakes being normally kept off by the state of vacuum existing in the train pipe and cylinders. A steam ejector on the engine produces the vacuum and maintains it constantly. As there is vacuum both above and below the pistons in the brake cylinders, the pistons fall by gravity and the shoes remain off. But when atmospheric air is admitted to the train pipe, by the driver or guard, or through a breakaway, it closes a ball valve in the piston so as to seal the upper side of the cylinder and exerts pressure on the lower side of the piston, forcing it upward and actuating the brake rods (*see* fig. 5).

The object of the "rolling ring" of rubber is to make a perfect joint or packing without friction, and the release valve serves to enable the brake to be released by hand.

Streetcar (Tramcar) Brakes.—The hand brake which applies shoes to the wheels of a streetcar is limited in power; hence other systems must be utilized in conjunction with it. The regenerative method (causing the motors to act as generators) imposes a powerful braking effect. Or this may be combined with the operation of slippers magnetically clinging to the rails (an alternative to mechanically applied slippers), thus affording axle braking combined with the powerful slipper drag. And sometimes the mechanism includes wheel shoe attachments, the drag of the magnets causing an application of the wheel brake blocks.

The magnet coil is usually a large wire coil having a small number of turns, whereas for certain conditions a supplementary shunt or fine wire coil is added, energized by current from the line. With shunt winding the car can be brought completely to rest without having to apply the hand brake.

Brake Materials.—Brake drums of cast iron are most successful but are heavy and require too much machining for automotive use. Composite drums of pressed steel lined with centrifugally cast iron liners are successfully used. Aluminum brake housings, frequently ribbed, are used to aid in heat dissipation.

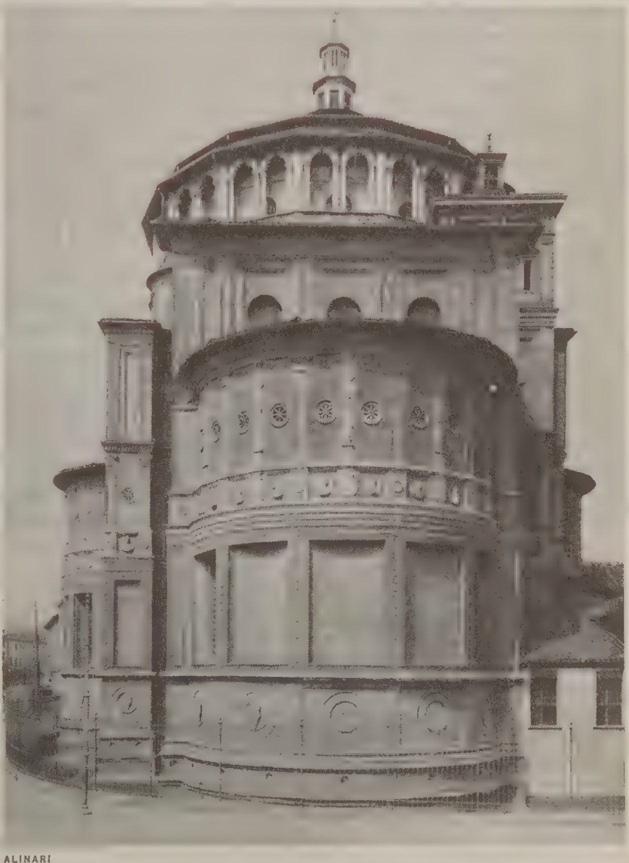
Railroads use cast-iron shoes bearing directly on the chilled rim of the cast wheels. Hard abrasive particles can be cast into the shoes so that the wheels are kept true without affecting the braking efficiency. Automotive and industrial brakes use a lining made in either woven or molded form of asbestos fibres, mixed with fillers and bonding material, and some cotton or copper wire or other metals. The cotton and wire give increased strength to the short-fibre asbestos. Materials used to bind and saturate the linings to make them impervious to oil and moisture are asphalts, natural gums and oils, and synthetic resins.

There are two types of metal-bonded linings—powdered metals or ceramic-metallic. Applications of the ceramic-metallic linings to aircraft brakes result in life about four times that obtained with organic linings. Ceramic-metallic brakes are brittle and expensive, however, and offer little improvement for automotive use. Coefficient of friction obtainable with the usual linings is from 0.3 to 0.4 for temperatures up to 500° F. (F. H.; E. S. A.)

BRAKPAN, a town of the Republic of South Africa, lies 5,400 ft. above sea level and 23 mi. E of Johannesburg, at the centre of the Far East Rand and of the mining and industrial complex of that area. Pop. (1960) 77,777, of whom 29,291 were of European descent. The municipal area is 93.5 sq.mi., the largest on the Witwatersrand. The climate is mild, and the average annual rainfall is 27.7 in. The town grew rapidly after it became an independent municipality in 1919. It is attractively laid out, with wide tree-lined streets and residential suburbs separated from its industrial quarters. There are 15 schools and colleges, and municipal grants and bursaries are provided to enable students to attend various universities. (A. S. v. J.)

BRAMANTE (DONATO D'AGNOLO or D'ANGELO, incorrectly called BRAMANTE LAZZARI) (1444–1514), Italian architect, who represents, with Raphael (probably a younger relation of his) and Michelangelo, the full flowering of the Italian Renaissance. He was born at Monte Asdrualdo (now Fermignano), near Urbino, one of the great centres of the period. At Urbino he came under the influence of L. B. Alberti and Piero della Francesca. Bramante's architectural career, which followed his brief activity as a painter, falls into two periods: that in Milan, *c.* 1480–99; and that in Rome, *c.* 1500–14, which includes the planning of St. Peter's.

In Milan he was largely preoccupied with central planning, *i.e.,*



ALINARI

APSE OF STA. MARIA DELLE GRAZIE, MILAN

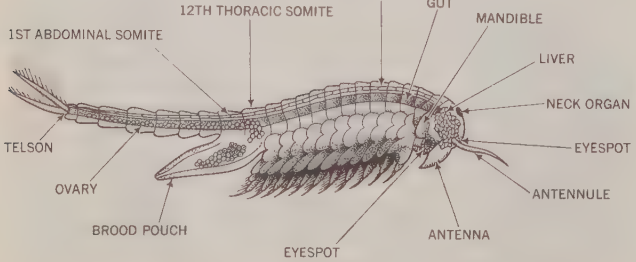
the design of buildings with plans of regular shape, such as the square or circle, related to one or more crowning domes. This reflected contemporary Lombard practice, especially the architectural ideas of Leonardo da Vinci, and was based on Milanese buildings, such as S. Lorenzo, which were thought to be antique. He studied such models closely and used classical forms derived from them and also from the classical elements of Filippo Brunelleschi's style. His principal Milanese buildings are Sta. Maria presso S. Satiro and the domed crossing, transepts and choir which he added to Sta. Maria delle Grazie.

As a result of the French invasion (1499) Bramante left Milan for Rome, where contact with far more important remains of ancient architecture led to increased classicism and gravity in his style. From about 1503 Bramante was engaged in the rebuilding of St. Peter's for Pope Julius II, and the foundation medal of 1506 gives some idea of his project. When Bramante died on March 11, 1514, little was actually built, but he had established the idea of a huge domed church, roughly square in plan and strongly classical in feeling. His ideas were later radically altered, especially by Michelangelo and Carlo Maderno. His major surviving works in Rome are the Tempietto at S. Pietro in Montorio (1502), a tiny church which is a microcosm of the main ideas behind St. Peter's, and the Belvedere court and other works in the Vatican, later much altered. The "House of Raphael," now known only from engravings, strongly influenced the design of Italian palaces from the 16th century onward. The principles of symmetry and classical repose informing all these works were imitated and then rebelled against by later architects, many of whom were trained under Bramante at St. Peter's, but the brief moment of harmony and equilibrium called the High Renaissance was, in architecture, Bramante's creation. (P. J. My.)

BRAMANTINO (d. 1530), Italian painter and architect; properly Bartolommeo Suardi but called Bramantino because of his association with the architect Bramante. Probably born about 1465 and a pupil of Bernardino Butinone, Bramantino seems to have been employed in the Milanese studio of Bramante, whose secular frescoes exercised strong influence on his style. Bramantino is mentioned in documents after 1490 and in 1508 was employed in Rome. In 1511 he designed the sepulchral chapel of the Trivulzio family in S. Nazzaro, Milan. Bramantino's principal extended works are 12 tapestries of "The Months," now in the Museo Civico, Milan. These were executed in 1509 and show him to have been the most gifted and original Milanese painter of his time. After his return from Rome his style suffered marked deterioration. (J. W. P.-H.)

BRAMBLE: *see* Blackberry.

BRANCHIOPODA, one of the subclasses of the Crustacea (*q.v.*), comprising some of the most primitive existing forms of the class, distinguished by the flattened, leaflike form of the limbs. Although, like most Crustacea, they cannot be said to have any popular English names, various members of the group have been distinguished by writers on natural history as fairy shrimps, tadpole shrimps, clam shrimps and water fleas. Nearly all of them are inhabitants of fresh water, and they are remarkable for the prevalence of parthenogenesis (reproduction by unfertilized eggs) and for the fact that the eggs resist desiccation and can survive for long periods in the dry state. Because of this they often make their appearance in great numbers in rain pools, even in dry countries where for long periods no aquatic life is possible.



FROM L. BORRADAILE AND F. POTTS, "THE INVERTEBRATA"; REPRODUCED BY PERMISSION OF CAMBRIDGE UNIVERSITY PRESS

FIG. 1.—CHIROCEPHALUS DIAPHANUS, AN ANOSTRACAN BRANCHIOPOD

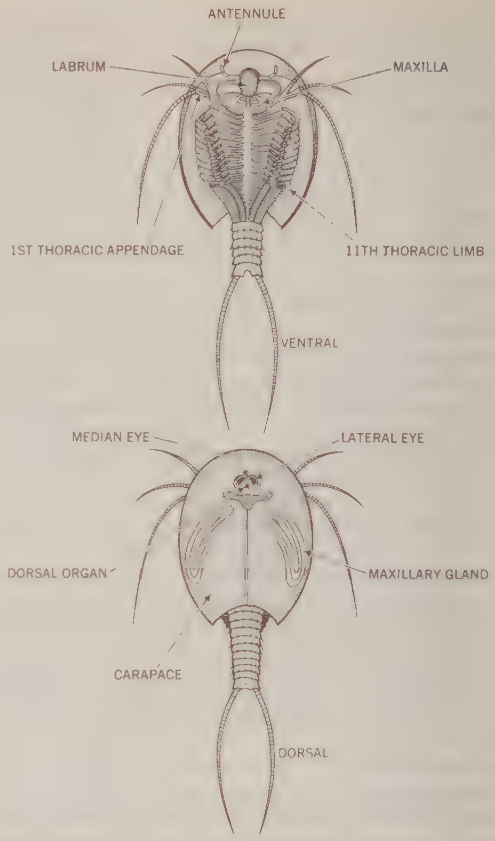


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FIG. 2.—TRIOPS CANCRIFORMIS, A NOTOSTRACAN BRANCHIOPOD

The members of the five orders named below differ much in structure. Those of the first four orders are characterized by the large number of somites, the general uniformity of the trunk limbs and, in the living species, by the tubular form of the heart and the ladderlike arrangement of the central nervous system. These characters are very primitive, but on the other hand the palpless mandibles and the reduced maxillulae and maxillae are more specialized than those of some other Crustacea.

Anostraca.—The Anostraca have no carapace (hard dorsal shield), and the fully segmented body is almost wormlike. The males are distinguished by the modification of the antennae into large and complicated claspers which are used for holding the females. The eyespots are set on movable stalks. Most Anostraca, such as the fairy shrimp (*Branchinecta*), inhabit rain pools and other temporary accumulations of fresh water, but the brine shrimp (*Artemia*) is found in the brine of salt pans in which sea water is exposed to evaporation for the manufacture of salt, and in salt lakes in which the brine is so concentrated that few other animals can live in it, such as Great Salt Lake, Utah. Brine shrimps are found throughout the world wherever conditions are suitable. Specimens from different localities differ considerably, but it has been shown that many of their variations are directly correlated with the degree of salinity of the water and probably many of the forms described are variants of a single cosmopolitan species. Brine shrimps are the only Anostraca known to be parthenogenetic, some colonies consisting entirely of females. Brine shrimp eggs are often gathered and sold in pet shops to fish hobbyists. When the eggs are placed in salt water, the young hatch and may be fed to aquarium fish.

Most Anostraca are of small or moderate size; giant among them are *Branchinecta gigas*, from Grand Coulee, Ore., a full two

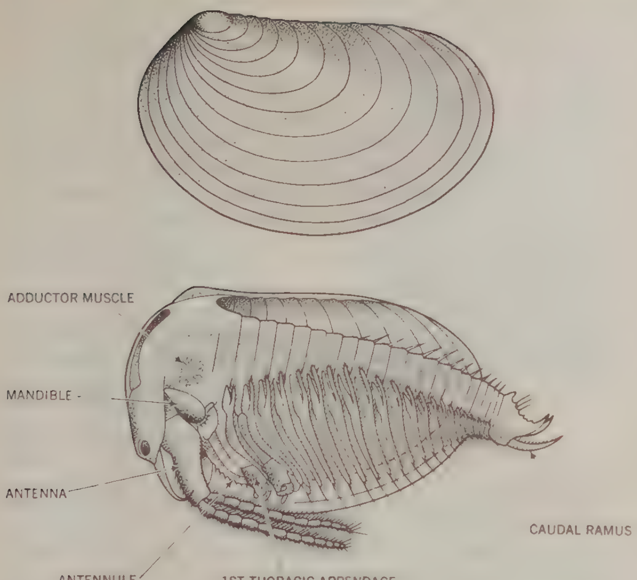

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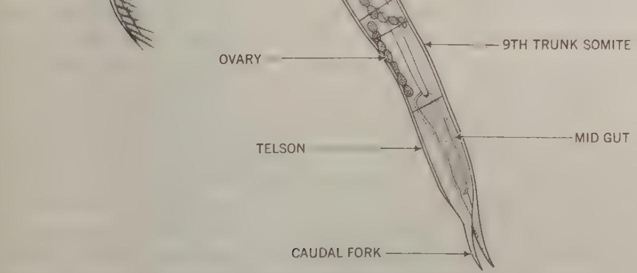
FIG. 3.—ESTHERIA OBLIQUA, A CONCHOSTRACAN BRANCHIOPOD; (TOP) SHELL OF A FEMALE, (BOTTOM) FEMALE AFTER REMOVAL OF LEFT VALVE OF SHELL

and three-quarters of an inch long, and *B. paludosa*, almost one inch long.

Lipostraca.—Related to the Anostraca is the order Lipostraca based upon the remarkable fossil *Lepidocaris* discovered in the Old Red Sandstone of Scotland. The fragmentary remains of this minute Crustacean are so perfectly preserved that its structure is known in greater detail than that of any other fossil Crustacean. Resembling the Anostraca in general form, it differs from them in the structure of the limbs, of which the posterior pairs are two-branched; in the absence of paired eyespots; and, most remarkably, in the claspers of the male which are formed, not by the antennae but by the maxillulae.

Notostraca.—The Notostraca have a broad, oval carapace covering the fore part of the body and giving the animals, at first sight, some resemblance to the Arachnidan horseshoe crabs, with which, however, they have no near relationship. The somites and appendages are more numerous than in any other living Crustacea. The eyespots are sessile on the upper surface of the head, and the antennules and antennae are much reduced, their place as "feelers" being perhaps taken by the filamentous terminal processes of the first pair of abdominal appendages. The principal genus is *Triops* (formerly *Apus*), the species of which may be two or even three inches long. Reproduction is largely parthenogenetic and males are rare.



FROM L. BORRADAILE AND F. POTTS, "THE INVERTEBRATA"; REPRODUCED BY PERMISSION OF CAMBRIDGE UNIVERSITY PRESS

FIG. 4.—A FEMALE LEPTODORA KINDTII, A CLADOCERAN BRANCHIOPOD

Conchostraca.—The Conchostraca have the carapace in the form of a bivalve shell enclosing the body and limbs and marked with concentric lines of growth, so that it resembles very closely the shell of a lamellibranch mollusk. The large two-branched antennae are used in swimming. The paired eyespots are sessile and are more or less coalesced into one. *Estheria* and *Limnadia* are well represented in Europe and America, but no Conchostraca have ever been found in the British Isles.

Cladocera.—The Cladocera are closely related to the Conchostraca, from which they should not, perhaps, be separated as a distinct order, and from which they differ chiefly in the great reduction in the number of body somites and of limbs. They are the water fleas, everywhere abundant in ponds and lakes. Nearly all are of small size, some species which do not exceed one hundredth of an inch in length are among the smallest of living Crustacea; the largest Cladoceran is *Leptodora kindtii*, from one-half to three-fourths inch long, found in larger fresh-water lakes of the northern hemisphere, and the only member of the order having a nauplius-like larval stage (characteristic of many Crustacea). The transparency of Cladocera allows the internal structure to be studied in the living animal, making them interesting objects for microscopic examination.

The Cladocera reproduce largely by parthenogenesis; the developing eggs are carried within the shell of the female. In addition to the parthenogenetic eggs, which hatch while still within the brood chamber, the Cladocera produce, at certain seasons, another kind of eggs which require fertilization. These thick-shelled "resting" eggs do not hatch at once but are cast off when the female molts. These eggs can survive drying or freezing without injury. They are often produced in autumn and do not hatch until the following spring; in species that live in small pools, they may be produced in spring, insuring survival in the event that the pool should dry up in summer. The only branchiopods occurring in the sea are a few species belonging to three genera of Cladocera, *Evadne, Penilia* and *Podon*. In converting the smallest aquatic and marine organisms into food material for animals higher in the scale of life, the Cladocera rank next to the Copepoda (*q.v.*) in importance.

The beating motion of the paired limbs in the Branchiopoda sets up a current of water along the midventral line of the body (food groove), from which particulate food is strained by bristles or feathered setae. Many have special provision for filtering off the fine particles of organic matter, chiefly microscopic algae, as well as coarser material and detritus, which some species may scrape or stir up from the bottom. The Notostraca and Conchostraca are primarily bottom feeders, the Anostraca and Cladocera pelagic foragers, but in many cases they derive some food also from the bottom. The Notostraca are not above scavenging and eating small living organisms. A few Cladocera, of which *Leptodora* is one, are predatory, enabled by their greater size and strength to capture other pelagic Cladocera and Copepoda.

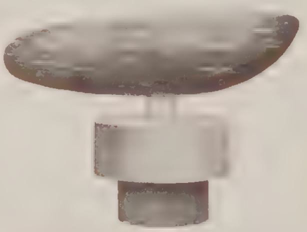
(W. T. C.; W. L. St.)

BRANCOVAN (properly Brîncoveanu), a noble family prominent in Rumanian history, deriving its name from the estate of Brîncoveni, in Walachia. From the great Matei Basarab (*see* Basarab), who died leaving no son in 1654, the Brîncoveni estate passed to a collateral line of his family.

From this emerged Constantin Brancovan, ruler of Walachia from 1688 to 1714. A vassal of the Turks, to whom he had to pay heavy tribute, he refused to subjugate himself entirely to the Austrians (whom he defeated at Zărnești in 1690 but from whom he received the title of prince in 1695) and negotiated with the third rival power, Russia. His promise to help Russia against Turkey in 1711 came to nothing. The Turks learned of it, and in 1714 he and his four sons were executed in Istanbul. Constantin built churches and palaces and founded printing works to produce books not only in Rumanian but also in other languages of the Orthodox Church.

The family was continued through Constantin's nephew. Its last direct descendant in the male line was the Greek scholar Grigore Brancovan (d. 1833), whose adoptive daughter married Gheorghe D. Bibescu. The latter's son Grigore (1827–1886) took the name and title of Brancovan. His daughter Anna (1876–1933), comtesse de Noailles by marriage, was a distinguished French poet.

BRANCUSI, CONSTANTIN (1876–1957), Rumanian sculptor, a pioneer of abstract sculpture whose work exerted a tremendous influence on the art of the 20th century, was born in Pestisani, Rum., on Feb. 21, 1876. He studied at a local art school and then at the Art academy in Bucharest where he won a prize for a realistic statue. In 1904 he went to Paris where he studied at the École des Beaux Arts with M. J. A. Mercié and came under the influence of Auguste Rodin. Gradually he abandoned naturalistic sculpture, and, influenced by primitive carving and the modern art movement, devoted himself to works in a highly original abstract style. In these works he tried to bring out the essential form rather than the surface appearance and to utilize to the full the beauty of the material itself. Brancusi achieved prominence in connection with a lawsuit (1927) against the U.S. customs service which had refused to admit his "Bird in Space" duty free as a work of art. The ensuing argument between conservative and modern critics ended in a victory for Brancusi and modern art. His fame grew steadily, and at the time of his death, in Paris on March 16, 1957, he was universally regarded as the grand old man of modern abstract sculpture.



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"FISH," BY CONSTANTIN BRANCUSI, 1930. GRAY MARBLE 21 IN. (53 CM.) HIGH

The most important collection of his work is in the Museum of Modern Art, New York city, including such masterpieces as "Bird in Space," "Fish," "Adam and Eve" and "Mlle Pogany." A large retrospective exhibit was held at the Solomon R. Guggenheim museum, New York city, in 1956.

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BRAND, SIR JOHANNES HENRICUS (Jan Hendrik) (1823–1888), South African statesman, who, as president of the Orange Free State from 1864 to 1888, sought to promote harmony between the Boer republics and the British colonies in South Africa, was born in Cape Town on Dec. 6, 1823. A son of Sir Christoffel Brand, speaker of the Cape Colony house of assembly, he was educated at the South African college, Cape Town, and at the University of Leiden, Neth. He was called to the English bar by the Inner Temple in June 1849 and thereafter practised as an advocate in the Cape supreme court (1849–63). He was appointed professor of law in the South African college in 1858.

Brand was elected president of the Orange Free State in Nov. 1863. He held office continuously from Feb. 2, 1864, until his death in 1888, being four times re-elected (*see* Orange Free State: *History*). He conducted his presidential office with dignity and moderation, defending his authority against periodic attacks in the *volksraad* (parliament) and following a peaceful line under difficult conditions in his relations with the British government. He fought successfully against the Basuto from 1865 to 1868 and then imposed such severe terms on them that Great Britain decided to annex Basutoland (1868). The resultant controversy with the British authorities was barely settled, by the treaty of Aliwal North (1869), when another arose in 1871 over the control of the Griqualand West diamond fields. Defeated by Great Britain's decision to annex the territory, Brand nevertheless obtained £90,000 compensation for his government when he visited London in 1876. Brand later mediated between the British government and the Transvaal leaders after the war of 1881 and was knighted (1882) for his services. Brand laid the basis for the customs and railway agreement between the Free State and Cape Colony which was signed soon after his death. He died at Bloemfontein on July 14, 1888. (T. R. H. D.)

BRAND, JOHN (1744–1806), English antiquary and topographer, who was historian of Newcastle upon Tyne and the resident secretary to the Society of Antiquaries, 1784–1806, was born on Aug. 19, 1744, at Washington, Durham. He was educated at Newcastle grammar school and Lincoln college, Oxford. Ordained in 1773, he occupied positions as a teacher and curate in and near Newcastle until 1784, when he received the livings of St. Mary-at-Hill and St. Mary Hubbard, London, from the duke of Northumberland, to whom he became a personal chaplain in 1786. He died in London on Sept. 11, 1806.

His most important works are *Observations on Popular Antiquities: Including the Whole of Mr. Bourne's Antiquitates Vulgares* (1777) and *The History and Antiquities of the Town and County of Newcastle upon Tyne*, two volumes (1789). Brand also published a poem entitled *On Illicit Love. Written Among the Ruins of Godstow Nunnery, Near Oxford* (1775) and numerous papers in *Archaeologia*. (J. M. Wi.)

BRAND, SIR (CHRISTOPHER JOSEPH) QUINTIN (1893–1968), South African pioneer aviator and an air vice-marshal in the Royal Air Force (R.A.F.), was born at Beaconsfield, near Kimberley, Cape Province, on May 25, 1893, and was educated at the Marist Brothers' school in Johannesburg. He served with distinction in the Royal Flying Corps and R.A.F. in World War I and destroyed a German Gotha bomber in the last air raid carried out on the United Kingdom in that war.

In 1920, in company with Sir Pierre van Ryneveld, he made the first flight from London to Cape Town, via Cairo, in a Vickers Vimy aircraft. For this pioneer achievement both men were knighted. Brand qualified in engineering at Cambridge university in 1922 and, after various R.A.F. appointments, became director general of civil aviation in Egypt from 1932 to 1936. During World War II, he commanded no. 10 fighter group, which played a distinguished part in the battle of Britain. Brand retired from the R.A.F. in 1943 and returned to live in Africa. He died at Umtali, Rhodesia, on March 7, 1968. (D. Cr.)

BRANDEIS, LOUIS DEMBITZ (1856–1941), U.S. jurist and public advocate of the interests of consumers, labour unions and investors, was born in Louisville, Ky., on Nov. 13, 1856. His parents, members of cultivated Bohemian Jewish families, had emigrated from Prague, Czech., to the United States in 1849. Brandeis attended the public schools of Louisville and the Annen Realschule in Dresden, Ger., before entering the Harvard law school, from which he was graduated at the head of his class in 1877. After less than a year of practice in St. Louis, Mo., he returned to Boston, Mass., where he maintained an active and prosperous practice until his appointment to the supreme court of the U.S. in 1916.

Career as Counsel.—At the bar Brandeis came to be known as the people's attorney, by virtue of his representation of interests that had not commonly enjoyed such formidable advocacy. For the most part he took these responsibilities on condition that he receive no compensation; in this way he was able as a private citizen to indulge his passion for public service and, more important, to devise constructive solutions that would transcend the narrow concerns of client and class. When the affairs of the Equitable Life Assurance society of New York precipitated widespread alarm in 1905, Brandeis became unpaid counsel for the New England Policy-Holders' Protective committee. His investigations and reports anticipated in some respects the findings and recommendations of the legislative committee appointed in New York under state Sen. William W. Armstrong, whose counsel was Charles Evans Hughes (*q.v.*). Characteristically, Brandeis, his mind challenged by the issues of insurance-company abuses (*see* Life Insurance: *United States*), reached beyond the immediacies to create a remedy that would be easily administered, self-motivating and enduring and that would above all enlist the participation of ordinary men. Such a measure he constructed in the system of savings-bank life insurance, whereby insurance for workingmen was offered by savings banks over the counter at economical rates. This plan, steered through the Massachusetts legislature in 1907 after a vigorous educational campaign, Brandeis regarded as his greatest achievement.

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As counsel for shippers opposing a rate increase before the Interstate Commerce commission in 1911, he probed the economic position of the railroads. Out of this study came his dramatic challenge that the railroads could save $1,000,000 a day through the adoption of the principles of scientific management. Labour relations came under his scrutiny in a similarly pragmatic way. Called on to settle a strike of New York garment workers, he put into effect a plan for a preferential union shop and continuing consultation between management and labour in the affairs of the industry.

During 1907–14 he served as counsel for a number of states in defending against the charge of unconstitutionality various state laws prescribing maximum hours of labour and minimum wages. For this purpose he devised what came to be known and emulated as the "Brandeis brief," in which the legal propositions are set forth simply and summarily and the bulk of the argument is given over to a massive assemblage of economic facts, historical experience and expert opinion in support of the reasonableness of the legislation being defended.

Brandeis' volume of essays, *Other People's Money and How the Bankers Use It* (1914), was a study of the power exercised by investment bankers over U.S. industry. Documented from his own intensive analysis of the financial condition of the New Haven railroad, as well as from the hearings of the Pujo committee of the U.S. house of representatives (1912–13), the book was a frontal assault on monopoly and interlocking directorates. The book was influential, as was Brandeis himself, in the enactment in 1914 of the Clayton act and the Federal Trade Commission act, strengthening the antitrust laws.

In politics, as in his law practice, Brandeis preserved his independence. Until his appointment to the supreme court in 1916 he had never held public office. Although he made a series of public speeches early in 1912 on behalf of Sen. Robert M. La Follette's nomination as Republican candidate for the presidency, the failure of this movement left Brandeis a choice between Theodore Roosevelt as the Progressive and Woodrow Wilson as the Democratic candidate. Without hesitation Brandeis gave his support to Wilson, whose antitrust philosophy of enforced competition was far more congenial to him than was Roosevelt's proposal of regulated monopoly. The first meeting between Brandeis and Wilson, in Aug. 1912, provided Wilson with an underpinning of facts and a framework of reform that stiffened his policy toward big business, and it laid the basis of an enduring friendship between the two men.

Supreme Court Justice.—On Jan. 28, 1916, President Wilson nominated Brandeis an associate justice of the supreme court. Over bitter opposition, which encompassed seven former presidents of the American Bar association, the senate by a vote of 47 to 22 confirmed the nomination. He was the first Jew to sit on the supreme court.

Brandeis' judicial opinions reflected his distinctive methods and the singularly coherent body of his beliefs. His major opinions are massive and close-textured, grounded in mastery of the facts, and conveying withal a prophetic and didactic note. His fundamental beliefs were simple: that the limits of man's capacity for understanding are soon reached; that responsibility in the performance of manageable tasks is the great developer of men; that the widespread sharing of responsibility is both a moral duty and a practical necessity. In constitutional law, accordingly, he was solicitous of a viable federal system, with due scope to the states for legislative experiment. But by the same token he was ready to declare out of bounds the suppression of radical or unpopular sentiments, except where the propagation of these views created a proximate danger of unlawful action. His sense of the fallibility of judgment extended to the judicial office itself; no one was more insistent that procedural and jurisdictional limits on the court's authority be scrupulously observed. Thus in the case of Charlotte Anita Whitney (*Whitney* v. *California*, 274 U.S. 357, 372 [1927]), convicted under a California criminal syndicalism statute, Brandeis delivered a deeply felt opinion urging that penalties on speech could be justified only by a "clear and present danger" as applied earlier by Justice Oliver Wendell Holmes (*q.v.*); paraphrasing Pericles' funeral oration he declared that the founders of the U.S. constitution "believed liberty to be the secret of happiness and courage to be the secret of liberty," and yet agreed that the conviction must be affirmed because the defendant's counsel had not properly raised the constitutional issue in the trial court.

On most important issues Brandeis was aligned, often in the minority, with his colleague Justice Holmes, although their outlook was by no means identical. Holmes was content to support legislative experiments because of a pervading skepticism in judging measures of social reform; Brandeis strove to understand and to explicate sympathetically the needs and aspirations embodied in such measures. During the period of the New Deal many of the dissenting positions of Holmes and Brandeis came to be accepted by the court. While Brandeis supported the constitutional validity of most New Deal legislation, he did not do so indiscriminately; he joined, for example, in the decision holding the National Industrial Recovery act to be unconstitutional.

As a judge Brandeis austerely withdrew from extrajudicial activities, even declining to accept honorary degrees. The one public interest with which he allowed himself to be identified was the Zionist cause. When Senator La Follette indicated in 1924 his desire that Brandeis become the vice-presidential candidate of the Progressive party, it was a foregone conclusion that the justice would be impassive. Brandeis retired from the court on Feb. 13, 1939, and died in Washington, D.C., on Oct. 5, 1941.

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BRANDENBURG, a margraviate or mark, then an electorate of the Holy Roman empire, in northeastern Germany, the nucleus of the dynastic power on which the kingdom of Prussia was founded. As a province of the *Land* Prussia in Germany after World War I, Brandenburg was bounded on the north by Mecklenburg and by the province Pomorze, on the east by the Polish province of Poznan, on the southeast by Silesia and on the south and west by parts of Prussian Saxony or by Anhalt (Berlin being a self-governing city from 1920). In 1945, at the end of World War II, under the Soviet occupation of eastern Germany, Brandenburg west of the Oder was constituted as a separate *Land* on the dissolution of Prussia, but in 1952 its old administrative identity was lost when the East German *Länder* were dissolved into new *Bezirke* ("districts").

The district was inhabited in ancient times by the Semnones and afterward by various Slav tribes, which were partially subdued by Charlemagne but soon regained their independence. In the 10th century, however, the emperor Henry I the Fowler defeated the Havelli (Havelane or Stodorane) and in 928, took their capital, Branibor, from which the name "Brandenburg" is derived. Subsequently, Gero, margrave of the Saxon East Mark (Ostmark), pressed the campaign against the Slavs with vigour, while the emperor Otto I founded bishoprics at Havelberg and Brandenburg (948). After Otto's death (973), the Slavs regained much of their territory, including Brandenburg; conquest was not yet sufficiently backed by the settlement of German peasants, and the new ruling class, both in church and castle, was still too weak. A succession of feeble margraves ruled only the district west of the Elbe together with a small district east of that river.

Albert the Bear and the Ascanians.—A new era began in 1106 when Lothair, count of Supplinburg, became duke of Saxony.

Aided by Albert I (*q.v.*) the Bear, count of Ballenstädt, he renewed the attack on the Slavs and, having become emperor in 1133, appointed Albert margrave of the North Mark (Nordmark) in 1134. About 1140 Albert made a treaty with Pribislav, the childless ruler of the Havelland, by which he was recognized as that prince's heir, taking the title margrave of Brandenburg. The pressure of population, which was rising everywhere in western and central Europe, brought special opportunities to the margrave of a territory with a frontier opening on a sparsely populated and economically backward country. Albert knew how to make use of such a chance and so became the real founder of Brandenburg. Under his rule Christianity and civilization were extended, bishoprics were restored and monasteries founded. The country was colonized with settlers from the lower Rhineland.

The process was continued for the next 100 years under the rule of the Ascanians, as Albert's descendants were called (*see* Ascanian Dynasties). Under Albert's great-grandsons, the margraves John I and Otto III, prosperity was maintained, and new districts were conquered or purchased from the surrounding princes. By 1240 a broad front had been established along the Oder river, and Frankfurt an der Oder was founded in 1253 at a focus of communications. Moreover, Otto III's marriage (1253) with Beatrice, daughter of Wenceslas of Bohemia, added upper Lusatia to the margrave's possessions. Berlin (*q.v.*) was one of the many new towns founded. Of the numerous monastic foundations, which were richly endowed, the most notable were those of the Premonstratensians and Cistercians, whose eremitical ideal of a self-supporting community with its own disciplined labour force made them model landowners well-suited to the pioneer work of colonization. Entrepreneurs, or *locatores,* men not necessarily of noble birth, also brought German settlers from the west and, as the margrave's agents, founded villages, the inhabitants of which lived on the produce of the land that they cleared and drained. The Slav population between the Elbe and the Oder was, on the whole, not displaced but gradually became assimilated in language and in way of life to the economically and politically superior newcomers. Brandenburg's prosperity in the 13th century formed a marked contrast with the political disintegration that prevailed in western Germany.

Brandenburg appears, about this time, to have fallen into three divisions: the Old Mark (Altmark), lying west of the Elbe; the Middle Mark (Mittelmark), between the Elbe and the Oder; and the New Mark (Neumark), as the newly conquered lands beyond the Oder began to be called. When Otto III died in 1267, the area of the mark had been almost doubled, and the margraves had attained to an influential position in the empire. The *Sachsenspiegel,* a private but influential codification of custom law written before 1235, mentions the margrave as one of the electors (*q.v.*), by virtue of the ceremonial office of chamberlain, which had probably been conferred on Albert the Bear by the German king Conrad III; and when the list of electors was definitely established in the second half of the 13th century, the Brandenburger was one of the secular electors. On Otto III's death, however, the margravial territory was divided between his family and his brother's.

There was a permanent rivalry between the margraves and the archbishops of Magdeburg, whose territory, on colonial soil, penetrated like a wedge into the southwestern corner of the margravial lands. The conflict was most acute in the last quarter of the 13th century, under John I's son Otto IV (d. 1308 or 1309). Otto IV's nephew and successor Woldemar conquered Pomerellen (eastern Pomorze), on the western bank of the Vistula, which he partitioned with the Teutonic Order in 1310. He also held his own in a struggle with the kings of Poland, Sweden and Denmark and others over the possession of Stralsund. By marriage, purchase or inheritance, Woldemar finally came to rule over the whole mark, upper and lower Lusatia and various outlying districts. He died childless in 1319. Next year the Brandenburg male line of the Ascanians became extinct.

Wittelsbach and Luxembourg Dynasties.—Brandenburg now seemed to lose its territorial unity; portions were seized by neighbouring princes, and various claimants disputed for the mark itself. In 1323 the German king Louis IV, the first medieval king from the house of Wittelsbach, took advantage of this condition to bestow the mark upon his young son Louis and so to obtain in Brandenburg a position in the colonial lands of eastern Germany; but Louis did not receive the whole succession of the Ascanian margraves. The king was forced to acknowledge competing claims, especially in the borderlands. During the struggle for power in Germany between the families of Wittelsbach and Luxembourg, which began in 1342, there appeared in Brandenburg an old man who claimed to be the margrave Woldemar. He was gladly received by Casimir III of Poland and other neighbouring princes, welcomed by a large number of the people and, in 1348, invested with the margraviate by Charles IV, the successful Luxembourg candidate for the German crown. This step compelled the Wittelsbach margrave Louis to make peace with Charles, who abandoned the false Woldemar, invested Louis and his half brothers Louis the Roman and Otto with Brandenburg and in return was recognized as king. Louis made peace with his neighbours, finally defeated the false Woldemar and was recognized by the Golden Bull of 1356 as one of the seven electors. After Louis' death in 1361 Charles IV took advantage of a family quarrel to obtain a promise from Louis' two half brothers and successors that the margraviate should come to his own son, Wenceslas, in case the electors died childless. Louis the Roman died in 1365, and when his brother Otto, who had married Catherine, daughter of Charles IV, wished to leave Brandenburg to his own family, Charles began hostilities; but in 1373 an arrangement was made, and Otto, by the treaty of Fürstenwalde, abandoned the margraviate for a sum of 500,000 gold gulden.

Charles invested Wenceslas with the margraviate in 1373 but undertook its administration himself and passed much of his time at a castle which he built at Tangermünde. He diminished the burden of taxation, suppressed the violence of the nobles, improved navigation on the Elbe and Oder and encouraged commerce by alliances with the Hanse towns and in other ways. He caused a *Landbuch* to be drawn up in 1375, in which are recorded all the castles, towns and villages of the land with their estates and incomes. When Charles died in 1378, and Wenceslas became German and Bohemian king, Brandenburg passed to the new king's half-brother Sigismund, then a minor, and a period of disorder ensued. Soon after Sigismund came of age he pledged a part of Brandenburg to his cousin Jobst, margrave of Moravia, to whom in 1388 he pledged the remainder of the electorate in return for a large sum of money, which he needed to build up his position as king of Hungary. As this money was not repaid, Jobst obtained the investiture in 1397 from King Wenceslas. In 1411 Jobst died and Brandenburg reverted to Sigismund, now German king, who appointed Frederick of Hohenzollern, imperial burgrave of Nürnberg, as his representative to govern the margraviate. A further step was taken when, on April 30, 1415, the king invested Frederick and his heirs with Brandenburg, together with the electoral privilege and the office of chamberlain in return for a payment of 400,000 gold gulden; the formal ceremony of investiture was delayed until April 18, 1417, when it took place at Constance. (*See* Frederick I, elector of Brandenburg; Hohenzollern.)

Before the advent of the Hohenzollerns in Brandenburg its internal condition had become gradually worse and worse. The margraves, though according to constitutional law they were only the representatives of the German king, had always had a more or less free hand as leaders of colonization and territorial organization; and this independence had become almost complete in consequence of the emperor Frederick II's preoccupation with Italy and the downfall of his dynasty after 1250. Moreover, in contrast to the German southwest, feudal relationships did not complicate political geography to any great extent. The towns, the peasants in the villages, the prelates and the knights held their lands and derived their rights directly from the margraves. The *locatores* were installed as hereditary chief magistrates of the communities and received numerous encouragements to reclaim wastelands. The dues paid by these *locatores* in return for the concessions and the tax assessed on the peasants formed the main source of the revenue of the margraves. Gradually, however, the expenses of politics and warfare and the maintenance of numerous and expensive households (in consequence of the division of the country among several branches of the ruling dynasty) compelled them to pledge these dues for sums of ready money. The movement of population toward the east had been favourable both to the peasants, whose diligence and initiative had to be stimulated, and to the margraves, who exercised central control.

The 14th century saw both the petering out of colonization and the rise of the local nobility to political power. During the colonization period knights had been settled on lands about five times the size of a farmer's holding; but in most parts of the margraviate they were merely the peasants' important neighbours, not their lords. By the 14th century, however, the village authorities, formerly the margrave's servants, had become the local nobleman's agents, and the peasants sank into a condition of dependence and lost their right of direct appeal to the margrave. Many of the towns were forced into the same position. Others were able to maintain their independence and to make use of the pecuniary needs of the margraves to become practically municipal republics.

In the embarrassments of the margraves originated the power of the *Stände*, or estates, the nobles, the prelates and the towns. In 1280 the Ascanian margraves Otto V, Albert III and Otto VI had solemnly bound themselves not to raise a special *Bede* or extraordinary contribution without the consent of the estates except in cases of genuine emergency. Anarchy had reigned for a century before the Hohenzollern rule began; upper and lower Lusatia, the New Mark of Brandenburg and other outlying districts had been shorn away; and the electorate now consisted of the Old Mark and the Middle Mark with Priegnitz, Uckermark and Sternberg, a total area of not more than 10,000 sq.mi.

The First Hohenzollerns.—Such was the condition and extent of Brandenburg in 1411 when Frederick of Hohenzollern became margrave. He entered the electorate with a strong force in June 1412, but it was not until 1417 that his authority over it was undisputed. His intention to renew all territorial rights of his Ascanian predecessors provoked an invasion of the mark by an army of Pomeranians with their allies in 1420, when Frederick inflicted a severe defeat upon them at Angermünde; but in 1424 a temporary coolness between the elector and the emperor Sigismund led to a renewal of the attack in 1425, which Frederick was unable to repulse. This reverse induced him to leave Brandenburg in Jan. 1426, after handing over its government to his eldest son, John the Alchemist, and to spend the rest of his life engaged with the military and political problems arising from the Hussite Wars.

On Frederick's death on Sept. 21, 1440, he was succeeded in the electorate by his son Frederick II, surnamed "Iron" from the rigour of his government. Suppressing the rebellious nobles with ease, he found it less easy to deal with the towns. Three strong leagues had been formed among them about 1431, and the spirit of municipal independence was most prominently represented by the neighbouring towns of Berlin and Kölln, which had united in 1432. In his conflict with the towns, the elector's task was lightened by a quarrel between the ruling aristocracy and the trade guilds of Berlin, which he was called in to decide in 1442. He deposed the governing oligarchy and forbade the union of Berlin and Kölln (the two towns were to be kept separate in the future by the elector's castle on the Spree river); indeed all associations of towns, including membership in the Hanseatic league, were declared illegal throughout the elector's territory. The inhabitants soon chafed under these restrictions. A revolt broke out in 1447, but the power of the elector overawed the people, and after arbitration the arrangement of 1442 was re-established. In 1447 Frederick was compelled to cede the Old Mark and Priegnitz to his younger brother Frederick, under whose feeble rule they quickly fell into disorder. In 1463, however, when the younger Frederick died sonless, the elector united them again with his own possessions and took measures to suppress the prevailing anarchy. In his dealings with neighbouring rulers Frederick pursued a peaceful and conciliatory policy. An attempt, however, to secure the duchy of Stettin (now Szczecin) failed, and the concluding years of his reign were troubled by warfare with the Pomeranians. As did other contemporary princes, he obtained important concessions from Pope Nicholas V on the appointment of bishops and on other ecclesiastical matters in 1447, and in general he maintained cordial relations with the papacy. By 1467 both his sons were dead, and increasing infirmity led him to contemplate abdication. An arrangement was made with his brother Albert Achilles, to whom early in 1470 the mark was handed over, and Frederick retired to Plassenburg in Franconia, where he died on Feb. 10, 1471.

Albert Achilles (1470–86).—Albert III (*q.v.*) took up the struggle with the Pomeranians, which he soon brought to a satisfactory conclusion; for in May 1472 he not only obtained the cession of several districts but was recognized as the suzerain of their country and as its future ruler. The expenses of this war and heavy debts left by his predecessor led to a long-lasting dispute with the estates. Albert tried to introduce a system of excise in Brandenburg and finally succeeded in increasing his annual income from 17,000 to 23,000 gulden, mainly by carefully controlling his officials. But this amount was still only half that of his revenue from Franconia. Accordingly his political testament of 1473, the famous *Dispositio Achillea*, left Brandenburg undivided to his eldest son, John, while Franconia went to his second and third sons and thus remained separated from Brandenburg until 300 years after Albert's death.

The 16th Century.—Albert's son and successor, John Cicero (1486–99), was mainly interested in administration and brought a certain degree of order into the finances, but his poverty and the constant inroads of external enemies prevented him from seriously improving the condition of the country. He welcomed Italian scholars to the electorate and strove to improve the education of his people. When Joachim I (*q.v.*), his son and heir, undertook the government of Brandenburg, he found that highway robbery kept the lives and property of traders in continual jeopardy, but in a few years stern measures restored some degree of order.

By this time most of the nobility in Joachim's territories were adapting themselves to the fact that changes in military technique and the declaration of the Eternal Peace within the empire (1495) had restricted the possibilities of profitable war service, while the export of grain from the Baltic countries to western Europe made agriculture on a big scale a lucrative venture. The nobles used their political power in order to establish a firm hold over the land and over the persons of the peasants living in the neighbourhood of their seats. By depressing the status of the peasantry and by either enlarging its existing obligation to unpaid work or establishing such an obligation when it had not existed, they obtained the labour required for the considerably increased arable land under their direct control. By this process they came to form the Junker class of grain-exporting landowners whose existence was based on a combination of businesslike husbandry with the exercise of local administrative power, whereas the nobility of western Germany lived on rents collected from various sources.

The elector meanwhile gave a new organization to the highest court of justice, the *Kammergericht* for his territories, secured for himself an important voice in the choice of its members and ordered that the local law should be supplemented by the law of Rome. He founded the University of Frankfurt an der Oder in 1506. Joachim's attitude toward the teaching of Martin Luther, which had already won many adherents in the electorate, was one of unrelenting hostility. The Jews also felt the weight of his displeasure and were banished in 1510.

Joachim I bequeathed Brandenburg to his two sons. When he died on July 11, 1535, the elder, Joachim II (*q.v.*), became elector and obtained the Old and Middle Marks, while the younger, John (*q.v.*), or Hans of Brandenburg-Cüstrin, received the New. John went definitely over to the side of the Lutherans in 1538, and Joachim allowed the Reformed doctrines free entrance into his dominions in 1539. It was not the elector's intention to surrender completely to the "Church of Wittenberg," and he tried to steer a middle course by combining traditional ceremonies with the new doctrine; he obtained the approval not only of Luther but also of the emperor Charles V and was very careful not to make common cause with the Protestant group of princes organized in the League of Schmalkalden. Territorial policy was an important factor in Joachim's ecclesiastical decision, in view of the possibility of using secularized bishoprics as endowments for members of his dynasty.

In 1537 Joachim had concluded a treaty with Frederick II, duke of Liegnitz, which guaranteed to the Hohenzollerns the succession to the Silesian duchies of Liegnitz, Brieg and Wohlau (Legnica, Brzeg and Wolow) in the event of the ducal family's becoming extinct; this arrangement is important as the basis of the claim made by Frederick the Great on Silesia in 1740. The treaty was declared invalid in 1546 by the German king Ferdinand I, who as king of Bohemia was suzerain of the Silesian principalities; but the elector insisted on its legality. Of more immediate consequence was an arrangement made in 1569 with the representatives of Joachim's kinsman Albert Frederick, son of Albert (*q.v.*), duke of Prussia, after which the elector obtained the joint investiture of the duchy of Prussia from Sigismund II of Poland and was assured of the succession if the duke's family became extinct.

Joachim II's extravagance compelled him in 1540 to appeal for help to the estates. The estates voted him a sum of money as the price of valuable concessions, the most important of which was that the elector should make no alliance without their consent. Fresh liabilities were soon incurred, and in spite of frequent contributions from the estates of Joachim left at his death on Jan. 3, 1571, a heavy burden of debt to his son and successor, John George.

Joachim II's death was followed ten days later by that of his brother John, and as John left no sons the whole of Brandenburg was united under John George. The rule of John George was popular with the nobles and, to some extent, with the towns because his thrifty methods of government eased their financial position. Although by faith and in his ecclesiastical administration a Lutheran, he did not allow his religious tenets to involve his state in military adventures in defense of the Protestant cause. He died on Jan. 8, 1598. By his will his dominions were to be divided, as he left the New Mark to a younger son, Christian.

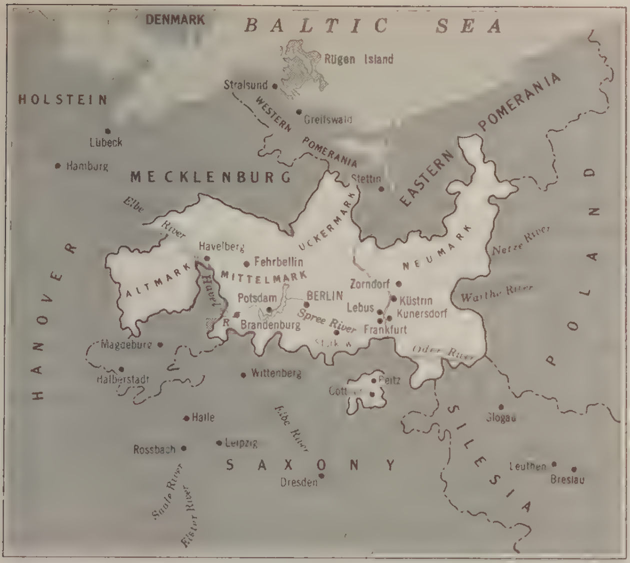
Joachim Frederick, the eldest son of John George, now became elector. He had been administrator of Magdeburg since 1566 and was also in control of the secularized Brandenburg bishoprics. Resigning these dignities in 1598, he contested his father's will and was successful in preventing a division of the electorate. Moreover, by a family agreement, known as the Gera bond, he definitely established the rule of primogeniture in Brandenburg for his dynasty. In Brandenburg he made concessions to the nobles at the expense of the peasantry and admitted the right of the estates to control taxation. In religious matters he was convinced of the necessity of a union between Lutherans and Calvinists and took steps to bring this about. Public opinion in Brandenburg, however, was too strong for him, and he was compelled to fall back upon the Lutheran *Formula Concordiae* and the religious policy of his father. Joachim Frederick seems to have been a wise ruler, who improved the condition of the mark in various ways. When he died, on July 18, 1608, he was succeeded by his eldest son, John Sigismund.

The most important facts in the internal history of Brandenburg during the 16th century were the growth of the power of the estates and the lapse of the peasantry into serfdom. A characteristic feature was the gradual decline of the towns in economic vigour and political importance, whereas in western Europe the rise of the commercial and industrial classes had already begun. The main trade routes to Leipzig and to Hamburg passed south and west of Brandenburg, and the change in the character of the landowning class, who had taken the export of grain into their own hands, considerably narrowed down the economic activities of the townspeople. These developments increased the power of the nobles, but circumstances were preparing for a great increase in the elector's authority. In the first place, the Reformation settlement had made him head of the church in his own territories; secondly, the introduction of Roman law served to strengthen the central authority and the central administration; thirdly, the tendencies to partition the electorate had been overcome; fourthly, the separate sections of the estates were inclined to act independently of one another rather than in unison; and, fifthly and most significantly, the Hohenzollern dynasty was becoming a power in international politics because of its possessions both in the east and in the west of Germany.

John Sigismund and Cleve-Jülich-Berg.—John Sigismund had married in 1594 Anna, daughter of Albert Frederick of Prussia and Maria Eleonora of Jülich, a union which not only strengthened the pretensions of the electors of Brandenburg to the succession in Ducal Prussia but also gave to John Sigismund a claim on the duchies of Cleve, Jülich and Berg and other Rhenish lands should the ruling family become extinct. In March 1609 the death of Duke John William, Maria Eleonora's brother, left these duchies without a ruler, and by arrangement they were occupied jointly by the elector and by his principal rival, the Catholic Wolfgang William, son of Philip Louis, count palatine of Neuburg. This proceeding was complicated by religious considerations and by the importance of these Rhenish lands for the Spanish line of communications between troops in the Netherlands and elsewhere on France's eastern frontier. However, on Nov. 12, 1614, the dispute was temporarily settled by the treaty of Xanten. Brandenburg obtained the duchy of Cleve with the counties of Mark and Ravensburg, but as the Dutch and Spanish garrisons were not withdrawn these lands were only nominally under the elector's rule. In 1613 John Sigismund had publicly professed himself a Calvinist, thus joining the group of princes of the Reformed religion already politically active in western Germany. In view, however, of the discontent this step aroused in the electorate, he abandoned attempts to proselytize and practically conceded religious liberty to his subjects. Over the Cleve-Jülich succession John Sigismund had incurred heavy expenses, and the public debt had again mounted. He was thus obliged to seek aid from the estates and to make concessions to the nobles. The elector spent much time in Ducal Prussia striving to assert his authority there. At last, with Albert Frederick's death (Aug. 26, 1618), he became duke according to the arrangement of 1569. He died, however, on Jan. 2, 1620 (new style; Dec. 23, 1619, old style), and was succeeded by his eldest son, George William.

The Thirty Years' War.—George William, who in 1616 had married Elizabeth Charlotte, sister of Frederick V, elector palatine of the Rhine (afterward king of Bohemia), had before his accession acted as his father's representative in Cleve. Although a Protestant, he was under the influence of Adam von Schwarzenberg, a Roman Catholic whose sympathies lay with the house of Austria. As a result the elector remained neutral during the early years of the Thirty Years' War (*q.v.*) in spite of his father-in-law's predicament and the obvious danger to his Rhenish lands. This attitude was not successful. Brandenburg was ravaged impartially by both parties, and in 1627 George William attacked his brother-in-law, Gustavus II Adolphus of Sweden, who was using Prussia as a base of operations for his war against Poland. This campaign was short and inglorious for Brandenburg, and the elector was soon compelled to make peace. Although alarmed by the Edict of Restitution of 1629, which ordered the restitution by Protestant princes of those ecclesiastical lands which they had taken over, George William took no steps to help the Protestants. In 1631, however, Gustavus Adolphus, at the beginning of his great expedition against the emperor Ferdinand II, marched on Berlin and compelled the elector to cede the fortress of Spandau and to aid him with men and money. Brandenburg troops then assisted the Swedes until the Swedish defeat at Nördlingen in 1634, after which the elector assented to the peace of Prague, made in May 1635 between the emperor Ferdinand II and John George I, elector of Saxony. The imperial armies did nothing, however, to drive the Swedes from Brandenburg. This was the principal reason why the elector was unable to annex Pomorze when its last duke, Boguslaw XIV, died in 1637. In 1638 George William transferred his residence to Königsberg, in Ducal Prussia, leaving Schwarzenberg to administer the electorate. Although his harsh measures aroused some irritation, Schwarzenberg did something to rid the land of the Swedes and to mitigate its many evils; but its condition was still deplorable when George William died at Königsberg on Dec. 1, 1640, leaving one son, Frederick William (*q.v.*).

Frederick William, "the Great Elector" (1640–88).—Frederick William's first task was to restore order and in this he was eminently successful. He freed Brandenburg of the Swedes and, in 1647, accepted the *status quo* of provisional possession in Cleve, Mark and Ravensberg (this was made definite in 1666).



FROM SIDNEY B. FAY, "THE RISE OF BRANDENBURG—PRUSSIA TO 1786," HENRY HOLT AND COMPANY (1937)

THE CENTRAL PROVINCES OF BRANDENBURG IN 1640

The terms of the peace of Westphalia in 1648 are the best commentary on the general success of the elector's policy. Although he was obliged to give up his claim to the western part of Pomorze in favour of Sweden, he secured the eastern part of that duchy, together with the secularized bishoprics of Halberstadt, Minden, Kammin and other lands, the whole forming a welcome addition to the area of Brandenburg. He was also promised the archbishopric of Magdeburg when its administrator, Augustus, duke of Saxe-Weissenfels, should die (the duke died in 1680).

The struggle between Sweden and Poland for the control of the Baltic coast on both sides of the Vistula estuary gave the elector the opportunity to obtain general recognition as sovereign in the duchy of Prussia, which his ancestor had taken over as a Polish fief. Military actions, political negotiation and changes of front brought about this important improvement in the European position of Brandenburg in 1660; under the terms of the peace of Oliva, which confirmed the Brandenburg-Polish treaty of Wehlau (1657), Frederick William's policy in the great conflict between Louis XIV and the Habsburgs was determined by his territorial interest in the Rhenish war zone, but still more by his great plan to obtain European backing for the conquest of the Oder estuary around Stettin from the Swedes. In this project he was finally frustrated, but his political and military activities increased the prestige of Brandenburg considerably. At his death on May 9, 1688, the state of Brandenburg, with Prussia behind it, was inferior to Austria alone among the principalities of the empire. The elector was regarded as the head of German Protestantism, his lands now covered more than 40,000 sq.mi. and his revenue had multiplied (though even so his policy remained dependent on subsidies from foreign powers). His army, still small but unsurpassed for its effective training, gave him the place formerly held by Sweden in the political and military combinations of the period.

The permanent financial needs of the army, his main instrument of power, proved the strongest motive in the Great Elector's internal policy, by which he initiated the age of absolutism for his territories. He fought successfully for a regular income no longer dependent on the votes of the various estates, which represented the local interest of the ruling classes in the widely dispersed territories under his rule. While his predecessor had been forced to leave the most important sources of income under the control of the estates, Frederick William was able to establish a loyal bureaucracy, well organized for the supervision of his domains and for the administration of the land tax in the rural districts and of the new system of excise in the towns. But the nobility were compensated at the expense of the peasantry; the Junker class yielded political power but completed its economic and social domination of the countryside. The land tax was paid by the peasants alone (the nobility's exemption having been confirmed in 1653), the peasants' legal status deteriorated, and villenage was more firmly established than ever.

In religious matters Calvinists and Lutherans were placed upon an equality, but the elector was unable to impress his own spirit of tolerance upon the clergy, who were occupied with ecclesiastical squabbles. The state of education and of public morals left much to be desired.

The Kingdom of Prussia.—The new elector, Frederick III (*see* FREDERICK I, king of Prussia), reaped the results of his father's policy under more favourable conditions. He assisted William of Orange to make his descent on England in 1688, allied himself with other German princes against Louis XIV and afterward fought on the side of the empire against both France and Turkey. Frederick's chief adviser about this time was Eberhard Danckelmann (1643–1722), whose services in continuing the reforming work of the Great Elector were very valuable; but having made many enemies, the electress Sophie Charlotte among them, he fell from power in Nov. 1697 and was imprisoned for several years. The most important work of the elector was to crown the labours of his father by securing the kingly title for himself and his descendants. Broached in 1692, this matter was brought up again in 1698 when the emperor Leopold I and his ministers, faced with the prospect of a fight over the Spanish succession, were anxious to conciliate Brandenburg. It was at length decided that the title should be taken from Prussia rather than from Brandenburg as the former country lay outside the empire, and in return Frederick promised to assist Leopold with 8,000 men. The coronation ceremony when Frederick made himself "king in Prussia" took place at Königsberg on Jan. 18, 1701. In his later years Frederick was largely preoccupied with participation in the War of the Spanish Succession and with watching his country's interests in the vicissitudes of the great Northern War. The territorial additions to Brandenburg during this reign were few and unimportant, but the state's comparative wealth and prosperity enabled the elector to do a good deal for education and to spend some money on buildings. In 1694 the University of Halle was founded; academies for arts and sciences were established; and Berlin was greatly improved.

Frederick died on Feb. 25, 1713. The subsequent history of Brandenburg is merged in that of Prussia (*q.v.*).

See also Index references under "Brandenburg" in the Index volume.

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BRANDENBURG (BRANDENBURG AN DER HAVEL), a city of Germany, lies on both banks of the Havel river, 61 km. (38 mi.) W.S.W. of Berlin. Pop. (1959) 86,862. Among the town's historic buildings are the cathedral on an island in the river, originally (1170) a Romanesque basilica but rebuilt in the Gothic style in the 14th century, and the 14th-century Gothic Katharinenkirche, built of brick. Brandenburg was much damaged in World War II and was largely rebuilt thereafter. Its industries include steelworks and the manufacture of tractors, machinery, textiles and leather; on the Plauer lake, west of the town are rolling mills, railway repair shops and an inland-water shipyard. Brandenburg is on the railway between Magdeburg and Berlin and is a busy inland-water port.

Slavs settled in the district by 512, and Brandenburg was founded as Brennabor or Brennaburg by the west Slavonic Hevelli tribe. The Hevelli were defeated in 928 by the German king Henry I ("the Fowler"), under whose son Otto I the town became a bishopric in 948. Fighting persisted between the Slavs and Germans until Albert I ("the Bear") subdued the Hevelli and in 1153 rebuilt the town. The Slav settlement on the south bank became the Altstadt ("old town"); the German village on the north bank became the Neustadt ("new town") and the seat of the margraves of Brandenburg (*q.v.*). The two parts were not united under one municipality until 1715. In 1544 the bishop became Lutheran, and in 1598 the see was incorporated in the electoral domains.

After the dissolution of Prussia in 1947, Brandenburg became a regional capital in the district of Potsdam, German Democratic Republic.

BRANDES, GEORG MORRIS COHEN (1842–1927), Danish critic and scholar, who had an unrivaled influence on Scandinavian literature after 1870, was born at Copenhagen, Feb. 4, 1842, of a Jewish family. In his youth he was influenced by Kierkegaard, Taine, Sainte-Beuve and John Stuart Mill. Feeling it his mission to bring Denmark out of cultural isolation, he became a friend of Ibsen, who charged him to lead the revolution of the spirit for which he himself was fighting. In 1871 Brandes began a series of lectures at Copenhagen university, published as *Hovedstrømninger i det 19de Aarhundredes Litteratur* (1871–87; Eng. trans., *Main Currents in 19th-Century Literature*, 1901–05), describing the growth and defeat of reaction. He succeeded in creating a following among the Copenhagen intelligentsia, although attacked as an "atheist Jew" by conservative opinion. Having been refused the professorship of aesthetics at Copenhagen and victimized in other ways, he settled in Berlin from 1877 to 1883.

During the 1870s and 1880s Brandes wrote many scholarly studies, illustrating his radical ideas. These include monographs on Kierkegaard, Ferdinand Lassalle, Lord Beaconsfield and Ludvig Holberg, and *Det moderne Gjennembruds Mænd* (1883; "The Men of the Modern Break-Through"; *i.e.*, his own followers). His *Danske Digtere* (1877; "Danish Poets") shows his penetrating critical gifts. In the late 1880s, influenced by Nietzsche, Brandes developed a philosophy of aristocratic radicalism, expressed in various essays, 1889–1905 (collected in Eng. trans. as *Friedrich Nietzsche*, 1909), and in his later biographies of Shakespeare, Goethe, Voltaire, Julius Caesar and Michelangelo. In other writings he discussed contemporary problems and gave an account of his travels, especially in Russia and Poland. He never lacked courage in denouncing tyranny and violence, and throughout his life remained a controversial figure. Such works as *Sagnet om Jesus* (1925; Eng. trans., *Jesus, a Myth*, 1926) made him many enemies, but his influence spread far beyond his native country. He died at Copenhagen, where he had become a professor of aesthetics in 1902, on Feb. 19, 1927.

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BRANDING. A brand is a distinctive design made by hot or superchilled metal, chemical, tattoo or paint for purposes of identification of livestock or goods; in agricultural usage it may also include tagging and notching. Brands are applied to animals principally to establish ownership, but they are also used widely for keeping records of purebred lines and for identification in disease control and age differentiation. Professional animal breeders sometimes adopt brands as trademarks to indicate high standards of quality.

Historical evidence indicates that hot-iron branding of livestock was practised in Egypt as early as 2000 B.C. In the 16th century Hernando Cortes introduced branding to North America, using three Christian crosses to mark his cattle and horses. As ranching spread across the open ranges, brands to show ownership developed into a heraldry as colourful as the armorial bearings of knighthood.

Branding of beef cattle and horses continued in general use in parts of North and South America and Australia. To prevent duplication of brands and to give legal protection to livestock owners, national and state governments passed brands acts requiring registration of all brands and making it an offense to alter registered brands. In the range country of western United States, laws require branding of cattle that run on public lands, and in some states it is illegal to slaughter unbranded animals. As hides became more valuable, laws were changed to permit stockowners to apply smaller brands to less valuable parts of the hide, such as jaw, neck or legs. In the 1960s scientists discovered a painless method of branding livestock with intense cold which brings about a growth of white hair and depigmentation where the superchilled metal is applied. Introduction of tranquilizer drugs made it possible to replace older methods of immobilizing large animals before applying marks and brands.

Development of permanent tattoo inks led to increased use of this method of branding. Dairy cattle are commonly branded with tattoo hand pincers, the application usually being inside the ear. Horses are sometimes tattoo branded in the upper or lower lip with clamp devices. Commercial poultrymen and fur farmers also brand poultry and fur-bearing animals with tattoo marks.

Swine breeders identify their animals with ear markings and notchings, a method occasionally applied to cattle, goats and sheep. Sheep most usually, however, are branded on the back with paint or lanolin-based dyes that adhere to the wool and are resistant to sun, air and moisture, but are dissolvable in the wool-scouring process used in commercial plants.

In lumbering areas where logs are transported mainly by floating down rivers to sawmills, identification marks are applied to logs with branding axes. In the 19th century American loggers devised thousands of ingenious brands, many of them reflecting the lusty humour of the woodsmen. Sorters in the collecting booms were able to determine ownership by brands and thus route logs to the proper mills. Each end of a log was marked, and in areas where organized thieves "rustled" river timber by cutting off the ends, owners adopted the practice of stamping brands into the middle of the log for additional protection. (D. A. B.)

Human Branding.—The Greeks branded their slaves with a delta, Δ, for *doulos*, "slave." Robbers and runaway slaves were marked by the Romans with the letter "F" (*fur*, "thief"; *fugitivus*, "fugitive"); and the toilers in the mines and convicts condemned to figure in gladiatorial shows were branded on the forehead for identification. Under Constantine the face was not permitted to be so disfigured, the branding being on the hand, arm or calf. The canon law sanctioned the punishment, and in France galley slaves could be branded "TF" (*travaux forcés*) until 1832. In Germany branding was illegal. The punishment was adopted by the Anglo-Saxons, and the ancient law of England authorized the penalty. By the Statute of Vagabonds (1547) vagabonds, gypsies and brawlers were to be branded, the first two with a large "V" on the breast, the last with "F" for "fray maker." Slaves who ran away were branded with "S" on cheek or forehead. This law was repealed in 1636. In the 18th century coinage offenses were punished by branding the right cheek with the letter "R" for "rogue." From the time of Henry VII, branding was inflicted for all offenses which received benefit of clergy, but it was abolished for such in 1822 (*see* Clergy, Benefit of). In 1698 it was enacted that those convicted of petty theft or larceny, who were entitled to benefit of clergy, should be "burnt in the most visible part of the left cheek, nearest the nose." This special ordinance was repealed in 1707.

Cold branding or branding with cold irons became in the 18th century the mode of nominally inflicting the punishment on prisoners of higher rank. Such cases led to branding becoming obsolete, and it was abolished in 1829 except for deserters from the army. These were marked with the letter "D" by tattooing with ink or gunpowder. Notoriously bad soldiers were also branded with "BC" ("bad character"). By the British Mutiny act of 1858 it was enacted that the court-martial, in addition to any other penalty, might order deserters to be marked on the left side, two inches below the armpit, with the letter "D," such letter to be not less than one inch long. In 1879 this was abolished.

In the colonies in America the branding of runaway slaves and petty criminals was fairly common but was abolished before the American Revolution.

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BRANDT, WILLY (1913–), German statesman, became on Oct. 21, 1969, his country's first Social Democratic chancellor in more than 39 years. His election was welcomed not only by West Germany's allies but also by the countries of Eastern Europe, for reconciliation with them had always been a cornerstone of his policy. Soon after taking office he proposed talks with the Soviet Union and Poland aimed at reducing tension, and his government was the first to acknowledge the existence of two German states, although stipulating that neither could regard the other as a foreign country. A firm supporter of a united Europe, Brandt exerted his influence to break down French objections to enlarging the European Economic Community (EEC). More than any other statesman he helped bring nearer the prospect of negotiations on the entry of Britain and other countries to the EEC.

Born Karl Frahm at Lübeck on Dec. 18, 1913, Brandt attended a grammar school and passed his university entrance examination in 1932. But a year later, when the Nazis came to power, his activities as a young Social Democrat brought him into conflict with the Gestapo and he had to flee the country to escape arrest. It was at this time that he assumed the name Willy Brandt. He went to Norway and earned a living as a journalist. When the Germans occupied Norway he escaped to Sweden where he remained for the duration of World War II. After the war he returned to Germany as a Norwegian citizen, and for a time was press attaché at the Norwegian mission in Berlin.

Pressed to return to politics, he became a German citizen again and, after a period as Berlin representative of the Social Democratic Party (SPD) Executive Committee, was elected a member of the Federal Parliament in 1949. Nine years later he became governing mayor of West Berlin, a post in which he achieved world fame. In times of crisis, as when the Soviet Union in 1958 demanded that West Berlin be given the title of a demilitarized free city, or at the building of the Berlin Wall in 1961, Brandt did not waver. He succeeded Erich Ollenhauer as chairman of the SPD in 1964, and campaigned for the office of chancellor three times—in 1961, 1965, and 1969.

When the grand coalition government of Christian Democrats and Social Democrats was formed in 1966, Brandt became foreign minister and vice-chancellor. His party improved its performance at the federal election in 1969 and formed a coalition government with the small Free Democratic Party, pushing the Christian Democrats into opposition for the first time. The first major decision of his government was to revalue the mark, the second to sign the nuclear nonproliferation treaty. (N. CR.)

BRANDY is an alcoholic liquor distilled from the fermented juice of grapes or other fruits and used as an after-dinner drink, as a flavouring in coffee and other foods and in mixed drinks. Brandy is usually aged for some time in wood. The word "brandy" came into the English language originally as *brandywine, brandewine* or *brandwine* from the Dutch *brandewijn*, from *branden*, "to burn," "distill," plus *wijn*, "wine." The art of distillation was known to the east long before it was introduced into the west. It was introduced to the Italians to produce *acqua di vite* or *arzente* in the 13th century or earlier, and from there the art traveled to France, where it produced *eau-de-vie*. The Moors introduced the process into Spain. The production of brandy became much more widespread in Europe in the middle of the 17th century.

The processing and the distillation of brandy are governed by laws or regulations of the country in which the brandy is produced. France and the United States are the chief producers; others are Greece, Spain, Portugal, South Africa, Italy and Peru.

In the United States, under the Internal Revenue Code of federal regulations 1954, brandy is spirits distilled solely from the fermented juice, mash or wine of fruit, or from the residue thereof, and distilled at less than 190 proof (95% alcohol by volume) in such a manner that the distillate possesses the taste, aroma and characteristics generally attributed to brandy.

The regulations further state that brandy to be used as a beverage cannot be distilled over 170 proof (85% alcohol) and must be distilled from the juice or mash of whole, sound, ripe fruit or from natural wine, specially sweetened natural wine or standard agricultural wine made from dried fruit, having a volatile acidity calculated as acetic acid and exclusive of sulfur dioxide not in excess of .20 g. per 100 millilitres with or without the addition (to juice or wine only) of not more than 20% by weight of the pomace of such juice or wine, or 30% by volume of the lees of such wine, or both, and this is classed as fruit brandy. Pomace is the pulpy mass remaining after the wine or juice is drawn off the fruit. The lees are sediment, or dregs.

Grape brandy is derived exclusively from grapes and is labeled as grape brandy. Fruit brandy, other than grape brandy, derived exclusively from one variety of fruit, must be designated by the word "brandy," qualified by the name of such fruit; *e.g.*, apricot brandy, cherry brandy, plum brandy, blackberry brandy, peach brandy, orange brandy, apple brandy, except that apple brandy may be designated as applejack.

Proof is an old English term for the strength or quality of spirits. In England 100 proof spirit contains 57.10% by volume of alcohol. In the U.S. proof spirit or 100 proof spirit contains 50% by volume of alcohol.

In the U.S. beverage brandies are distilled at not over 170 proof, while what is known as high-proof brandy can be distilled up to 190 proof. The high-proof brandies are used almost exclusively in fortifying dessert wines. The annual production of beverage brandy in the U.S. in the early 1960s was approximately 3,000,000 proof gallons (one proof gallon = one gallon of 100 proof spirits), while the production of high-proof brandies (those between 170 proof and 190 proof) was approximately 27,000,000 proof gallons. High-proof brandy and neutral spirits are produced in Italy almost wholly for use in making sweet or fortified (dessert) wines.

The congeners in brandy are responsible for its taste and character, but it is recognized that the amounts necessary are quite small in comparison to the volume of the spirits. In France the brandies are required to have a minimum "coefficient of non-alcohol," obtained by totaling the contents of these substances and expressed as milligrams per 100 millilitres of absolute alcohol. The lowest coefficient permitted is 280, but, generally, French brandies average 400 or 500 or more.

The Cognac Region of France.—The most famous beverage brandies are produced in or near the town of Cognac, in the Charente *département* of southwestern France. For labeling purposes the Cognac brandy region was officially defined by decree on May 1, 1909, as including all of the Charente *département* except for a few northern communes and extending beyond the Charente boundaries on the north into parts of Deux-Sèvres *département* and on the southeast into Dordogne. Only those brandies produced in the officially defined Cognac region can bear the word "Cognac" on their labels. Much brandy, however, is produced in other regions of France, and in other parts of the world.

The Cognac region is divided into seven subregions according to the quality of brandy produced. The best quality brandy comes from grapes produced in the Grande Champagne subregion, followed by that made from grapes grown in the Petite Champagne. Cognac distilled from wines of the Borderies, Fins Bois, Bons Bois, Bois Ordinaires and Bois à Terroir subregions are of varying quality. The best brandies are distilled from grapes grown on soil with a high limestone content.

White varieties of grapes, for reasons not known, produce better brandy than do red grapes. The varieties used are the Folle-Blanche, St. Émilion and Colombard. The St. Émilion grape was used almost exclusively in the early 1960s because of its superior ripening qualities and ability to resist mildew and other causes of spoilage. The soil and climatic conditions make the grapes of the Cognac region highly acidic, and when the juice is fermented, the resulting wine has an alcoholic content of from 7% to 10%. The high-acid content contributes to the quality of the resulting brandies.

Processing Cognac Brandy.—In making the wine that is later to be distilled into cognac brandy the grapes are crushed in a roller-type crusher and pressed in a basket-type press. The white juice is allowed to ferment naturally without the addition of sugar or sulfur dioxide. The high acidity of this juice favours a clean fermentation with no deleterious flavours. It also seems to inhibit oxidation of the wine, which would adversely affect the flavour of the brandy. The wine is distilled during the winter months in the traditional pot stills of the region by the method known as the *méthode charentaise*. The still holds about 250 gal. and is enclosed in a brick firebox; either wood or coal is used to heat the wine. The first distillation, which is about 25% alcohol, is called *brouillis*. There are generally three charges of wine, and the *brouillis* collected is returned to the still for a final distillation. This distillation is done very slowly and with much care. About 1% to 2% of the first of the distillation, or heads, is collected separately and eventually mixed with the tails and redistilled to recover their alcoholic content. The middle cut or the heart of the brandy is called the *bonne chauffe*. This cut, which starts out at about 150 proof, drops gradually to about 68 to 70 proof, after which the remainder is run to tails to recover the remaining alcohol.

The cognac collected is then run into casks of Limousin or Troncais oak for aging. Before being coopered into casks, the oak is aged for several years, which helps in imparting a desirable character to the brandy. Brandy when it comes from the still is colourless, but under aging in oak barrels or casks, it gradually becomes yellowish brown in colour; caramel colouring often is added to meet commercial standards. Before new casks are filled, they are often washed with steam under pressure and then soaked for some time with a solution of alcohol. Cognacs are sweetened with sugar sirup in order to soften the blend. The amount added is generally about ½% to 1% by volume. The particular flavour of cognac brandy is due, among other things, to an oily substance produced by yeast cells in the distilling substance, to certain qualities of the grape attributable to their variety as well as the soil and climate, to the variety of oak in which the brandy is aged, to long aging and to blending with older brandies. Most cognacs are from 5 to 10 years old but have some aged stock blended in them, which may be 25 or 30 years old.

Other Brandies.—Armagnac is a brandy produced in the *département* of Gers, and the best armagnac is produced in the Bas Armagnac. The white wine made for distilling is a wine made essentially from the same variety of grapes as those used in the Cognac region. However, the armagnac brandy is distilled in a type of still called the *alambic du Gers Système Verdier*. The wine is fed into this still continuously, but the spent wine is drawn off intermittently. The brandy flows from the still at about 52% to 54% alcohol and is run into casks of about 100-gal. capacity. Only one distillation of the brandy is made. These casks are made from Gascony black oak, which is given a great deal of credit for the distinctive flavour of armagnac brandy. Armagnac is recognized as an outstanding brandy. Here again proper maturation in the wood is as necessary to produce a good armagnac as a cognac.

Stars on brandy labels have no standardized meanings. Neither do such symbols as "V.S.O.P.," which once meant "very superior old pale" brandy. The so-called Napoléon brandies 80 to 104 years old are a bit of romantic nonsense aimed at promoting sales. Whereas cognac will age in the wood with improvement for from 50 to 55 years, the cost of aging brandy this long would be extremely excessive. Brandy ages either very slowly or not at all in the bottle.

Some brandy is made by distilling the pomace, or marc. In France this brandy is known as *eau-de-vie de marc* and is akin to the dop brandy of South Africa and the *grappa* brandy in the United States.

In the U.S. most of the grape beverage brandy is produced in California by the use of continuous or column stills. Not much attention is paid to the grape varieties used. The use of a column still with its accompanying high rectification (purification) apparently eliminates certain of the congeners responsible for the distinguishing character and flavour of the cognac brandies. There also is a tendency to make the California brandy more neutral. The California brandy is generally a straight brandy barreled at 102 proof in either new or used white oak cooperage of about 50-gal. capacity. Rectification of beverage brandy is allowable upon payment of an excise tax and provided that not more than 2½% by volume of approved ingredients are added. These added ingredients are generally sugar, sirup and wine, which tend to give body and smoothness to the final product. Brandy is generally aged about four to six years in California. No old stocks of brandy are kept for blending purposes as in France. The quality of California brandy is generally improving as most of the aldehydes and a large percentage of the fusel oils are being removed.

See also ALCOHOLIC BEVERAGES, DISTILLED. (E. M. BN.)

BRANDYWINE, BATTLE OF, an engagement of the American Revolution (*q.v.*) fought Sept. 11, 1777, in which Sir William Howe's British army of about 15,000 defeated George Washington's American army of about 11,000. The battle took place in the vicinity of what is now Chadds Ford, on Brandywine creek in southeastern Pennsylvania, about 25 mi. S.W. of Philadelphia. The area is now maintained as a battlefield park.

Howe embarked his army at New York city early in July 1777 and proceeded, by way of Chesapeake bay, to approach Philadelphia from the south and west. Landing at the head of the Elk river, Howe's troops marched toward Philadelphia but found Washington's army barring their crossing of the Brandywine. Rather than attempt to force the sometimes steep banks of the creek, Howe merely feinted against Washington's front with one wing of his army, while he marched northward with a somewhat stronger wing to cross the Brandywine and fall upon the American right and rear. At best he hoped this envelopment might destroy the American army; short of that, the enveloping column might interpose itself between Washington and Philadelphia and, thus, open the city. During the morning and early afternoon of Sept. 11, Washington unaccountably ignored evidence that Howe was turning his right. Thus, the turning column was across the Brandywine before Washington reacted to it, and the troops he dispatched to oppose it had little time to form a defensive line. Hastily assembled, both flanks of the new American line quickly collapsed. The centre fought valiantly, however, and held long enough to permit the army reserve to form a second line, which, in turn, held stubbornly to protect the road toward Philadelphia so that Washington might withdraw safely those troops who had remained in the original position along the Brandywine. In the end, the British troops occupied the battlefield, but they neither destroyed Washington's army nor cut it off from the American capital at Philadelphia. Washington still stood before the city, and it required a skilful campaign of maneuver before Howe could find his way into it. Even then, the bravery of many of the American troops kept Washington's army intact and, thus, the Revolution alive. (R. F. WE.)

BRANGWYN, SIR FRANK (1867–1956), English decorative painter, was born May 13, 1867, at Bruges, Belg. When he was 15 he began designing textiles for William Morris, and a large collection of his work is at the William Morris museum, Walthamstow, Essex. After selling his first picture at the Royal Academy exhibition of 1885, he went to sea, visiting Africa and the east, where he acquired a great love of oriental art. Elected to the Royal Academy in 1919, he was knighted in 1941 and in 1952 became the first living artist to be honoured with a retrospective exhibition at the academy. Brangwyn showed his mastery of design in richly if somewhat floridly coloured, dramatic, large compositions, such as those in Skinner's hall and the Royal exchange, London, Christ's hospital, Horsham, Sussex, the Canadian house of parliament, Ottawa and Radio City, New York. His work on the royal gallery in the house of lords, begun in 1925, was rejected when partly finished, and in 1933 he presented it to the town of Swansea, Wales. Brangwyn also worked as architect, book illustrator, and pottery and stained glass designer. He died at Ditchling, Sussex, on June 11, 1956.

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Bunt, *Water-colours of Sir Frank Brangwyn* (1958); V. Galloway, *Oil and Mural Paintings of Sir Frank Brangwyn* (1962); F. Brangwyn, *Drawings of Sir Frank Brangwyn*, ed. by J. D. Boyd (1967).
(D. L. Fr.)

BRANKS (Scolding Bridle), a contrivance formerly in use throughout England and Scotland for the punishment of scolding women. It seems never to have been a legalized form of punishment, but corporations and lords of manors in England, town councils, kirk sessions and barony courts in Scotland assumed a right to inflict it. While specially known as the "gossip's or scold's bridle," the branks was also used for women convicted of petty offenses, breaches of the peace, street brawling and abusive language. Apparently, it was not used in America, where, instead, the tongue of the scold was sometimes put into a cleft stick.

In its earliest form it consisted of a hoop headpiece of iron, opening by hinges at the side so as to enclose the head, with a flat piece of iron projecting inward so as to fit into the mouth and press the tongue down. Later it was made, by a multiplication of hoops, more like a cage, the front forming a mask of iron with holes for mouth, nose and eyes. Sometimes the mouth plate was armed with a short spike. With this on her head the offending woman was marched through the streets by the beadle or chained to the market cross to be gibed at by passers. The date of origin is doubtful. It was used at Edinburgh in 1567, at Glasgow in 1574, but not before the 17th century in any English town. A branks in the church of Walton-on-Thames, Surrey, bears the date 1633, and as late as 1856 another was in use at Bolton-le-Moors, Lancashire.

See W. Andrews, *Old Time Punishments* (1890); A. M. Earle, *Curious Punishments of Bygone Days* (1896). (R. G. Cl.)

BRANSFIELD, EDWARD (*c.* 1795–1852), English naval officer who was the first man to chart a portion of the antarctic mainland and holds the honour of having discovered that continent. The South Shetland Islands were discovered in Feb. 1819 by W. Smith, during a voyage to Valparaíso, Chile, in the brig "Williams." On arrival, he reported to Capt. W. H. Shirreff of H.M.S. "Andromache," who subsequently chartered and dispatched the "Williams" to survey the newly discovered lands. Shirreff appointed Bransfield, master of the "Andromache," to command this voyage, Smith remaining aboard as pilot. The "Williams" arrived at the South Shetlands in Jan. 1820. Bransfield repeated Smith's examination of the islands, landed on King George Island to take formal possession and coasted to Deception Island. He then turned southward, charted Tower and Ohlin islands and skirted the northern coast of Trinity peninsula, sighting and charting "high mountains, covered with snow" (Mts. Bransfield and Jacquinot). This discovery was made on Jan. 30, 1820. He then followed the ice edge to Elephant and Clarence islands, where he repeated the ceremony of taking possession.

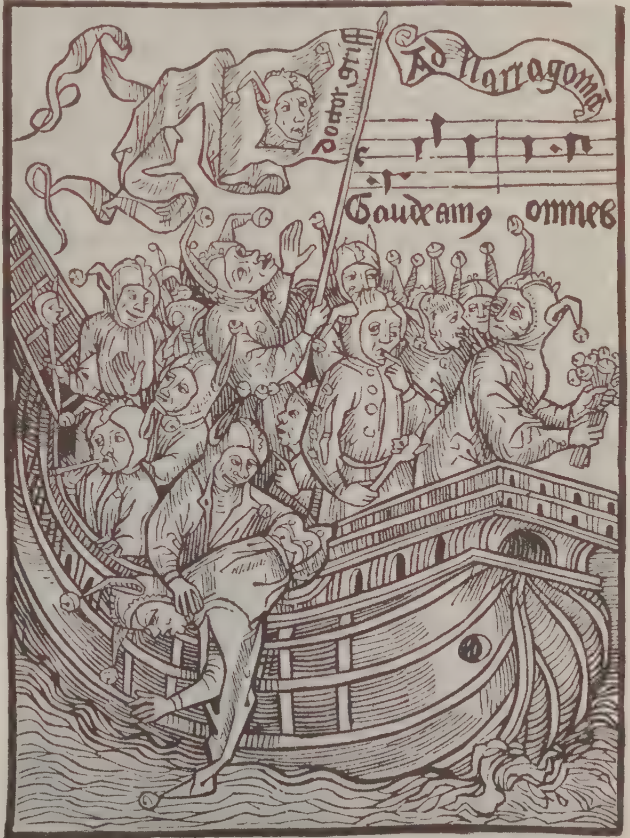
On his return to Valparaíso, Bransfield delivered his charts and journals to the senior naval officer, who forwarded them to the admiralty. The original charts survive in the hydrographic department, but his journal has been lost. No official account of the voyage was issued, but two private versions are extant, in the *Edinburgh Philosophical Journal* (April 1821) and in the *London Literary Gazette* (Nov. 1821).

See *Geographical Journal* (Oct. 1939) and *Mariner's Mirror* (July 1941). (B. B. Rs.)

BRANT, JOSEPH (1742–1807), American Indian chief of the Mohawk tribe, known also by his Indian name, Thayendanegea, was born on the banks of the Ohio river in 1742. He was educated at Lebanon, Conn., in Moor's Indian Charity school, in which Dartmouth college had its origin. He took part, on the side of the English, in the French and Indian War and in 1763 fought with the Iroquois against Pontiac. He later devoted himself to missionary work and translated the Prayer Book and St. Mark's Gospel into the Mohawk tongue (1787). When Guy Johnson (1740–88) was named superintendent of Indian affairs in 1774, Brant became his secretary. At the outbreak of the American Revolution, he remained pro-British and organized and led the Mohawks and other Indians allied to the British against the settlements on the New York frontier. After the war he discouraged the continuance of Indian warfare on the frontier and aided the commissioners of the United States in securing treaties of peace with the Miamis and other western tribes. Settling in Upper Canada, he again devoted himself to missionary work and in 1786 visited England, where he raised funds to erect the first Episcopal Church in Upper Canada. His character was a peculiar compound of the traits of an Indian warrior—with few rivals for daring leadership—and of a civilized politician and diplomat of the more conservative type. He died on an estate granted him by the British government on the banks of Lake Ontario on Nov. 24, 1807.

BRANT, SEBASTIAN (1458?–1521), German humanist and satirical poet, is best known for his landmark allegory, *The Ship of Fools*. He was born at Strasbourg and studied in Basel, where he was made doctor of laws (1489) and taught in the law faculty. When Basel joined the Swiss Confederation (1499), he returned to Strasbourg; in 1503 he was made city clerk. Maximilian I appointed him imperial councillor and count palatine.

Brant's writings are varied: legal; religious (hymns to the Virgin and the saints); political (in support of Maximilian, against the French and Turks); and, especially, moral (adaptations of medieval didactic works: *Facetus*, 1496; *Disticha Catonis*, 1498; *Freidank*, 1508). His chief work, however, is *Das Narrenschiff* (1494; *The Ship of Fools*), an allegory telling of a ship laden with fools and steered by fools setting sail for Narragonia, the "fool's paradise." The ship allegory, probably familiar to readers from Shrovetide customs, is not sustained; instead Brant presents over 100 fools representing every contemporary shortcoming, serious and trivial. Criminals, drunkards, ill-behaved priests and lecherous monks, spendthrifts, bribe-taking judges, busybodies, and voluptuous women are included in this unsparing, bitter, sweeping satire by Brant of the weaknesses, vices, and grotesqueries of his time. His aims are the improvement of his fel-



BY COURTESY OF PHILIP KRAPP

"THE SHIP OF FOOLS" SETS SAIL FOR NARRAGONIA; WOODCUT FROM THE FRONTISPIECE TO BRANT'S "DAS NARRENSCHIFF," 1494, FROM A FACSIMILE EDITION, 1913 lows and the regeneration of church and empire. The language is popular, the verse rough but vigorous, and each chapter is accompanied by a woodcut, probably by Albrecht Dürer, beautifully executed but often only loosely connected with the text. Its success was immediate. Numerous editions and adaptations appeared, as well as translations into Latin (the first by Jakob Locher, 1497), Low German, Dutch, French, and English (the first by Alexander Barclay, 1509). A whole "fool literature"—by Erasmus, Thomas Murner, Hans Sachs, Johann Fischart—followed. Yet Brant essentially looks backward. He is not a forerunner of the Reformation nor even a true humanist, but rather a last embodiment of medieval thought and ideals.

Bibliography—The best edition of *Narrenschiff*, by F. Zarncke (1854; reprinted, 1961), contains most of the other works; there is a facsimile ed. by F. Schultz (1913); and a modern Eng. trans. by E. H. Zeydel (1944). *See* also A. Pompen, *The English Versions of the Ship of Fools* (1925); *Die deutsche Literatur des Mittelalters. Verfasserlexikon*, ed. by W. Stammler, vol. 1 and 5 (1933 and 1955). (J. R. We.; X.)

BRANTFORD, the county seat of Brant county, Ontario, Can., is located 21 mi. W. of Hamilton on the Grand river, which was formerly commercially navigated between Brantford and Lake Erie. First named Brant's Ford after Joseph Brant (*q.v.*), the Mohawk chief who was granted the site in 1784 for settlement of the Six Nations Indians, after the American Revolution, Brantford was incorporated as a town in 1847 and became a city in 1877. Agricultural implements, motor coaches, truck bodies, refrigerators, stoves, garments and clocks are among the products of more than 150 factories. The city has a statue and a monument commemorating Alexander Graham Bell's first successful experiment with the telephone carried out at nearby Tutela Heights where the Bell homestead is now a museum. Pop. (1966) 59,854. (G. Fn.)

BRANTING, KARL HJALMAR (1860–1925), Swedish statesman, a pioneer of social democracy in his country and the winner of the Nobel peace prize in 1921, was born in Stockholm on Nov. 23, 1860. After studying science at Stockholm and at Uppsala, he began work for the Radical newspaper *Tiden* in 1883 and became its editor shortly afterward. From 1886, however, he was editor of the *Socialdemokraten,* and when the Social Democratic Labour party was formed in Sweden in 1889, he was prominent among its founders. Elected to the lower chamber of the *riksdag* for the first time in 1896, he was until 1902 the only Social Democrat in it. His advocacy did much to ensure that the separation of Norway from Sweden came about peacefully in 1905. In 1907 he became the leader of his party.

Branting had been energetic in his party's mobilizing of the working classes in support of the demand for adult, equal and direct suffrage (*see* Sweden: *History*), but he also took care to make co-operation possible between his party and the progressive middle class. From this resulted the Liberal-Socialist coalition government of 1917 (in which he was minister of finance) and the constitutional reform of 1918, which facilitated the spread of social democracy throughout Sweden.

Throughout World War I, Branting insisted that Sweden should be strictly neutral. He was appointed delegate to the Paris peace conference in the spring of 1919 and to the London discussions on the Åland Islands in 1920. He was also the first Swedish representative in the assemblies of the League of Nations, becoming a member of its council in 1923. He was chairman of the Berne conference of the Second (Socialist) International in 1919 and became a member of the permanent international commission for reconstruction within the International.

In March 1920 Branting formed Sweden's first Social Democratic government, but the elections of the following September went against him. The elections of Sept. 1921, however, enabled him to form another government, which remained in power till April 1923. In Oct. 1924 he formed a third government, but ill-health made him resign the leadership to Rickard Sandler on Jan. 25, 1925. He died in Stockholm on Feb. 24, 1925.

BRANTÔME, PIERRE DE BOURDEILLES, Abbé and Seigneur de (*c.* 1540–1614), French soldier and chronicler, and author of a valuable and informative account of his life and times. He was born in Périgord, third son of the baron of Bourdeilles, at some date between 1539 and 1542. After spending his early childhood at the court of Marguerite de Valois, where his mother and maternal grandmother were ladies of the royal household, he went to Paris to continue his education, which was finished at the university at Poitiers in 1555. He then visited the court of Henry II, by whom he was given the abbey of Brantôme, but, although he also held several other benefices, his contact with religious life was limited to the enjoyment of ecclesiastical revenues.

Adventurous and brave by nature, though without any real military talent, he passed most of his life in the combined roles of courtier and soldier. Between 1557 and 1569, wars and fighting took him to Italy, Spain, Portugal, Malta and north Africa, while in 1561, when he was part of the retinue of the widowed Mary Stuart, he visited Scotland and England. Intermittent fever forced him to retire to his abbey from 1569 to 1571. Thereafter during the reigns of Charles IX and Henry III he was rarely absent from court until he incurred royal disfavour. In the wars of religion he fought against the Huguenots and took part in the siege of La Rochelle, but he was influenced by the ideas of the reformers. In later years, severe incapacity resulting from a fall while riding provided him with the opportunity to write. He died on July 5, 1614.

His works, characterized by frankness and naïveté, consist mainly of accounts of battles or tales of chivalry. Though not a great or reliable historian, his bold, capricious and amoral character well equipped him to be a chronicler of the 16th century. The first edition of his works was published posthumously in 1665 and 1666 as *Mémoires de Messire Pierre de Bourdeilles.* It comprises *Les vies des dames illustres, Les vies des dames galantes, Les vies des hommes illustres et grands capitaines français* and *Les vies des hommes illustres et grand capitaines étrangers.* There were many later editions, most of which have also included *Discours sur les duels;* the edition produced by Ludovic Lalanne for the Société de l'Histoire de France (11 vol., 1864–82) is definitive.

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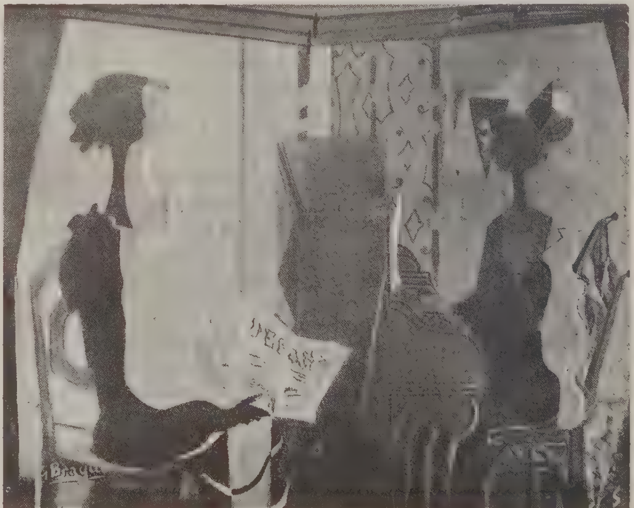
BRAQUE, GEORGES (1882–1963), one of the most distinguished modern French painters, was born at Argenteuil on May 13, 1882. He passed his youth at Le Havre where he became an apprentice house painter and attended night classes in drawing; he then moved to Paris. His early paintings (1906–07) were in the Fauve style but soon he came under the influence of Cézanne. This led to a close friendship with Picasso and subsequently to the development of Cubism. The paintings of the two artists for the next years (1910–14) were often quite similar: still lifes of bottle,



ARCHIVES PHOTOGRAPHIQUES

"THE DUET" BY GEORGES BRAQUE; 1937. IN MUSÉE D'ART MODERNE, PARIS glass and tobacco, or a seated figure severely broken into angular planes in colours of tan and gray with occasional insertion of block letters. Braque seems to have originated the collage (*papier collé*), a Cubist picture, composed mainly of cutout strips of newsprint or wallpapers pasted on canvas. After serving in World War I, he returned to a less austere kind of Cubism: still lifes of musical instruments on a table with textural variations of marbleizing, wood graining or sand-roughened surfaces. Toward 1920 the lingering geometric traits of Braque's Cubism began to be softened by elaborations of brushwork and looser drawing, particularly in his large paintings of fruit, flowers, pitchers or guitars, magnificently composed on low-keyed harmonies of gray-green, black and oyster white. Though he occasionally did figure paintings, especially of ancient Greek subjects, and a few small landscapes of the Norman coast, his best work was in still life, particularly his paintings of the 1920s and 1930s.

During World War II his health suffered but he managed to paint many large canvasses, somewhat looser in execution than his previous work. Braque also made prints, colour lithographs, plaster reliefs, a few small sculptures and jewelry. In the 1950s he worked with the theme of birds in flight. After World War II his painting became more colourful and impressionistic but did not lose its former subtle beauty. His later painting is the epitome of French taste and elegance. He died in Paris on Aug. 31, 1963.

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BRAS D'OR LAKE, a complex lake system occupying 360 sq.mi. in the heart of Cape Breton Island, Nova Scotia. The water is saline but tideless. Two channels, the Great Bras d'Or and Little Bras d'Or, join the lake to the Atlantic Ocean at the north end, while St. Peter's Canal (less than one mile in length) connects it with the ocean at the south. The lake system has many channels and bays and is surrounded by high hills and deep glens. At Baddeck, pop. (1961) 825, a federal museum commemorates Alexander Graham Bell, who with others founded the Aerial Experiment Association in 1907. His friend J. A. D. McCurdy made the first public airplane flight in the British Empire there two years later. (C. W. RD.)

BRASIDAS (d. 422 B.C.), a Spartan officer and the only commander of genius whom the Spartans produced during the Archidamian War, the first decade of the Peloponnesian War (*q.v.*). He won his first laurels by the relief of Methone, which was besieged by the Athenians (431). During the following year he seems to have been eponymous ephor, and in 429 he was sent out as one of the three commissioners to advise the admiral Cnemus. As trierarch he was wounded in the assault on the Athenian position at Pylos in 425.

In the next year, while Brasidas mustered a force at Corinth for a campaign in Thrace, he frustrated an Athenian attack on Megara. Immediately afterward he marched through Thessaly with a force of helots and mercenaries and, refusing to join the Macedonian king Perdiccas in a private war, set about breaking up the Athenian empire in the north. During the winter he won over to alliance with Sparta the cities of Acanthus and Stagirus, and, most important of all, the Athenian colony of Amphipolis.

An attack on Eion was foiled by the arrival of Thucydides, the historian, at the head of an Athenian squadron. In the spring of 423 a truce was concluded between Athens and Sparta, but Brasidas refused to give up Scione, which, the Athenians declared, revolted two days after the truce began, and he occupied Mende shortly afterward. Thus, fighting still continued in Thrace. An Athenian fleet recovered Mende and blockaded Scione, which fell two years later (421).

In April 422 the truce with Sparta expired, and the Athenians sent Cleon to recover Thrace. By the skilful generalship of Brasidas the Athenian army was routed at Amphipolis and Cleon was slain, but the Spartan general also fell. He was buried at Amphipolis, and the sacrifices which had formerly been offered to the Athenian founder Hagnon were transferred to him. Brasidas and Cleon had been leaders of the war party, and their deaths enabled Athens and Sparta to conclude the peace of Nicias (421).

Brasidas possessed charm and eloquence, qualities unusual in a Spartan, and his diplomatic treatment of the cities caused the allies of Athens to regard Sparta more favourably and paved the way for revolt against Athens after the disaster in Sicily.

BRASÍLIA, the federal capital of Brazil, is in the west central state of Goiás (*q.v.*) at the headwaters of the Tocantins, Paraná, São Francisco, and Corumbá rivers. The serenely rolling federal district of 2,245 sq.mi. (5,814 sq.km.) is 550 mi. (885 km.) N of São Paulo, 580 mi. (933 km.) NW of Rio de Janeiro, and 640 mi. (1,030 km.) SW of São Salvador, whence the capital had been moved to Rio de Janeiro in 1763.

The site was selected after a search for an interior capital location that began in 1789 with the Inconfidência Mineira, the revolutionary party that started the first movement toward independence for Brazil. In 1822 José Bonifácio de Andrada e Silva, the "Patriarch of Independence," proposed the movement of the capital to the interior. With the founding of the republic in 1889, the projected movement to the central plateau was set down in the constitution. In 1894 a commission under Luis Cruls recommended a general area in the sparsely populated temperate central plateau at an elevation of 3,500 ft. (1,070 m.). A 1948 commission under Gen. Djalma Poli Coelho made no progress toward defining a site, and it was not until 1956 that a definite site was chosen by a commission under Marshal José Pessoa. The technical work was a joint Brazilian and United States enterprise under the direction of Donald J. Belcher, Thomas W. Mackesey, and Hollister Kent from the United States and Edson de Alencar Cabral and Placidino Machado Fagundes from Brazil. No site for a city has been so carefully chosen. Consideration was given to topography, climate, drainage, water supply, geology, soils, land use, engineering, power, transportation, recreation, building materials, public administration, scenery, and the general relation of man to his surroundings.

A combination of aerial photoanalysis, photogrammetry, and ground surveys was used on the study area of 20,000 sq.mi. (51,800 sq.km.). In the process, topographic maps were produced for the entire study area, for five city sites in particular, and for the federal district to surround the site finally selected. Not only was information prepared for the capital site but also data were collected that were used for the development of satellite urban areas and regions to support them.

The project was conceived with the dual object of serving the administrative needs of a rapidly growing nation and providing a nucleus for the development of the vast Brazilian back country and at the same time removing the centre of political life from Rio

PAUL ALMASY

"THE WORKERS," A MONUMENT TO THE CITY BUILDERS BY BRUNO GIORGI, STANDING BEFORE THE PALACE OF JUSTICE, BRASÍLIA de Janeiro, a city which in many ways was unsuited for a capital. In essence, the main object was to hasten national development.

As soon as the site was selected, in 1956, a new federal commission, NOVACAP (Companhia Urbanizadora da Nova Capital do Brasil), was established under the leadership of Israel Pinheiro da Silva to finance, construct, and move the capital. In 1957 NOVACAP conducted a design competition for the city, limited to Brazilians, which was won by Lúcio Costa. His design resembled a huge airplane or a cross, which Costa described as the primary gesture of one who marks or takes possession of a place. He saw Brasília not as the outcome but as the cause of the development of the interior, and in his words, "Though the city is monumental, it is also convenient, efficient, welcoming, and intimate."

The seat of the federal government was moved officially in April 1960 as Pres. Juscelino Kubitschek had designated. A concentrated burst of design and construction work was needed, not only to prepare for this move but also to commit succeeding governments so deeply to it that there could be no turning back. Rather than devote time to architectural competitions for the major buildings, the Brazilian government gave full design responsibility to the Brazilian architect Oscar Niemeyer, whose individual stamp may be seen on such buildings as the Presidential Palace (Palace of the Dawn), the cathedral, the Plaza of the Three Powers (executive, legislative, and judiciary), the Presidential Chapel, the Brasília Hotel, and others. Niemeyer continued to design other buildings after the official opening of the capital, and schools, hospitals, hotels, the university, the Yacht Club (by the artificial lake), embassies, and residential and commercial blocks by him and other architects have been erected. As in many boom developments, temporary or satellite towns have sprung up.

The population of Brasília increased from none in 1956 to an estimated 120,000 in 1960 and 210,000 in 1965. Although the upper limit was originally designed to be 500,000, the planners appreciated that the capital of a growing country is difficult to contain. Accordingly, the site provided room for expansion and development of satellite towns. (H. Kt.)

BRAŞOV (formerly Stalin; Ger. Kronstadt; Hung. Brassó), a town in central Rumania, headquarters of the Braşov *regiune* (administrative and economic region) and centre of the old German district of the Burzenland, lies on the northern slope of the Transylvanian Alps at an elevation of 1,900 ft., 75 mi. N.N.W. of Bucharest. Pop. (1966) 163,345. In a valley opening northeast toward the plain, the inner town with its old walls is dominated by the Tâmpa mountain (3,140 ft.); it contains the town hall (1420, restored 1777); the Gothic Protestant church (1425), called the Black church because of its smoke-stained walls caused by the fire of 1689; the Orthodox St. Nicholas church (1392, restored 1751); the ruined citadel (1553) on a steep hill; and the 13th-century St. Bartholomew's church. In the town are the polytechnic, a state theatre and a regional museum and library. "The apostle of Transylvania," Johannes Honterus (1498–1549), who led the Reformation in the area, was born and died in Kronstadt, and established there the first printing press in Transylvania. There also was published in mid-16th century the first book printed in Rumanian, by the deacon Coresi.

Adjoining the chief passes from Transylvania into Moldavia and Walachia, Braşov is an important rail and road junction and is linked by air services with Bucharest, Cluj and Tîrgu Mures. Industrial development, initially stimulated by neighbouring deposits of lignite, was expanded by the Communist regime, and production included tractors, trucks, electrotechnical equipment, chemicals and textiles.

Braşov was founded by the Teutonic Order in 1211 and settled by Germans, becoming one of the chief centres of expatriate Germans in Transylvania (*q.v.*). Under Habsburg rule they enjoyed a substantial autonomy that was ended in 1876 by the abolition of their separate national status. Following World War I Braşov with Transylvania was ceded by Hungary to Rumania, but in 1922 more than 30% of its inhabitants described themselves as Germans. Between 1950 and 1960 it was named Stalin or Orasul Stalin ("Stalin city"), after which it reverted to its former name of Braşov.

Braşov Administrative and Economic Region had a population (1966) of 442,692 and an area of 2,066 sq.mi. In the south the Transylvanian Alps reach 8,343 ft. (Mt. Moldoveanu). The climate is colder than that of the rest of Rumania, with a mean temperature of 47° F. and about 31½ in. annual precipitation. The chief towns are Braşov, Sibiu (*q.v.*), Mediaş, Sighişoara and Săcele, a new industrial centre near Braşov. Forest covers about 30% of the region and agricultural land 60%; wheat, maize (corn), sugar beets and potatoes are the chief crops, and livestock is raised.

Industrial development was encouraged by rich supplies of natural gas (methane) at Bazna, Copşa Mică and Saraş amounting to nearly three-quarters of Rumanian output, by lignite deposits and by the hydroelectric power station on the Sadu river. Industrial products include machinery, ball bearings, machine tools, timber, pulp and paper, cement, glass and food products.

BRASS, an alloy consisting mainly if not exclusively of copper and zinc; in its older use the term was applied rather to alloys of copper and tin, now known as bronze (*q.v.*).

The brass of the Bible was probably bronze, and so also was much of the brass of later times, until the distinction between zinc and tin became clearly recognized. It is quite likely that from very early times brass was made accidentally, owing to the admixture of zinc ores with those of copper, but was not recognized as distinct from bronze. The Latin word *aes* signifies either pure copper or bronze, not brass, but the Romans comprehended a brass compound of copper and zinc under the name of *orichalcum* or *aurichalcum,* into which, according to Pliny, copper was converted by the aid of cadmia (a mineral of zinc). One of the earliest examples of Roman brass is a coin of date 20 B.C. containing 17.3% zinc. There was considerable production of brass in the Low Countries commencing about A.D. 300, and it became an important article of commerce. Monumental brasses, memorials of hammered sheet brass, or latten, may still be seen in many churches, particularly in East Anglia. The word latten is a corruption of the French word *laiton;* and until about 1550 latten was always imported from Flanders and Germany. One of the earliest lattens in England is at Stoke d'Abernon (*c.* 1277). The composition of these lattens is approximately 66% copper, 1%–3% tin, up to 7% lead and the remainder zinc. (*See* also Metalwork, Decorative.)

There is good evidence of the manufacture of brass in England in the 16th century, for Queen Elizabeth I by patent granted to William Humfrey and Christopher Schutz the exclusive right of working calamine (zinc ores) and making brass. This right subsequently devolved upon a body called "The Governors, Assistants and Societies of the City of London of and for the Mineral and Battery Works," which continued to exercise its functions down to the year 1710. The word battery refers to the process of hammering brass into sheets, which was the normal method in England for some 200 years; but by the latter half of the 18th century this method began to be superseded by the rolling mill, and became obsolete. Until 1850 brass was still being made by the process in which copper shot were heated with zinc ores and charcoal. The resulting partially-brassed shot were then melted, mixed and cast. This process, however, had been going out of favour since 1781, when James Emerson patented the production of brass from copper and zinc metals, which replaced the older method.

Copper and zinc will alloy in all proportions, but there are several distinct series, known technically as solid solutions, which are distinguished by the letters of the Greek alphabet, the alpha brass having the greatest percentage of copper and being the sole constituent of all wrought brasses containing over 63% copper. It is to this constituent that brass owes its malleability and general usefulness. (*See* also *Brass Manufactures,* below.) The beta constituent contains less copper and is of a much harder nature. As it increases, the brass (37%–45% zinc) becomes less amenable to cold-work, but well adapted to hot-work. The other solid solutions contain less and less copper. (For further information on solid solutions *see* Alloys.)

Malleable and Nonmalleable Brass.—The brasses may be conveniently divided into two groups by the test of malleability, the dividing line being about the composition of 55% copper and 45% zinc. All the higher copper alloys are workable either hot or cold and in some cases both hot and cold, while the remainder are not malleable at all.

The unworkable brasses are known as the white brasses and are not of great industrial importance. The 50% mixture is much used in a crushed or granulated form for purposes of brazing, and those with lower percentages of copper can be cast and used for sliding parts, since though brittle they offer considerable resistance to frictional abrasion. They also form the basis of certain alloys used for die casting (*q.v.*), a form of casting which came into much prominence after World War II.

The malleable brasses may be further divided into the cold-working and the hot-working alloys. The dividing line is not precisely drawn but commercially it is not usual to cold-work alloys of less than 62% copper on account of increasing hardness and brittleness. Hot-working of the high copper alloys is feasible only with brass practically free from lead, which usually is added to facilitate machining; hot-working does not give the smooth surface, the dimensional accuracy or the hardening which is obtained with cold-work. Hot-worked brass is often finished cold.

The most widely used of the brasses are those around 70% copper, or cartridge brass, and from 62% to 67% copper. The former is the most suitable for extreme amounts of cold-work and the latter, with lead from ½% to 3%, for combined cold-work and machining operations. Cartridge brass, cold-worked, has a tensile strength of 30 to 45 tons per square inch and 10% elongation or less; when soft annealed, of some 22 tons and up to 70% elongation. The general mechanical properties of brass vary widely; indeed it is this wide range which makes brass such an important alloy. By variation of the composition, or by the amount of cold-work put upon the metal, or by the degree of annealing, a tensile strength of from 15 to 45 tons per square inch, an elongation of from 3% to 70% and a hardness of from 60 to 150 Brinell can be obtained with all the intermediate degrees. It is readily drawn into fine wire, rolled into strips as thin as .001 in., drawn into tubes and extruded as rods or sections.

Colours of Brass.—The alloys of copper and zinc give a remarkable series of colours, of which the most notable are those with about 80% of copper, since they simulate gold, and have names which were once familiar, such as Dutch metal, Mannheim gold, pinchbeck (invented by Christopher Pinchbeck, a London clockmaker, in 1732), and others too numerous to mention. The colours due to composition vary from that of pure copper through yellow to dull white. Brass is susceptible of a fine polish, but tarnishes on exposure to the air; the brilliancy of the surface can however be preserved if the metal is thoroughly cleansed and lacquered. The brasses also lend themselves to a variety of chemical and heat colour finishes which are quite different from the natural colours of the alloy. There is also the possibility of producing a thin almost invisible oxide film by heat treatment at about 100° C. as a protection against tarnish.

There is a series of alloys which are commonly classed as brasses since brass is their foundation, but they contain other metals also. (*See* also ALLOYS; COPPER; ZINC.) (S. P.; C. H. MN.)

BRASS MANUFACTURE

The manufacture of brass is usually, although not always, associated with the fabrication of copper and copper-base alloys in general.

The manufacture of copper and its alloys, including brass, is essentially a heavy industry and the normal products of copper and brass mills are the basic forms of the metal industry, namely, sheet, strip, rod, tube, bars and plates.

Brass is a generic term applied to the most widely used and industrially important copper-base alloys. There is a large number of commercial brass alloys but in general the brasses can be classified in three broad groups.

Group I comprises the binary alloys of copper and zinc containing more than approximately 63% copper. Alloys in this group, where the range of copper content is 63%–95%, are, structurally, single-phase solid solutions of zinc in copper. Brasses in this group known as alpha brasses are characterized by excellent cold-working properties and are widely used in applications requiring extreme ductility and ease of forming and drawing.

Group II comprises those alloys of copper and zinc in which the copper range is about 55%–63%. Structurally, these alloys exhibit the two constituents, or phases, previously mentioned: an alpha phase, which is typical of the alloys of Group I, in combination with a beta phase richer in zinc.

The alpha-beta brasses are excellent hot-working metals and in general are characterized by higher strengths and lower ductilities than the alpha brasses. They find their principal applications in engineering fields as structural materials and are seldom used for spinning, stamping or drawing, or other fabrication requiring cold-working or deformation substantially beyond the point of original manufacture.

Group III may be considered as including a large range of special or modified brasses in which third and fourth constituents have been added to the basic copper-zinc alloys for the purpose of usefully modifying their properties.

The added elements may serve to improve physical properties, such as tensile strength, increase corrosion resistance, render the material more readily machinable or in some instances to modify the colour of the basic alloy.

Typical of these special brasses are the aluminum brasses, in which aluminum has been added to increase the corrosion resistance and strength of the brass; the leaded brasses, where lead has been added to improve machining properties, as in certain alpha-beta brasses for free cutting on high-speed automatic screw machines; the admiralty and naval brasses in both of which 1% tin has been added to improve resistance to corrosion by sea water; the manganese bronzes, where manganese and iron have been added to increase the tensile strength of alpha-beta brass; and nickel silver, in which nickel has been added to brass in order to obtain a desirable white colour in base material for subsequent nickel or silver plating. Following is an outline of certain basic operations, namely casting, annealing and pickling, employed in the fabrication of brass. Other basic operations such as hot- and cold-rolling, cold-drawing, extrusion and piercing will be discussed in connection with types of finished products, such as sheet and strip, rod and bar, and tubes.

Castings.—It has often been said that the heart of the brass industry is its casting shop. Here are produced from basic raw material the specially shaped castings required in the production of its many manufactures. The most rigid control must be exercised along all fronts to secure the quality necessary to the production of brass products.

Raw material used consists of cathode copper, *i.e.*, copper refined electrolytically, scrap copper from its own mills or purchased on the market, zinc, pure aluminum, lead and other virgin metals. In addition to pure metals large quantities of both processing and purchased scrap brass are used.

Regardless of the source of the scrap, precautions are taken to keep it segregated according to its composition. Scrap which is secured from without is carefully analyzed and then placed in special bins to be utilized later for the casting of alloys whose composition it most closely approximates. Purchased scrap is usually passed over a magnetic separator so that all iron and steel which may be present are removed. The presence of iron in most brass alloys is not desired in amounts above 0.10%.

Depending upon the type of equipment used for melting furnaces, charges will vary from 100 to 10,000 lb. The composition of the alloy is determined to a large extent by the care with which these charges are weighed. Usually separate departments are set up within the casting shop under the direct supervision of a chemical control department. For any given composition the necessary amounts of copper, zinc and scrap are carefully weighed. Usually an excess of 0.5% of zinc is added as this much is lost due to volatilization during the melting period. Every effort is made to keep the scrap as free as possible from oil, dirt and grease, which on burning produce gas which may be trapped when the metal is solidifying.

The furnaces used for melting vary from the pit-crucible type used for small-sized castings and for sand castings to electric furnaces of the induction type which usually hold between 1,000 and 2,500 lb., to the reverberatory furnace which holds up to 10,000 lb. and which is extensively used for making large castings for the production of heavy sheet and plate. Large-size oil- and gas-fired, tilting crucible furnaces are also used extensively. These are particularly useful because of their flexibility, it being possible to change from one alloy composition to another at a minimum cost.

Electric furnaces are lined with special refractories depending on the composition to be melted. Such linings are quite expensive and usually separate furnaces are set aside for casting special mixtures. Electric furnaces are highly adapted to big production runs of a particular alloy or alloys within a narrow composition range.

During melting of the metal considerable care is taken to protect the molten metal from the atmosphere and a cover of charcoal is used. The cover produces a reducing atmosphere at the surface and prevents undesirable oxidation of the molten metal. (*See* also FURNACE, METALLURGICAL.)

Molds used for the making of castings for the production of wrought brass products are usually cast iron. Their shape is determined by the shape of casting required. For the manufacture of tubing or rod, castings may vary from 2 in. to 30 in. in diameter and from 12 in. to 96 in. in length.

Molds may be of the air-cooled type or the water-cooled type. The latter represents common practice in the production of large-sized castings. Cooling is effected by circulating water through a chamber between the outer casing of the mold and an inner plate usually made of copper or bronze.

Molds are dressed with mixtures of oil and rosin, graphite or black lead. These dressings serve to produce cleaner surfaces on casting and to protect the casting surfaces of the mold.

In the best practice, the temperature at which the molten metal is poured is carefully controlled by means of thermocouples immersed in the liquid and either read visually or arranged for continuous recording.

To standardize the rate at which the metal is poured, special pouring boxes, cups or funnels are used. These serve two purposes: to regulate the rate of rise of the molten metal in the mold and to prevent the molten metal from splashing on the mold wall and forming bad spots on the casting.

When brass changes from the liquid to the solid condition shrinkage takes place. In order to compensate for this shrinkage the casting is fed by adding liquid metal during the entire period of solidification. Sometimes mold extensions called hot tops or dozzles are employed. Before any processing of the castings, their top ends containing the pipe or the gate are sawed or sheared off. Continuous casting of slabs or billets is becoming well established in the brass industry. Molten brass is poured continuously into a shallow, water-cooled mold. At the start of the process the bottom of the mold is closed by means of a piston but, as the solidification of the brass proceeds, the piston is lowered at a controlled rate so that the solidified brass emerges from the bottom of the mold. The process can be continuous, appropriate lengths of the brass casting being cut as it is withdrawn from the bottom of the mold, or semicontinuous, the length of the brass casting being limited by the depth to which the piston can be lowered. (*See* also FOUNDING.)

Annealing.—Annealing consists of heating a metal that has become hardened by cold-work to a temperature which renders it soft and suitable for further cold-work. Annealing operations are usually conducted in furnaces of the muffle, or oven, type but of many forms of construction. Many designs of furnace incorporate a control of the furnace atmosphere for the purpose of preventing the excessive oxidation or tarnishing of metal during the annealing operation. The term open-fire annealing is frequently used to designate annealing operations in which no effort is made to prevent oxidation of the metal. Controlled-atmosphere annealing ordinarily designates an operation in which excessive oxidation or scaling is prevented by suitable control of the furnace atmosphere, and bright annealing is a term descriptive of those annealing operations which are conducted under conditions so controlled as to prevent tarnishing of the metal.

The design of annealing furnaces for brass varies from a mechanical point of view with the particular type of product being handled. There are continuous- and batch-type furnaces, strip-annealing furnaces, roller-hearth furnaces, salt-bath furnaces for special work such as end-section annealing of brass tubing or partial annealing of artillery cases and many others to meet specific needs.

In the United States there is a wide use of electrically heated annealing muffles. Gas- and oil-fired furnaces are also widely used. (*See* also ANNEALING.)

Pickling.—Pickling is a term applied in the brass industry to the cleaning of annealed metal by acid solutions. Ordinary pickling practice on copper and brass products consists in immersing the annealed metal in a sulfuric acid solution, usually containing about 10% by weight of sulfuric acid. The function of the acid is to combine chemically with the metallic oxides formed in annealing operations and to remove dirt, combustion products and other impurities from the surface of the metal.

Such a cleaning operation is essential before cold-working operations can continue, as otherwise subsequent cold-working would result in the imbedding of oxides and other impurities in the surface of the metal, rendering it unsuitable for most commercial applications.

While sulfuric acid is the chemical used for ordinary pickling operations, there are several pickling or finishing solutions commonly used in the brass industry. A solution of sodium or potassium bichromate in a water solution of sulfuric acid is frequently employed as a bright dip. Such a bright dip is used, not essentially as a pickle, but rather to give a lustrous, clean finish to metal or metal parts after they have been subjected to their final processing operation. Nitric acid solutions are also frequently used for the same purpose and other chemicals appropriate to the composition of special alloys are sometimes used when the constituents of such special alloys necessitate such treatment.

Sheet, Strip and Plate.—Brass sheet, strip and plate are manufactured by either hot-rolling or cold-rolling or combinations of these two forms of working. As a general rule the dimensions of the finished product will to a large extent influence the manner in which it is produced, *e.g.*, thick, wide and long plates are usually produced by hot-rolling only, while thin sheet and strip are produced by a combination of the two forms or by cold-rolling alone.

While no clear-cut line of demarcation between sheet and strip exists, generally thin brass over 22 in. wide furnished in flat lengths is considered sheet, and brass under this width furnished in flat lengths or coils, considered strip.

Each of the brass alloys possesses a temperature range in which it is most plastic. Some brasses, as mentioned above, hot-work much easier than others. These compositions are usually hot-rolled with just enough cold-rolling to secure close dimensions and the desired properties. The castings, or cakes as they are called, are first heated to the optimum hot-rolling temperature and held at this temperature for several hours to insure uniformity of heating. They are then fed to a pair of driven rolls which exert pressure on the plastic cake, causing it to be elongated and thinned. This rolling operation takes place so rapidly that it is possible to reduce a four inch or five inch thick casting to $\frac{3}{16}$ in. with only one heating. In hot-rolling, no hardening of the metal takes place so it is not necessary to anneal.

In cold-rolling much the same operations take place with the exceptions that the castings or bars are narrower, not as thick, and the operation is performed at room temperature.

When a metal is cold-rolled the crystals or grains of which it is composed are elongated in the direction of the working; as working increases these crystals become fragmented. The combination of fragmentation and elongation of the grains results in the metal becoming very hard. When this condition is reached, it becomes necessary to anneal the bar before further cold-work can be done.

Annealing temperatures of from 800°–1,350° F. and exposure times of from 30 minutes to 2 or 3 hours are standard practice. The temperature and time utilized depend upon the amount of metal being annealed and the degree of softness required. The hardness of annealed brass is proportionate to its grain size, *i.e.*, small grain size brass is harder than large grain size material. After annealing the brass is pickled and is then ready for further cold-rolling.

Usually in the production of brass sheet, strip and plate, it is necessary to remove the surface, as by milling, at some intermediate point to insure a finish surface free of imperfections. This surface removal is called overhauling or scalping.

Brass sheet or strip is furnished to the trade in both hard and soft conditions. If furnished hard its final operation consists of a definite amount of cold-rolling, *e.g.*, quarter-hard brass is brass cold-rolled to give a reduction in thickness of about 10%; half-hard, about 20%; hard, about 35% and extra hard, about 50%. Soft brass sheet or strip is annealed to various degrees of softness, *i.e.*, different grain sizes. If the brass is going to be further worked and is subsequently going to be polished and plated, a grain size of 0.03 mm. or even less average diameter will likely be specified. If surface characteristics of the finished article are of no importance, a larger grain size will be selected.

Rods, Bars and Shapes.—Brass rod, bar or shapes may be produced by hot-rolling, hot-rolling and cold-drawing, cold-rolling, cold-rolling and cold-drawing, extrusion, extrusion and cold-drawing, or even continuous casting and hot or cold processing.

The hot-rolling process for the manufacture of rods, bars and shapes of brass is similar in principle to that employed in the production of sheet and plate with the exceptions that castings of 4 in. or 5 in. round or square cross sections and up to 60 in. long are used and the rolls used are grooved to produce the cross-sectional shape desired. Roll stands for rods, etc., as for sheet and plate, are so made that the direction of the rolls can be reversed quickly, thus allowing rolling to proceed from either side. In the manufacture of brass wire and small diameter rods, it is possible to hot roll in one preheating from a 4 in. square or round to ¼ in. round. This operation is performed at high speed. As a general rule only alpha-beta and lead-free alpha brasses are manufactured by the hot rolling process and this process is used only when the cross section of the shape desired is relatively simple. For complicated cross sections, such as hexagons, triangles, T-shape and others, the hot extrusion method is utilized. This method of working is very flexible and adapted to the production of extremely complicated shapes of all types. Castings used are cylindrical and dimensions vary depending upon the capacity of the extrusion equipment. The extrusion operation consists essentially of pushing a casting, which has been heated to its most plastic range, through an alloy steel die.

Both the hot-rolling and extrusion methods are used as intermediate steps for the production of rods and bars. It is impossible to produce materials to very close gauge tolerance with either of these processes; in addition strengths are low. In order to secure both close dimensions and higher strengths the material is finally cold-drawn.

In the cold-drawing operation a piece of equipment known as a draw-bench is used. Fixed at one end of the bench is a holder which contains the die. The remainder of the bench, which may be 50 ft. or 60 ft. long, contains an endless chain operating similarly to a conveyor belt. Fixed to one point on this endless chain is a pair of viselike jaws. First, the rod or bar to be drawn has one end swaged, or forged, to a smaller diameter than the size to which it is to be drawn. This reduced end is then inserted through the die and clamped or engaged with the jaws. Power is then applied and the rod, etc., are drawn through the die assuming the cross-sectional shape of the die. This operation is then repeated using smaller dies until the required cross section is secured. Usual reductions of area are of the order of 25% for each operation. Very often such large reductions are required that it becomes necessary to anneal frequently as cold-drawing, like cold-rolling, hardens the brass rapidly. Brass rods, etc., are furnished in both hard and soft conditions. Brass rods of less than 80% copper content, etc., are even more sensitive to season cracking (failure of highly stressed brass under mildly corrosive conditions of storage or service) than brass sheet so it is necessary to relieve strains as soon after the cold-working operation as possible. This is done by low-temperature annealing and by springing or straightening operations. Both of these latter operations consist essentially of whipping the product by fixing one end and flexing the other. This operation readjusts the strains sufficiently to eliminate danger of cracking in storage or in service.

Cold-rolling is used when the composition of the material is such that it is not economical to extrude or it cannot be hot-rolled. Alpha brasses containing lead as a free-cutting constituent (that is, to improve machinability) cannot be hot-rolled. While they can be extruded in the larger sizes and less complicated sections, the process is slow and expensive. Accordingly, it is usual practice to cold-roll to some intermediate size and then cold-draw to the finish size.

The cold-rolling of rod is similar to the hot-rolling process except that working speeds are slower and cross sections of castings are smaller. As in any cold-working operation the metal becomes hard and it is necessary to anneal frequently to soften it.

Tubes.—In the manufacture of brass tube there are several methods by which intermediate sizes of tube can be secured. The method which is utilized for the production of the tube is determined by the nature of the brass alloy and the use for which the tube is intended. These processes are: (1) extrusion; (2) piercing—Mannesmann process; (3) hollow shell castings; (4) cup drawing; (5) brazing; and (6) lock-seam construction. With the exception of the lock-seam method these are all preliminary methods and in order to produce commercial size tube to close dimensions it is necessary to cold-draw or cold-reduce.

Extrusion.—The extrusion of tube is similar to the extrusion of rod, etc., with the exception that prior to any extrusion a mandrel is forced through the hot casting forming thereby a cylindrical hole whose diameter conforms to the inside diameter of the extruded tube. The mandrel remains in this hole and simultaneously with the completion of this piercing operation the casting is pushed through the die and over the mandrel. The outside diameter of the tube or shell is controlled by the die and the inside diameter by the mandrel. (*See* also METALLURGY: *Mechanical Working: Extrusion.*)

Piercing.—In the piercing operation, castings are used which vary from 2 in. to 6 in. or larger in diameter and up to 50 in. long. These castings are placed in a furnace and heated uniformly to the optimum hot-working temperature of the alloy, and then are placed between two revolving rolls which are so constructed as to present to the surface of the castings or billets inverted broad vee surfaces. These rolls are so adjusted that rolling of the billet occurs and elongation results. Due to the shape of the rolls a small opening is made at the centre of the billet during the rolling operation. This opening is further enlarged and controlled roughly as to tolerances by entrance therein of a pointed steel mandrel which is rotating at high speed counterclockwise to the revolving billet. The beginning of rolling of the billet and the entrance therein of the mandrel point are coincidental.

This operation is very rapid and is extensively used for the production of intermediate tube sizes of red brass, 85% copper, 15% zinc; Muntz metal, 60% copper, 40% zinc; and others.

Hollow Shell.—The hollow-shell method involves the use of special castings which are secured by pouring molten metal into a cylindrical mold with a removable core through its middle. The core controls the inside diameter of the casting. The shell or hollow casting is reduced to smaller sizes by suitable cold-drawing operations.

Cup Drawing.—The cup-drawn shell or tube is produced by deep-drawing, *i.e.*, pushing a flat piece of metal through a die by means of a round-nosed punch. One of the disadvantages of this method is that there is a definite weight limitation to the tube that can be produced. It is practically impossible to produce a tube of 1 in. diameter much more than 15 to 20 ft. long. Any of the other methods mentioned above can produce tubes of this size up to 60 ft. long.

Brazing.—At one time all of the brass tubes supplied were made by the brazing method, which has become practically obsolete. This method consisted essentially of taking flat strip of the proper gauge and drawing it through a forming die of the desired shape and then brazing the contiguous edges with a solder consisting of 50% copper and 50% zinc.

Lock Seam.—The lock-seam method is similar to the brazing method with the exception that the contiguous edges are lock seamed, or clamped. Soft solder, *i.e.*, lead-tin alloy, may or may not be applied to the joint depending upon the ultimate use of the tube.

Cold-Drawn Tube.—The cold-drawing of extruded and pierced shells, hollow-shell castings, cup-drawn and brazed tubes is performed on equipment identical to that used in the cold-drawing of rod, etc. The operation in the main is similar except to control the inside diameter of the tube there is introduced into the tube at the moment of drawing either a polished steel plug attached to a rod of smaller diameter than the plug or a polished steel mandrel of uniform cross section. The mandrel method of maintaining inside diameters is most widely used in England while the plug method is used in the United States. The outside diameter of the tube is controlled by the die. As in other cold-working operations it is necessary to anneal the tubes as they become hard so that further cold-drawing operations can be performed.

Tube Reducing.—This method for cold-working extruded shell to smaller sizes, developed in the 1930s, consists essentially of swaging or forging a tube over a tapered mandrel. Simultaneously with the swaging the tube is automatically rotated slowly. Very large reductions can be effected in single operations due to the uniform working of the metal that occurs.

Forgings.—Brass alloys containing from 55% to 62% copper can be readily hot-forged into very intricate shapes of close dimension limits thus eliminating the necessity for very much machining as is the case with sand castings. Such articles as faucet handles, sprinkler heads, window and door fittings and many others are produced in this manner.

Brass containing in excess of 64% copper can be cold-forged very easily into many shapes and articles. This method is used in the manufacture of pins, bolts, screws, and the like. Most often automatic equipment is used. Wire of the proper diameter is fed into the special machines and upsetting, cold-heading and threading operations are performed.

Other Forms of Fabrication.—Large castings in alpha-beta brass or manganese bronze are manufactured by sand casting methods for uses such as marine propellers and the bodies of large pumps. Brass die castings are readily made in cold-chamber machines but owing to their relatively high melting points and consequent adverse effect on the life of the dies have not reached large production. Similarly, centrifugal, precision investment and plaster-mold brass castings are produced in limited amounts where specially applicable. Sintered brass powder compacts, made principally from atomized 80% (leaded) copper alloy, are rapidly increasing in importance, both as to variety of products and range of proven alloys.

See Copper: *Manufacture, Uses, Alloys and Production; see* also Index references under "Brass" in the Index volume.

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(R. A. W.; E. S. B.; C. H. Mn.)

BRASSEUR DE BOURBOURG, CHARLES ÉTIENNE (1814–1874), French missionary and ethnographer, who specialized in the prehistory of Central America, was born at Bourbourg, near Dunkirk. From 1848 to 1864 he traveled as a missionary, chiefly in Mexico and Central America. He published in 1857–59 a history of Aztec civilization and from 1861–64 edited a collection of documents in the indigenous languages. In 1864 he was archaeologist to the French military expedition in Mexico, and his *Monuments anciens du Mexique* was published by the French government in 1866. He translated into French the *Popol Vuh*, a sacred book of the Quiché Indians, and wrote a Quiché grammar. In 1871 he brought out his *Bibliothèque Mexico-Guatemalienne*, and in 1869–70 gave the principles of his decipherment, much disputed, of Indian picture writing in his *Manuscrit Troano, études sur le système graphique et la langue des Mayas.* *See* also Quiché.

BRASSEY, THOMAS (1805–1870), notable English railway contractor, was born at Buerton, near Chester, on Nov. 7, 1805. At 16 he was apprenticed to a surveyor, afterward becoming a partner and finally sole manager of the business. Invited by Joseph Locke, in 1835 he constructed a section of the Grand Junction railway and later was responsible for completion of the London and Southampton line, contracts for which totaled some £4,000,000, requiring the use of about 3,000 men. Other lines were his responsibility in northern England and Scotland. In 1841–43, with W. Mackenzie, he built the Paris-Rouen railway, Locke being engineer, followed by other lines in France, the Netherlands, Italy, Prussia and Spain. The Grand Trunk railway in Canada, 1,100 mi. long, including a lengthy bridge over the St. Lawrence, was constructed by Brassey in association with Sir M. Peto and E. L. Betts and, at one period, he had work in hand in Europe, India, Australia and South America, with a labour force estimated at 75,000. Coal, ironworks and dockyards were among his other interests. He died at St. Leonards, Sussex, on Dec. 8, 1870.

The eldest of his three sons, Thomas (1836–1918), educated at Rugby and Oxford, became a baron in 1886 and an earl in 1911. Elected member of parliament for Hastings in 1868, he concentrated on naval matters, becoming civil lord of the admiralty (1880–83) and then parliamentary secretary to it (1884–85). President of the Institution of Naval Architects (1893–95), he became governor of Victoria, Austr. (1895–1900) and warden of the Cinque Ports (1908). Lord Brassey founded the *Naval Annual* (1886) and wrote *The British Navy* (1882–83), a monumental work. Dying in London on Feb. 23, 1918, he was succeeded by his son Thomas Allnutt Brassey, who died in 1919.

See Sir Arthur Helps, *Life and Labours of Mr. Brassey* (1872).

(C. E. R. S.)

BRASSICA, a plant genus of the family Cruciferae (*q.v.*), including the cabbage, mustard (*qq.v.*) and other well-known plants.

BRATHWAIT, RICHARD (1588–1673), English poet best known for the lively *Barnabees Journall*, was born in 1588 near Kendal, Westmorland. Educated at Oxford and Cambridge, he went to London to practise law but instead wrote plays and pastoral poetry of little merit. Upon his father's death he retired to Westmorland, where his life as a country gentleman enabled him to write *The English Gentleman* (1630) and *The English Gentlewoman* (1631), courtesy books of interest to the social historian. *Barnabees Journall* was first written in Latin rhymed verse (1636) under the pseudonym "Corymbaeus," and later published with an English translation (1638); the title page says it is to be chanted to the old tune of "Barnabe." It contains much amusing topographical information and its gaiety is unflagging. At Banbury, Oxfordshire, the author saw the Puritan who has become proverbial,

Hanging of his cat on Monday,
For killing of a Mouse on Sunday.

Brathwait's identity with "Corymbaeus" was established by J. Haslewood, who edited the *Journall* in 1805, 1818 and 1820. Brathwait died at Catterick, Yorkshire, on May 4, 1673.

Brathwait's many works are listed in Haslewood's edition of *Barnabees Journall*, ed. by W. C. Hazlitt (1876).

See M. W. Black, *Richard Brathwait* (1928).

BRĂTIANU, the name of a prominent Rumanian family of statesmen and financiers.

Ion C. (Constantin) Brătianu (1821–91) was born at Pitești, in Walachia, on June 2, 1821. After studies in Paris, where he imbibed revolutionary ideas, he returned to Walachia to take a prominent part in the uprising of 1848. The restoration of

Turkish authority drove him back to Paris, where he worked for the union and autonomy of Moldavia and Walachia, gaining the attention of Napoleon III. He and his brother DUMITRU BRĂTIANU (1818–92) returned home in 1856; after the union of the principalities (1859) under Alexandru Cuza (*q.v.*) they founded the Rumanian Liberal party and assisted, in 1866, in the deposition of Cuza and the election, with the approval of Napoleon III, of Prince Charles of Hohenzollern-Sigmaringen, later King Carol I (*q.v.*), under whom Ion Brătianu held several ministerial posts in the next four years. Accused of complicity in the abortive plot of 1870 against the king, Brătianu was temporarily arrested. Restored to favour, he became prime minister in 1876, remaining in office for 12 years—with a short break in the spring of 1881, when he resigned in favour of his brother. Ion Brătianu was thus in office when Rumania signed the secret treaty of 1883 with Germany and Austria-Hungary. From 1883 onward he was sole leader of the Liberal party, his old political associate C. A. Rosetti and his brother Dumitru having broken away. There was an inevitable clash between their doctrinaire views and Brătianu's realism. His long tenure of office and autocratic methods made him very unpopular, and the Conservative government which succeeded him in 1888 actually demanded an impeachment of him, but this was rejected by a substantial majority in the chamber of deputies. Ion Brătianu died on May 16, 1891, Dumitru on June 21, 1892. Ion stands second only to King Carol I as the maker of modern Rumania. (For his policy in internal and foreign affairs, *see* RUMANIA: *History*.)

ION I. C. or IONEL BRĂTIANU (1864–1927), eldest son of Ion C. Brătianu, was born at Florica, near Cîmpulung, on Aug. 20, 1864. He and his two brothers Vintila and Dinu (*see* below), who all received a technical education in Paris, carried on their father's work for Rumania as leaders of the Liberal party and as financiers. They pursued their party's traditional policy in favouring the growth of a prosperous urban middle class and in opposing the admission of foreign capital. Ionel Brătianu served as an engineer on the state railways. Elected deputy in 1895, he was appointed minister of the interior in Dimitrie Sturdza's cabinet, formed in 1907 after the outbreak of the peasant revolt. Taking over the party leadership and premiership from Sturdza in 1909, he remained in power until Jan. 1911. Out of office during the Balkan Wars, he was in power again in 1914. Loyal to the secret treaty that his father had signed in 1883, Ionel Brătianu hoped to avoid conflict with Germany, but agreed to Rumania's entry into World War I on the Allied side in Aug. 1916. He resigned in Feb. 1918, before Rumania signed the separate peace with Germany, but became prime minister again in Dec. 1918. He put Rumania's case brilliantly at the Paris peace conference, but resigned in Dec. 1919 rather than accept the minority clauses of the treaty of Trianon and the division with Yugoslavia of the Banat, which had been promised to Rumania by the Allies in 1916. Prime minister again from Jan. 1922 to March 1926, he was responsible for the passing of a new constitution (which included universal suffrage) and for the confirmation of the agrarian reform. In June 1927 he again formed a government. After King Ferdinand's death on July 20, Brătianu supported the regency and maintained a stout opposition to the return of Prince Carol, who had been excluded from the succession in Jan. 1926 (*see* CAROL II). Ionel Brătianu died in Bucharest on Nov. 24, 1927.

Ionel was succeeded as prime minister by the younger of his two brothers, VINTILA BRĂTIANU (1867–1930), who had been minister of finance in his cabinets of 1922 and 1927. Lacking Ionel's prestige and incurring unpopularity by continuing to block the admission of foreign capital at a time of growing economic crisis, he had to resign in Nov. 1928. He died suddenly on Dec. 22, 1930.

Although a year older than his brother Vintila, CONSTANTIN or DINU BRĂTIANU (1866–1952?) appeared later on the political stage, having confined himself at first to the family's business and banking interests. A deputy since 1895, his first government post was that of minister of finance, held for a few months in 1933–34. After the assassination in Dec. 1933 of Ion Duca, who had succeeded Ionel Brătianu as leader of the Liberal party, Dinu in turn became leader of the party. He kept its organization intact against Gheorghe Tătărescu's splitting tactics (instigated by Carol II) and from 1953 onward co-operated increasingly with the National Peasant leader Iuliu Maniu (*q.v.*) in opposing the king's dictatorial methods. He refused to join the king's National Renaissance front in 1938. During World War II, Dinu Brătianu joined Maniu in protesting against Marshal Ion Antonescu's policies and the continuance of the war into Soviet territory and worked with Maniu in preparing King Michael's *coup d'état* of Aug. 23, 1944. He was minister without portfolio in the two postwar non-Communist governments, but refused to participate in the Soviet-imposed government of Petru Groza in 1945. With Maniu he protested against that government's refusal to implement the Moscow agreement and to allow free elections. Dinu Brătianu was arrested without trial, probably in 1950, and died in prison.

CONSTANTIN BRĂTIANU, called "BÉBÉ" (1887–1955?), son of Dumitru, worked with his cousin Dinu in keeping the Liberal party together and helped in the *coup d'état* of 1944, serving also in the non-Communist postwar governments. He also died during imprisonment.

The only prominent member of the third generation of the family, Ionel's son GHEORGHE BRĂTIANU (1898–1955?) was, unlike his uncles, a supporter of King Carol and formed for a time a dissident Liberal group. A scholar and dean of the faculty of letters at Bucharest university, he also died in prison. (B. BR.)

BRATISLAVA (Ger. PRESSBURG; Magyar, POZSONY), the third city in population of Czechoslovakia and the capital of historic Slovakia, is situated near the meeting place of the frontiers of Czechoslovakia, Austria and Hungary. It stands on the left bank of the Danube at the exit of the gorge which the river has cut through the Little Carpathians and just upstream from the branching of the river to embrace the Vel'ky Zitny Ostrov ("the Great Rye island"). Pop. (1969 est.) 288,200. Flanked by hills and surrounded by parklands, the city bears the stamp of its frontier history, particularly in its architecture and in the mixture of its population. On the plateau 270 ft. above the Danube stand the ruins of the former castle and royal palace, destroyed by fire in 1811. Between the castle and the river lie the former ghetto and the 13th-century churches and old town hall (now a museum) flanked by the old river port. On the flat land of the north bank is the main producing and trading centre of Slovakia, with commerce in grain, timber, wine, meat and petroleum, and developing industries, including oil refining, textiles, timber and other products. On the opposite side of the river is the bridge-head settlement of Petržalka. The systematic application of capital to Slovak resources in the third Czechoslovak republic suggests that the growth of its principal city will continue. Bratislava is an important centre of both railways and roads, with connections with other parts of Czechoslovakia and with Austria and Hungary.

The most ancient settlement in this region is Devin, upstream on the western side of the Danube gorge, near its confluence with the March (Morava), where a mass of ruined fortifications crowns the cliff about 240 ft. above the river. Bratislava itself dates back to the 10th century and has seen some spectacular changes of population. Up to the 19th century it was largely a community of German traders and its university (with a broken history) dates from 1467. The city became the capital of Hungary between 1541 and 1784, when most of the middle Danube basin was in the hands of the Turks, and the coronation of the Habsburg rulers as kings of Hungary took place in its Gothic cathedral. The Hungarian parliament continued to meet at Bratislava until 1848, and in the 19th century it was a Magyar rather than a German city; but in the 20th century it became the Slovak capital. With the formation of the first Czechoslovak republic after World War I its function as regional capital began, and in spite of fluctuations in development because of political upheaval, Bratislava has grown markedly since 1918, as revealed by the statistics of its population (1931, 140,000; 1969 est., 288,200).

BRATSK, a town of Irkutsk Oblast of the Russian Soviet Federated Socialist Republic of the U.S.S.R., on the Angara River, just below the Oka confluence. Pop. (1970 prelim.) 155,000.

Bratsk was founded as a fort in 1631, during the initial Russian settlement of Cis-Baikalia. One wooden tower of the original fort is preserved. Bypassed originally to the north by the Ilim route to Yakutsk and later to the south by the highway and Trans-Siberian Railway through Irkutsk, the settlement remained very small and unimportant until the completion in 1954 of the railway through the town, from Tayshet on the Trans-Siberian to Ust-Kut on the Lena.

In 1954, also, construction of the huge Bratsk barrage and hydroelectric power station on the Angara began. On its completion in 1966 it was the world's largest hydroelectric station, with an installed capacity of 4,100,000 kw., subsequently raised to 4,500,000 kw. The dam, 410 ft. (125 m.) high and 3 mi. (4.8 km.) long, created a reservoir covering 2,124 sq.mi. (5,501 sq.km.) and necessitated the removal of the town to a new site, several kilometres to the north. Constructed in Bratsk to utilize the power were an aluminum plant, planned to become the largest in the U.S.S.R., and a very large timber-processing plant, producing cellulose pulp (for tire cord), paper, cardboard, and veneer. As a result, the town and its immediately adjacent satellites (Energetik, Osinovka, Porozhsky, and Chekanovsky) developed very rapidly, the 1959 population of 51,455 tripling within a decade—the fastest urban growth in the U.S.S.R. Other industries include the building and repair of river craft, sawmilling, and the production of building materials. (R. A. F.)

BRATTAIN, WALTER HOUSER (1902–), U.S. physicist, who with John Bardeen and William Shockley was awarded the 1956 Nobel prize in physics for their investigations on semiconductors and the development of the transistor. He was born in Amoy, China, Feb. 10, 1902. He spent his youth in the state of Washington and graduated from Whitman college, Walla Walla, Wash., in 1924. After receiving the M.A. degree from the University of Oregon in 1926, he attended the University of Minnesota and was awarded the Ph.D degree in 1929. In that same year he joined the technical staff of Bell Telephone laboratories as a research physicist. His chief field of research is the surface properties of solids. His early work was concerned with thermionic emission and adsorbed layers on tungsten. He continued with research on rectification and photo effects at semiconductor surfaces, beginning with a study of rectification at the surface of cuprous oxide. Similar studies of silicon followed. After World War II he pursued the same line of research with both silicon and germanium. His chief contributions to solid state physics have been the discovery of the photo effect at the free surface of a semiconductor; the invention of the point-contact transistor, jointly with Bardeen; and work leading to a better understanding of the surface properties of germanium. Jointly with Bardeen he received the Stuart Ballantine medal of the Franklin institute in 1952 and the John Scott medal in 1955, for their invention of the point-contact transistor. He has been granted a number of patents and has written extensively on solid state physics. *See* Transistor.

BRATTLE, THOMAS (1658–1713), American colonial merchant and official of Harvard college, was born into a wealthy Boston family on June 20, 1658. He amassed a considerable fortune and made substantial contributions to the finances of Harvard as a personal benefactor and by good management as treasurer from 1693 until his death. He had a marked influence on the intellectual life of New England largely because of his liberalism in politics and religion and his breadth of intellectual interests. The liberal Brattle Street church was organized under his direction. It violated Puritan orthodoxy by dispensing with the "relation of experiences" as a qualification for membership and by other unorthodox practices such as the use of the Lord's Prayer and Bible reading without comment as a part of the services. The witchcraft proceedings he condemned as "ignorance and folly" and he circulated a pamphlet "giving a full and candid account of the delusion." Brattle was an accomplished amateur mathematician and astronomer whose observations of Newton's comet, 1680, based on fixed stars helped Newton test Kepler's laws. He continued to make observations until his death on May 18, 1713.

His brother William Brattle (1662–1717) was for many years pastor of the First Church of Cambridge and tutor in Harvard college. He has the distinction of being the author of America's first textbook in logic. Urbane, tolerant and scholarly, he contributed to the softening of Puritan orthodoxy, as did his brother. (Ra. Mu.)

BRAUCHITSCH, WALTHER VON (1881–1948), German field marshal, was commander in chief of the army at the outbreak of World War II. He was born in Berlin on Oct. 4, 1881, the son of a cavalry officer. Brauchitsch was educated at a military academy and commissioned to the Prussian guard in 1900. In World War I he was employed on the general staff.

A contemporary described him as a very able man, with charm and breadth of vision to a degree not always found in the German officer class. He was appointed inspector of artillery in 1932 and, with the expansion of the German army under Hitler, became an army group commander in 1937. In Feb. 1938 he succeeded Werner von Fritsch as commander in chief. In that capacity, when World War II broke out, he directed operations against Poland (1939), Norway, Denmark, the Netherlands, Belgium and France (1940) and the early part of the campaign against the U.S.S.R. He was dismissed by Hitler after the failure of the last assault against Moscow in 1941. He died on Oct. 18, 1948, while awaiting trial by the Allies as a war criminal.

See W. Görlitz, *History of the German General Staff*, Eng. trans. (1953); Telford Taylor, *The March of Conquest* (1959). (C. N. B.)

BRAUN, EVA (1912–1945), mistress and later wife of Adolf Hitler, was born on Feb. 6, 1912, into a lower middle-class Bavarian family. She was educated at the Catholic Young Women's institute in Simbach-am-Inn and in 1930 was employed as saleswoman in the shop of Heinrich Hoffman, Hitler's photographer. In this way she met Hitler. She became his mistress and lived in a house that he provided in Munich; in 1936 she went to live at the Berghof.

There is no evidence that the relationship between Hitler and Eva Braun was other than a normal one, except that the pleasures which she provided him were those of domesticity and relaxation rather than eroticism. She was an accomplished swimmer and skier, but her interests were generally frivolous. Hitler never allowed her to be seen in public with him or to accompany him to Berlin, and she had no influence on his political life.

In April 1945 she joined Hitler in Berlin, against his orders, determined to stay with him until the end. In recognition of her loyalty he decided to marry her, and the civil ceremony was carried out in a bunker on April 29. The next day Eva Hitler ended her life by taking poison; her husband is believed to have shot himself at her side. (W. Kp.)

BRAUN, KARL FERDINAND (1850–1918), German physicist whose pioneer work in wireless telegraphy won him, jointly with Guglielmo Marconi, the Nobel prize for physics in 1909. He was born at Fulda, Hesse-Nassau, Ger., on June 6, 1850, and was educated at the universities of Marburg and Berlin. After appointments at Würzburg, Leipzig, Marburg and Strasbourg, he was in 1883 elected to the chair of physics in the Karlsruhe polytechnic school, and in 1885 became professor of physics in the University of Tübingen, where he did much to establish the new physical institute. In 1895 he returned to Strasbourg to the chair of physics and the directorship of the institute of physics. Braun's first notable contribution to wireless telegraphy was the discovery of crystal rectifiers, and his invention of the "coupled" system greatly improved wireless transmission. He contributed to the early study of cathode rays and in 1897 devised the Braun tube, which represented an important improvement in the cathode-ray oscilloscope. He died in New York on April 20, 1918. (D. McK.)

BRAUN, LILY (1865–1916), leading German feminist and socialist writer, was born at Halberstadt on July 2, 1865, the daughter of a Prussian infantry officer, Hans von Kretschman. Passionate and enthusiastic, she was converted to atheism, pacifism and feminism by Georg von Gizycki, whom she married in 1893. After Gizycki's death (1895) she joined the Social Democratic party and, in 1896, married a member of it, Heinrich Braun (1854–1927). With Minna Cauer, she founded the feminist newspaper *Die Frauenbewegung*. In her important book, *Die Frauenfrage*, *ihre geschichtliche Entwicklung und wirtschaftliche Seite* (1901), she sought to show how capitalism, by employing women in industry, destroyed the family and thus made socialism inevitable. Never a conformist, she collaborated with her husband in publishing their own weekly *Die Neue Gesellschaft* (1905–07). Attacked by orthodox Social Democrats, she finally left the party.

Lily Braun's successful books were two large-scale period studies in novel form: *Im Schatten der Titanen* (1908), based on her grandmother's recollections of the era of Napoleon and Goethe; and *Memoiren einer Sozialistin,* two volumes (1909–11), mainly autobiographical. She died in Berlin-Zehlendorf on Aug. 8, 1916. Her collected works were published in five volumes in 1922.

Her son, Otto Braun (1897–1918), who was killed in World War I, also showed precocious talent as a writer.

See J. Vogelstein, *Lily Braun, ein Lebensbild* (1922). (O. K. F.)

BRAUN, WERNHER VON (1912–), rocket engineer and space flight proponent, was born in Wirsitz, Ger., March 23, 1912. Von Braun's youthful dreams of space flight led to his joining the German Society for Space Travel (Verein für Raumschiffahrt) in Berlin in 1930 where he worked on liquid-fueled rocket motors. In 1934 he received his Ph.D. in physics from the University of Berlin and began full-time work on rocket motors. Success resulted in his appointment as technical director of the German Army rocket centre at Peenemünde on the Baltic. There liquid-fueled rocket aircraft and jet-assisted takeoffs were successfully demonstrated and the long-range ballistic missile A-4 (the V-2) and the supersonic, antiaircraft missile *Wasserfall* were developed. At that time, the level of technology of rockets and missiles at Peenemünde was years ahead of all other countries.

At the end of World War II, von Braun went to the United States with key members of his technical staff. Working first at the White Sands Proving Grounds, N.M., he was by 1950 in charge of the U.S. Army ballistic weapon program at Huntsville, Ala., where the Redstone, Jupiter-C, Jupiter, Juno, and Pershing missiles were developed. In 1955 he became a U.S. citizen. During the early 1950s von Braun was a focal point for professional interest in space flight, but federal and scientific support for satellite flight lagged. A program to launch a satellite by 1957, Project Orbiter, was thwarted for lack of official support. The launching of Sputnik I by the U.S.S.R. on Oct. 4, 1957, changed the situation. Given approval in November 1957, von Braun and his team placed the first U.S. satellite, Explorer 1, in orbit on Jan. 31, 1958, using the Jupiter-C as a booster.

In 1960 von Braun and his organization were placed under the National Aeronautics and Space Administration (NASA). As director of the George C. Marshall Space Flight Center in Huntsville, he developed large space-launch vehicles, notably the Saturn V for the Project Apollo manned lunar program. In 1970 he left the Marshall Center to become deputy associate administrator of NASA. (*See* further Rockets and Guided Missiles.)

Von Braun received the Smithsonian Institution Langley Medal and many academic doctorates and highest professional awards. Among his published works are *Conquest of the Moon* (with F. L. Whipple and W. Ley), edited by C. Ryan (1953); *Exploration of Mars* (1956); *First Men to the Moon* (1960); *History of Rocketry and Space Travel* (with F. I. Ordway III) (1967); *Space Frontier* (1967).

See also a biography of von Braun, E. Bergaust, *Reaching for the Stars* (1960). (F. C. D. III)

BRAUNSCHWEIG: *see* Brunswick.

BRAVO, NICOLÁS (*c.* 1786–1854), Mexican general and political leader, was born at Chilpancingo of lower-class parents. In 1811 he joined José María Morelos y Pavón in his fight for independence against Spain, and upon the death of Morelos he became a guerrilla leader in southwest Mexico. After independence and adoption of a constitution Bravo served as vice-president of Mexico from 1824 to 1827. He led an unsuccessful revolution against the president, Guadalupe Victoria, in 1827. At various times Bravo was acting president, the last occasion during the war with the United States. He was taken prisoner by the U.S. forces under Gen. Winfield Scott in Mexico City in 1847. After the war Bravo retired to private life on his hacienda at Chichihualco, where he died on April 22, 1854. (R. E. Q.)

BRAXTON, CARTER (1736–1797), American colonial leader and signer of the Declaration of Independence, was born in Newington, Va., Sept. 10, 1736. He graduated from William and Mary College, and in 1761 became a member of the Virginia House of Burgesses, where he served for more than a dozen years. He was active in the earliest step of protest against British taxation, serving as a member of the Committee of Safety preceding the establishment of a state government. He was chosen a delegate of Virginia to the Continental Congress. He expressed conservative political views in an "Address to the Convention of Virginia on the Subject of Government," published in Philadelphia in 1776. He continued to serve his state in the assembly and the privy council until his death in Richmond, Va., on Oct. 10, 1797. (E. E. R.)

BRAY, THOMAS (1658–1730), English clergyman and a founder of the Society for Promoting Christian Knowledge (1698) and of the Society for the Propagation of the Gospel (1701), was born at Marton, Shropshire, and educated at All Souls College, Oxford. After ordination he held a number of appointments, and in 1695 Bishop Henry Compton made him his commissary for Maryland. To assist poor clergy Bray established parochial libraries, first in America and then in England. Out of this grew the S.P.C.K. and later the S.P.G., for encouraging educational and missionary activity. From 1706 until his death in London on Feb. 15, 1730, he was rector of St. Botolph, Aldgate, London. His writings include the *Catechetical Lectures* (1696). For portrait *see* article Protestant Episcopal Church.

See H. P. Thompson, *Thomas Bray* (1954). (G. Hu.)

BRAY, a village in Berkshire, Eng., on the right bank of the Thames between Maidenhead and Windsor. Pop. (1961) 4,858. The name is celebrated in a well-known ballad, "The Vicar of Bray," of unknown authorship, which tells how a vicar held his position by changing his creed according to necessity, from the days of Charles II until the accession of George I. Tradition ascribes the song to the reign of George I, but the story is supposed to have originated around an earlier vicar named Simon Aleyn. The church, dating from the 13th century, is partly Early English decorated with a Perpendicular tower. Bray is residential, with early 17th-century red brick almshouses (Jesus Hospital).

BRAYLEY, EDWARD WEDLAKE (1773–1854), English antiquary and topographer, coauthor and coeditor of a popular topographical work, *The Beauties of England and Wales,* was born in London in 1773. He was apprenticed to the enameling trade but early developed an interest in literature. He became a close friend of John Britton (1771–1857), a young man of similar interests, and together they wrote some popular songs and plays. Brayley assisted Britton with his *Beauties of Wiltshire,* three volumes (1801–25), and they then began *The Beauties of England and Wales,* 18 volumes in 25 (1801–15). They toured every county in north Wales, and several western and midland counties in England, on foot, and descriptions of these counties appeared in alphabetical order, illustrated with copperplate engravings. The first six volumes ended with Herefordshire, at which point disagreements between the authors and their publishers caused Brayley and Britton to dissociate themselves gradually from the work, which was completed by others.

Of indefatigable industry, Brayley continued his enamel work long after he had become famous as a topographer, and also published many other historical and antiquarian works. He died in London on Sept. 23, 1854.

BRAZIL, a republic occupying nearly half the continent of South America. It is exceeded in size only by the Soviet Union, China, Canada, and the United States. It has an area of 3,286,470 sq.mi. (8,511,965 sq.km.) extending 2,684 mi. (4,320 km.) from north to south and 2,689 mi. (4,328 km.) from east to west. Its territory touches on that of all the other South American countries except Chile and Ecuador. Brazil is made up of the former colonies of Portugal; unlike the Spanish colonies, which became separate countries, the Portuguese colonies were united in one huge country. The language of Brazil is Portuguese. Beginning on April 21, 1960, its federal capital was Brasília, replacing Rio de

Janeiro (*qq.v.*). In many fundamental ways Brazil stands in strong contrast to the other countries of the Western Hemisphere.

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There are separate articles on all the Brazilian states and territories and more important towns.

I. PHYSICAL GEOGRAPHY

1. Geology and Surface Features.—The greater part of the area of Brazil consists of hilly uplands, plateaus and low mountains. Very little of the national territory can be described as a plain. The largest area of plain is in the upper Amazon Basin, and Brazil shares with Bolivia a part of the upper Paraguay plain. There is no coastal plain. The Guiana highlands north of the Amazon and the Brazilian highlands south of the Amazon are both similar in geology and surface features. Underlying them are some of the oldest geological formations on earth. The ancient igneous and metamorphic rocks of Archean age were described by John Casper Branner as the Brazilian complex. The rocks are granites, gneisses and metamorphic schists, folded and faulted, and cut in many places by pegmatite veins in which are found gold, diamonds and a variety of semiprecious stones. The ancient crystalline rocks weather rapidly under the rainy conditions of the tropics, forming convex slopes, rounded hilltops and narrow valleys.

More resistant than the Archean rocks are the Algonkian (Proterozoic) beds, consisting of phyllites, quartzites and limestones. Where these beds occur they hold massive rounded low mountains that stand above the general level of the Archean rocks. The Serra do Espinhaço and Serra Geral running northward from central Minas Gerais into Bahia are made up of Algonkian rocks, as is also the Pico da Bandeira, Brazil's highest peak (9,495 ft.), located near the border of Minas Gerais and Espírito Santo. In the Algonkian rocks are found the chief occurrences of iron ore, gold and manganese.

A large part of the Brazilian and Guiana highlands consists of tabular land forms. Here the Brazilian complex is covered by Paleozoic sedimentary rocks consisting of sandstones, shales and limestones, and ranging mostly from Silurian to Permian in age. The Permian beds of southern Brazil contain seams of low-grade coal and the remains of plants, some of which belong to the *Glossopteris* flora. In some of the Permian formations, also, there are traces of ancient glaciation, including erratic boulders, striations and glacial till. Where the limestones are exposed, as in the middle São Francisco valley, karst land forms are developed.

Overlying the Paleozoic rocks, especially in São Paulo and the southern states, there are soft, reddish sandstones of Triassic age, interbedded with sheets and flows of diabase lava. The diabase is very resistant and wherever it occurs holds up prominent cuestas and mesas, and the rivers are frequently interrupted by falls and rapids.

The great waterfalls of the Rio Paraná (Salto das Sete Quedas) and the Iguaçu falls on the Iguaçu river are formed where the rivers pour over the edge of the diabase. One of the world's largest lava plateaus, the Paraná plateau, is in southern Brazil. Diabase formations appear also in Paraguay, Argentina and Uruguay. Where the diabase is exposed at the surface it weathers into the dark purple-coloured soil known as terra rossa, famous as a producer of coffee.

Still more recent rocks of Cretaceous and Tertiary age occur along parts of the Brazilian coast, especially in the northeast. These sedimentary strata form the mesalike *tabuleiros* along the coast. From the vicinity of Salvador a sedimentary basin filled with Tertiary strata extends northward across the lower São Francisco. Oil has been found in these shallow formations near Salvador (*q.v.*).

The Brazilian and Guiana highlands are made up of an intricate pattern of hilly upland, low mountain and tabular plateau. Each surface form reflects the underlying geological formation. The hilly upland, associated with Archean rocks, stands at a general elevation of about 2,600 ft. above sea level. The low mountains on Algonkian formations stand about 1,000 ft. higher, with a few peaks that are just under 10,000 ft. The highest tabular uplands, such as Mt. Roraima are also just under 10,000 ft. (9,094 ft.), but the general elevation of the plateaus is between 3,000 and 4,000 ft.

2. Physiography.—The geomorphologist L. C. King has pointed out the remarkable similarity of the land forms of South Africa and Brazil. The various levels, such as the conspicuous summit level at about 2,600 ft., are the result of successive cycles of erosion. The oldest cycle, now preserved on a few of the highest summits, was probably developed in the Cretaceous—so that these highest surfaces have been exposed to erosion for a very long period of time. As the rock material was stripped off during each cycle of erosion, the land rose higher above sea level because of isostatic readjustment. Each rise of the land initiated a new cycle, which cut back into the older and higher lands, thus creating a landscape that looks much like a relief model when the layers have been put together but before the edges have been smoothed over.

The Great Escarpment.—The eastern margin of the Brazilian highland descends abruptly to the sea. In some places the descent is over a series of steps; but in back of Rio de Janeiro, Santos and Paranaguá, there are places where the descent from about 2,600 ft. to sea level is accomplished in one steep slope. Whether there is one slope, or a series of steps, the eastern edge of the highland is sharply marked all the way from Salvador to Pôrto Alegre. This feature is called the Great Escarpment. In back of Santos it was given the name Serra do Mar (*q.v.*), although incorrectly described as a mountain (*serra*). According to King and others, the Great Escarpment is not a fault scarp, but rather a monoclinal flexure. The same erosion levels that stand at different elevations in the interior are warped down below sea level along the eastern margin of the highlands. From Cabo Frio southward the Great Escarpment is unbroken by rivers; but north of Cabo Frio a succession of rivers have cut back across the Escarpment, from the Rio Paraíba in the south to the Rio Paraguaçu in the north, west of Salvador. The Rio Doce, which reaches the sea north of Vitória, provides a relatively easy route back into the highlands from the sea.

The Coast.—Although there is no true coastal plain along the Brazilian coast, there is a zone of varying width in which there are sand bars and lagoons. There are many miles of white, sandy beaches, and many places where there are sand dunes. The largest zone of sand bars and lagoons is in the south, where two large lakes are separated from the ocean by bars—the Lagoa dos Patos and Lagoa Mirim. But the bar and lagoon coast is interrupted in a few places where the rocky slopes of the Great Escarpment plunge directly into the ocean, as they do east of Santos. The coast, 4,603 mi. in length, has several very fine, deep harbours. Most famous are Guanabara bay, on which Rio de Janeiro and Niterói are situated, and All Saints bay (*q.v.;* Baía de Todos os Santos) on which Salvador is located. But there are also many smaller harbours from São Francisco in the south to São Luís in the north. Especially important among these smaller harbours are Paranaguá, Vitória, Ilhéus and Recife. The Amazon itself is drowned at its mouth, providing deep water for ocean-going ships as far inland as Manaus, and for ships drawing 14 ft. of water as far as Iquitos in eastern Peru.

The Rivers.—The Brazilian highlands are drained by three major river systems. In the north is the great Amazon river, with its succession of great tributaries such as the Tocantins-Araguaia, the Xingu, the Tapajós and the Madeira on the southern side, and the Rio Negro on the northern side. The headwaters of the Amazon collect the water from the Andes all the way from Bolivia to Colombia. The Amazon lowland has the peculiarity of being widest along the eastern base of the Andes. It becomes narrower toward the east, until, east of Manaus, only a narrow ribbon of flood plain separates the Guiana highlands to the north from the Brazilian highlands to the south. At Óbidos the flood plain is less than a mile wide. The flood plain opens up again as it approaches the Atlantic. The main river, as noted above, is navigable all the way into eastern Peru. But the tributaries are all interrupted by falls and rapids where they descend from the Brazilian highlands. (*See* AMAZON; ARAGUAIA.)

The second of the great river systems of Brazil is that of the Paraguay-Paraná-Plata. From southwestern Minas Gerais southward, the highlands are drained into the Paraná. The water that falls at the crest of the Great Escarpment overlooking the Atlantic ocean in back of Santos, flows westward and then southward, eventually reaching the sea through the Río de la Plata, near Buenos Aires. The two southernmost states are drained through the Rio Uruguai (Spanish, Río Uruguay) also to the Plata. None of these rivers in Brazil is navigable except for short stretches. (*See* PLATA, RÍO DE LA.)

The third of Brazil's great river systems is that of the Rio São Francisco, the largest river wholly within Brazil, and a river for which many Brazilians have an almost mystical feeling. The São Francisco, like the Paraná and the Tocantins, rises in the Planalto Central in western Minas Gerais and southern Goiás, inland from Rio de Janeiro. A place on the high country, about 4,000 ft. above sea level, where the three great rivers have their origin, was selected as the site for Brasília, the new capital. The São Francisco flows for over 1,000 mi. northward into the state of Bahia and the border of Pernambuco before it turns eastward to the ocean. The great river is navigable for shallow-draft river boats between Pirapora in Minas Gerais north of Belo Horizonte and Juàzeiro in Bahia. Below Juàzeiro the river current becomes swifter as it approaches the Paulo Afonso falls, 279 ft. high, where the water plunges into a deep trench. Only the last 172 mi. of the lower river are navigable for ocean ships. The Brazilian government has built a hydroelectric plant at the Paulo Afonso falls. (*See* SÃO FRANCISCO.)

E. AUBERT DE LA RÜE

CONFLUENCE OF THE AMAZON (SOLIMÕES) AND NEGRO RIVERS DOWNSTREAM FROM MANAUS

There are also a number of smaller rivers that drain more directly to the Atlantic, and because they pass through the most densely populated part of Brazil they are of great importance. In the state of Piauí, the Rio Parnaíba flows northward to the ocean, and is navigable for hundreds of miles for river barges. South of the Rio Paraguaçu, which drains into All Saints bay, there are several short streams descending from the Serra do Espinhaço across the Great Escarpment to the coast. Among these are the Rio de Contas, the Rio Jequitinhonha and the Rio Doce—the latter by far the most important. The Rio Paraíba rises in São Paulo state and starts flowing toward the west. A little east of São Paulo city the river turns completely around and flows eastward parallel to the coast. In its middle course it meanders across a wide flood plain used now for the production of rice. It then plunges on eastward through a narrow gorge, finally to emerge on its delta near Campos. The headwaters of the Rio Paraíba, which flow toward the west, were formerly a part of the Rio Tietê, a tributary of the Paraná, but were captured by the Paraíba. In the far south, in the state of Rio Grande do Sul, the Rio Jacuí drains eastward past Porto Alegre into the Lagoa dos Patos. The water of both Lagoa Mirim and Lagoa dos Patos enters the sea through an opening in the bar near the port of Rio Grande do Sul. The Jacuí together with Lagoa dos Patos is the inland river system of Brazil that carries the largest tonnage of goods, partly because of coal shipments to Pôrto Alegre.

3. Climate.—The climate of Brazil contains no extremes of temperature or rainfall. Contrary to popular opinion, the temperatures of the equatorial regions are not excessively high. The average annual temperatures in the Amazon basin are between 78° and 79° F., with ranges between warmest and coldest months of about 4°. Temperatures as high as 100° have never been experienced in the Amazon, nor are there temperatures below 50°. In the northeast of Brazil temperatures of over 100° do occur during the dry season each year, but this is the hottest part of the country. At Rio de Janeiro the average temperature of the warmest month is 79°. The average of the coldest month in Rio de Janeiro is 68.7°. The temperatures on the highlands are several degrees lower than those of the coast with frosts occurring every winter as far as the southern border of São Paulo state. Frosts also occur at sea level in southern Rio Grande do Sul.

Most of Brazil receives moderate rainfall. Very heavy rains are received in the upper Amazon and near its mouth; and along the sea-facing slope of the Great Escarpment in São Paulo state. Moisture deficiency is encountered in the northeast, and in this region there is a record of recurring droughts that cause great distress for the inhabitants. Over most of Brazil the rainfall is between 40 and 60 in. In the Amazon the rainy season is from January to June, but the rest of the year is only a season of less rain. In most of the country the rains come in summer (*verão*) from December to April and the winters (*inverno*) are dry.

TABLE I.—*Average Temperatures (Fahrenheit) and Annual Rainfall*

Locality	Average temperature		Annual rainfall (in.)
	Warmest month	Coldest month	
Amazon basin			
Manaus	82.8	79.7	69.7
Belém	79.9	77.4	86.0
Atlantic coast			
Recife	82.2	77.0	64.9
Ilhéus	79.3	71.4	88.0
Rio de Janeiro	79.0	68.7	43.3
Santos	77.9	66.0	78.5
Pôrto Alegre	76.5	56.3	50.0
Highlands			
Belo Horizonte	72.1	62.2	59.3
São Paulo	69.1	57.9	56.2
Curitiba	70.0	54.0	55.0
Goiás	78.1	72.3	66.8

4. Vegetation.—The various conditions of the climate together with those of soil and drainage are reflected in the cover of vegetation. Seven major kinds of vegetation are found in Brazil. In the Amazon basin, and in those places along the Atlantic coast where the rainfall is very heavy, there is a tropical rain forest or selva, composed of broadleaf evergreen trees growing luxuriantly. The selva is made up of a great many different species—as many as 3,000 in a square mile. The trees have tall, straight trunks, and the branches are interlaced overhead, with foliage so thick that little light reaches the ground below. The soil under the selva is deeply leached, and when the forest is cleared the land quickly loses its capacity to produce shallow-rooted crops.

Where the rainfall is slightly less and the dry season is really dry, there is a semideciduous forest, composed of broadleaf trees most of which are evergreen, but a few of which lose their leaves in the dry season. The trees are smaller than in the selva, and the land is easier to clear. This type of forest extends in a narrow band from near Natal southward to Pôrto Alegre. It covers a wide area in southern Minas Gerais and in São Paulo state. This kind of land supported Brazilian agriculture during the 400 years of Portuguese settlement, but due to lack of soil conservation techniques it is now largely destroyed.

CARL FRANK FROM PHOTO RESEARCHERS

THICK SUBTROPICAL FOREST IN PARANÁ STATE

In the dry area of the northeast, inland from the semideciduous forest, there is a scrubby thorn woodland or caatinga, consisting of gnarled low broadleaf trees that lose their leaves in the dry periods. The land is of little value except for the grazing of goats.

The greater part of the interior of Brazil, south of the forest of the Amazon basin and west of the semideciduous forest, is covered with a woodland savanna known as *campo cerrado*. This is a mixture of scrubby deciduous woodland and savanna. There are patches of pure savanna (*campo limpo*), probably produced by repeated burning of the grass, and patches of uninterrupted woodland (*cerradão*). Where rivers have cut back into the upland surface, the valleys are often covered with semideciduous forest. With some exceptions, attempts to use the *campo cerrado* for the growing of crops have not been successful, nor is this vegetation good for cattle grazing. The soils are very poor and the grass is lacking in essential minerals.

In the flood plain of the upper Rio Paraguai (Spanish, Río Paraguay) the area that is covered annually with flood waters is covered with a mixture of wet savanna and palms—known as *pantanal*. In the dry season the savanna can be used for the grazing of cattle.

In the southern part of Brazil two vegetation types reflect the recurrence of frosts. Where the land is covered with grass, the *campo cerrado* gives way to a tall-grass prairie with little clumps of trees on the hillsides where water emerges in springs at the valley heads. These open prairies extend southward from the vicinity of Sorocaba in São Paulo state through Rio Grande do Sul into Uruguay. These prairies have long been used by the Portuguese for pasture land. There has been some effort to use these lands for wheat, but with uncertain results.

Where the land is covered with forest recurring frosts limit the southward extension of the semideciduous forest. This tropical type of forest is replaced by an *Araucaria* or Paraná pine forest, consisting of an upper story of evergreen needle-leaved trees, and a lower story of broadleaf deciduous trees, among which is the tree that is used to produce Paraguay tea (*Ilex paraguayensis*). The Paraná pine is not a producer of high-grade lumber, but the better stands are used for this purpose. A paper mill makes use of this pine in the state of Santa Catarina.

The part of Brazil that has been used most completely for agriculture is the semideciduous forest, and this forest, also, has furnished most of the cabinet woods for which Brazil is famous. A serious problem has arisen as this forest has been largely destroyed, partly through burning to clear the land, and partly through charring wood for charcoal which is used both for cooking throughout Brazil and in some of the steel plants for fuel. The question is can any of the other kinds of land in Brazil be developed for agriculture? Many Brazilian political leaders are urging the advance of farmers onto the *campo cerrado*.

5. Animal Life.—Brazil has no large game animals, such as are found in the savannas and forests of Africa. There are many kinds of birds, insects and reptiles. There are also several species of the cat family. The largest land animal of the selva is the tapir, and the rivers of this tropical rain forest abound with fish and turtles.

In a country like Brazil, where the climatic data are not very reliable and where only a few localities have been studied by the methods of modern soil science, the vegetation is the best indicator of the potential utility of the land.

II. GEOGRAPHICAL REGIONS

The vast national territory of Brazil, 3,286,470 sq.mi. in area, can be divided into six major geographic regions. These are: (1) north; (2) northeast; (3) east; (4) São Paulo; (5) south; and (6) central-west. These regions are shown on the map as states or groups of states. In most cases the more accurate construction of regional boundaries would cut across state territories, but for census purposes whole states are placed in one or another region. The Conselho Nacional de Geografia, an official Brazilian government agency charged among other things with the mapping of enumeration areas for the census, uses essentially these same geographical regions, excepting that it includes the southern part of the northeast with the east, and it includes São Paulo with the south.

1. North.—The largest of Brazil's regions includes the world's most extensive area of tropical rain forest, or selva, and the central part of the Amazon basin. There are low-lying alluvial lands around the embayed mouth of the great river and in a narrow ribbon along the flood plain. But most of the surface of the north consists of low plateaus, or low, rolling hills. Very little of the area is subject to floods, for the flood plain of the Amazon in the vicinity of Óbidos is scarcely a mile wide, and the tributary rivers occupy narrow valleys and descend to the main stream over falls and rapids. The rain forest, consisting of enormous trees with boughs interlaced overhead and with little undergrowth, covers most of the north. The dense tangle of vegetation which the popular books describe as "steaming jungle" exists only in old clearings or along the river banks. The soil, excepting on the flood plains, has been so deeply leached during long exposure to heavy rainfall that it has little sustained fertility for shallow-rooted crops.

The main problem in the economic development of the north is the lack of inhabitants. A million rice-growing orientals working the flood plain might make this region highly productive; but the few thousand Brazilians and foreign immigrants, limiting their agriculture to the high ground away from the river where soils are poor, are lost in the great forest. At one time this was the world's only source of natural rubber. Rubberworkers went along the rivers and into the forest to look for rubber trees growing wild. The rubber boom ended in 1910, when rubber was produced more cheaply on plantations in southeast Asia. Attempts by the Ford industries to plant rubber in the Amazon failed, not because of climate, or health, or agronomical problems, but because there were not enough workers in the whole basin to clear land sufficiently to plant the trees. In the late 1950s there was a new speculative boom of planting along the lower Amazon where Japanese settlers were raising jute and black pepper. The manganese deposits in Amapá were being rapidly developed. But most of the region remained decadent. There are still great possibilities for economic development when enough capital and enough labour can be brought together; but lacking these things the north remains one of the world's great empty areas.

2. Northeast.—There are two contrasted parts of the northeast. Along the east coast there is a belt of dependable rainfall, supporting a strip of forest running northward from Bahia as far as Natal. The rest of the region is one of recurring calamities of flood or drought, which, in this densely populated area, cause widespread suffering. The rainy belt was originally occupied by a semideciduous tropical forest, not so dense as the selva. Most of this forest has been cleared away for crops or pastures. The other part of the region is covered with a thorny deciduous scrub woodland known as caatinga. The western part of Maranhão is covered with selva and resembles the north; and the southern part of Bahia, south of Salvador, resembles the east. Bahia and Sergipe have been included in the northeast being typical of this region; only the southern part of Bahia really fits the geographical characteristics of the east.

The northeast was the first part of Brazil to achieve great wealth. In the 16th century the Portuguese established the world's first large-scale sugar-cane plantations with Negro slave labour in the forested areas of Pernambuco and Bahia. This part of the northeast still produces sugar, largely, but not exclusively for the Brazilian domestic market. In Rio Grande do Norte large areas are used to grow cotton. The chief profits are made from the sale of cottonseed cake to the cattlemen. In the state of Paraíba there is a boom area of sisal planting; and in Pernambuco there are coffee plantations. In the state of Bahia, west of the sugar-cane plantations, there is a tobacco-growing area. The greater part of the northeast, however, is used for a shifting cultivation of food crops and for the pasture of animals. Cattle can only be raised where the rainfall is adequate; the dry interior is mostly used for goats. In Maranhão there is an area where the babassu palm (a source of oil) grows wild; and Ceará is the world's chief source of carnauba wax, derived from the leaves of a palm.

Politically, the states of the northeast often co-operate to decide national issues in their favour. The region has a sense of unity, based on long history and cultural tradition, that is far stronger than that found in any other Brazilian region.

3. East.—This is a region of complex terrain. Immediately in back of the swampy lowlands along the coast the Great Escarpment rises like a wall, breached in only a few places by rivers. From the top of the Great Escarpment, 2,600 to 2,800 ft. above sea level, the land rises in a series of steps to the top of the Serra do Espinhaço between 6,000 and 6,500 ft. above sea level. Most of the east receives abundant rainfall, but toward the interior the rains are concentrated in a rainy season from October to April. The slopes of the Great Escarpment and the uplands to the east of the Serra do Espinhaço were originally covered with a tropical semideciduous forest, most of which has now been cleared. The western part of Minas Gerais is within the area of the *campo cerrado,* the woodland savanna, which is characteristic of the central-west.

The settlement of the east took place largely between 1700 and 1800. Gold was discovered in the stream gravels in 1698, and diamonds soon after. Rio de Janeiro was selected as the outlet of the mining region, and made its start as a great city when a road was built to Ouro Prêto in 1701. But gold mining declined about 1800, and the 19th century was one of decadence. Sugar cane and coffee were planted and remained productive for a time. But the major use of the land in this region remains the grazing of cattle on planted pastures. The shifting cultivation of food crops (corn, rice, beans) has resulted in the widespread destruction of the forest. But in the 20th century the east has again become an important mining region. Now it is the iron and manganese that are of major significance. Iron ore is mined at Lafaiete for use in the new steel plant at Volta Redonda (*q.v.*) in the Paraíba valley. Other ore bodies are used to supply the large charcoal-burning steel plants in and around the Serra do Espinhaço. Manganese and limestone are also supplied from this region; and other minerals include semiprecious stones, industrial diamonds and quartz crystals. Rio de Janeiro is second only to São Paulo in manufacturing industry, and throughout southern Minas Gerais and Rio de Janeiro states there are numerous industrial towns, such as Juiz de Fora.

4. São Paulo.—São Paulo is identified as a separate region because of its outstanding economic development. Immediately in back of Santos the Great Escarpment stands like a wall, rising to 2,600 ft. Transportation up or down this steep slope has always

CARL FRANK FROM PHOTO RESEARCHERS

WORKER ON A COFFEE PLANTATION NEAR LONDRINA IN PARANÁ STATE been a problem. In 1867 a British company completed a cable railroad to connect São Paulo with its port, and until 1946 this railroad had a monopoly of all shipments in or out. In the 1950s a four-lane highway was built for motor vehicles. The Escarpment, too, is used for Latin America's largest single hydroelectric installation at Cubatão. The greater part of the interior of the state is a hilly upland, covered with semideciduous forest or woodland savanna.

During the gold period of the 18th century, São Paulo was a frontier. Sorocaba and Campinas were on the margin between settled country and the wilderness. São Paulo as a geographical region was created during the coffee period from 1850 to 1930. The rise of São Paulo city as an industrial centre came after 1930, and only in 1954, at its 400th anniversary, did São Paulo declare itself larger than Rio de Janeiro. Coffee is produced in the interior, and also sugar cane, cotton, oranges and cattle. São Paulo leads Brazil in the production of almost everything except cacao (from Bahia), tobacco (from Bahia and Rio Grande do Sul) and minerals.

CARL FRANK FROM PHOTO RESEARCHERS

GAUCHOS ROUNDING UP CATTLE ON A RANCH IN THE SOUTHERN STATE OF RIO GRANDE DO SUL

5. South.—The surface features of this region in many ways resemble those of São Paulo. The Great Escarpment continues southward as far as Pôrto Alegre. But along the southern border of São Paulo is the northern limit of occasional winter frosts, marking the southern limit of such tropical products as coffee. The forest in the south consists of a mixture of pine and deciduous broadleaf trees; but a large part of the area, especially of Rio Grande do Sul, is a tall-grass prairie.

The Portuguese gave scant attention to this part of Brazil. Finding no source of wealth in the forested areas they left this part of the south to the Indians. They settled on the prairies and raised cattle and mules to supply the miners of the east. Starting in 1822 in Rio Grande do Sul, and in 1850 in Santa Catarina, German colonists were settled in the previously unoccupied forests. Later came colonists from Italy, Poland and other European countries. The south is today very largely populated by the descendants of these European colonists. Lacking the speculative profits from sugar cane or coffee, the south has developed a less spectacular kind of agricultural economy, producing pork and lard, rice, cattle and sheep, and manufactured products based on these raw materials. Rio Grande do Sul supplies a quarter of the rice needed in São Paulo and the east, and a large part of the *carne seca,* or dried beef. From the Paraná pine forests come timber, charcoal and yerba maté (or Paraguay tea). The Italian settlements in Rio Grande do Sul produce most of Brazil's wines. And in both Santa Catarina and Rio Grande do Sul there are coal mines. Pôrto Alegre is a rapidly growing commercial and industrial city.

6. Central-West.—This region includes a vast area of the Planalto Central, or Central plateau, an old erosion surface standing now about 3,300 ft. above sea level. Into this old erosion surface the numerous streams are in the process of extending their valleys. Where the valleys have been cut into the high surface, the land is hilly and the streams torrential; but the high country along the drainage divides is conspicuously level. The old erosion surface has probably been exposed to the work of the weather since the Cretaceous period, during which time the soils have been deeply leached. The undissected part of this surface is covered with a woodland savanna, or *campo cerrado;* however, where the stream valleys have been cut below this surface the valleys are filled with semideciduous forest. The annual rainfall is about 40 in., but is concentrated in the rainy season from October to April. In the dry season the woodlands lose most of their leaves, and the savanna grasses turn brown.

Although the central-west has been tramped over in search for gold or other sources of wealth, it has been settled only in a few places, these mostly in the patches of forest. The *campo cerrado* has never been easily occupied by farmers or cattlemen.

(P. E. J.)

III. THE PEOPLE

1. Ethnic Composition.—The population of Brazil has been formed of three racial stocks, namely the Indians of Mongolian derivation, the African Negroes, and the Europeans from Portugal. When the Portuguese arrived in the 16th century, they found the huge area which is today Brazil inhabited by only about 1,000,000 Indians. These were divided into numerous warlike tribes speaking a variety of native tongues. Their technology was simple, although the majority of these tribes practised agriculture; yet their way of life was well adapted to the tropical forest and the open savanna uplands. In a relatively brief period, most of the Indians along the coast died off from disease acquired from the Europeans, from slavery or from war; others fled deep into the interior. During this short period, however, Portuguese men formed unions with Indian women, and their offspring, called mamelucos, became an important element in the early colonial population.

About the middle of the 16th century, the Africans began to arrive in Brazil in large numbers. Neither the remaining Indians nor the mamelucos were numerous enough to supply the necessary labour for the very prosperous sugar-cane plantations along the northeastern coast. The planters turned to Africa, where the Portuguese were already established in the slave trade. No one knows with any exactness just how many Negro slaves came to Brazil; but during the 17th, 18th and 19th centuries at least 3,500,000, probably many more, were imported, mainly from West Africa. For a time there were more Negroes in the colony than either Portuguese colonists or Indians. The total population of the colony in 1817 has been estimated at 3,617,000, of whom 1,888,000 were Negroes, 628,000 mestizos (mixtures of Indians, Negroes and whites), 843,000 whites and 258,000 Indians. During the 19th century, however, the flood of Africans came to a halt with the suppression of the slave trade after 1850, and slavery was abolished in 1888. The Portuguese had little prejudice against people of dark skin colour and they mixed rather freely with Negro slaves as well as with the remaining Indians. For a time, the most numerous elements in the population were people of mixed ancestry—mulattoes and mestizos (mamelucos) descended from all three racial stocks.

During the second half of the 19th century and the early decades of the 20th, Brazil received a large number of immigrants from Italy, Portugal, Spain, Germany and other countries of central Europe, and from the middle east. Between 1874 and 1949, 4,546,560 immigrants entered Brazil, the great majority of whom were Europeans. This increased the proportion of Caucasoids in the population; but immigration alone cannot be held accountable for the fact that after the turn of the century the preponderance of the population of Brazil has been white. It has been explained that, in addition to the wave of immigrants of European origin, the whites in Brazil, both the older Portuguese stock and the newcomers, have reproduced faster than the Negroes, Indians and people of mixed ancestry. The higher rate of reproduction of the whites was possible because of their higher standard of living, resulting in lower indices of infant mortality and a lower death rate in general. This progressive increase of the proportion of people of light skin colour in the population has been called, in Brazil, the "bleaching process." Whatever the explanation, by 1950 the official census showed 62% of the population to be white, 11% to be Negroes, 26% to be "brown" or *pardo* (*i.e.*, people of mixed ancestry and Indians) and the remainder to be either "yellow" or of undeclared colour. Those classed as "yellow" are of Japanese and Okinawan origin. Between 1925 and 1940, about 200,000 Japanese and Okinawans immigrated to Brazil, settling in São Paulo state and in the Amazon valley. By 1950 there were perhaps no more than 150,000 tribal Indians left in Brazil, but since the remaining tribes lived deep in the interior they were often not counted in the official census.

EMIL SCHULTHESS FROM BLACK STAR

CARAJA INDIAN VILLAGE CHIEF DECORATING SON'S BODY WITH TRIBAL DESIGNS

The population of Brazil continues to be a highly mixed one in racial composition but the relative importance of each racial stock in the make-up of the population varies from one part of the country to another. Whites predominate in the southern states, which received the largest number of European immigrants. Indian elements are of greatest importance in the Amazon basin, where the so-called *caboclo*, or backwoodsman, often is the descendant of both Portuguese and Indian ancestors. The Negroes and mulattoes are most numerous in the northeast coastal and the central states, the region which had a large slave population.

Brazilians are generally proud of their racially mixed population and racial equality is a point of national pride. Although there is undoubtedly some degree of prejudice toward people of dark skin colour, Brazilians point out the relative lack of discrimination and segregation on the basis of race as part of their highly valued national heritage.

2. Cultural Heritage.—Just as three main racial stocks contributed physically to the Brazilian population, the cultures of the American Indians, the African Negroes and the Portuguese have together formed the modern Brazilian way of life. By far the most important of these three elements is the cultural contribution of Portugal. Brazilians acquired their language, their religion and most of their traditional customs from the Portuguese. Throughout the vast area of Brazil, the Portuguese were able to establish a remarkably homogeneous way of life. Except for a few colonies of German, Italian and Japanese immigrants, and except for the few remaining Indian tribes, all Brazilians speak Portuguese with relatively little variation in dialect from one region to another. Analogous to the English spoken in the United States, Brazilian Portuguese has its own accent and vocabulary which sets it off from the same language as spoken in the mother country. Also derived from the Portuguese heritage is Roman Catholicism, which has deeply influenced Brazilian culture. Church and state are entirely separated and religious tolerance prevails. By far the great majority of Brazilians are by tradition Roman Catholics although church writers indicate that a large proportion of them are not practising Catholics. Protestants of various denominations are numerous, especially in the southern portion of the country, and there are significant numbers of Spiritualists, Jews, Orthodox Eastern Catholics, Buddhists, Maronites and Muslims in the population. Very numerous, although their exact number has never been determined, and of great influence among the lower classes are the devotees in various Afro-Brazilian fetish cults which flourish in the poorer residential districts of Bahia, Rio de Janeiro, Recife, São Luís and other large cities, as well as in numerous rural communities throughout the nation.

From one end of the country to another, Brazilians share a set of traditions inherited from Portugal or formed in the new world during their own history as a nation. Among the important popular festivals is Saint John's Eve (June 23rd) on which families and friends gather around bonfires to roast yams, set off fireworks and paper balloons, and sing. This is a Catholic festival celebrated also in Portugal. Brazilians also celebrate their Independence day (Sept. 7) in memory of their separation from Portugal, and other patriotic holidays.

Although the Portuguese were able so successfully to transmit their way of life to the Indians, Negroes and the mixed population, the influence of the aborigines and of Africa can be felt in the way of life of the Brazilian countryman. From the Indians. Brazilians learned much about their environment. Throughout the country, Brazilian farmers still use a rather wasteful type of aboriginal fire agriculture and they plant manioc (cassava) and other crops which were cultivated by the Indians. Tupi, the language which was spoken by most of the Indians along the coast, was adapted as early as the 16th century by missionaries for catechism and came to be called *lingua geral*, the general language. For a time, this language was spoken widely throughout the interior of northern Brazil by Indians, mestizos, Portuguese and Negroes. From this language come many of the names of plants, animals and places in Brazilian Portuguese. Some of these terms of Tupi origin have come to be used in English, such as tapioca (a by-product of the manioc tuber) and cashew (*acajú* in Tupi). The Indian contribution to Brazilian culture is most apparent in the Amazon valley, where many Indian customs and beliefs have been retained by the rubber collectors and isolated farmers.

African influence on the Brazilian way of life is strongest in the old plantation region north along the coast from Rio de Janeiro. Particularly in Salvador, the capital of Bahia state, one encounters a series of traditional dishes of African origin, such as *vatapá*, made of rice flour, coconut oil, fish and shrimps, red peppers and many condiments, and *acarajé*, a beancake fried in coconut oil. In most northern coastal cities, there are religious cults of African origin called *macumba* in Rio de Janeiro and *candomblé* in Bahia which are analogous to the voodoo, or *vodum* of Haiti. These cults worship West African deities as well as Catholic saints. Throughout Brazil, people tell folktales similar to the Uncle Remus stories told in southern United States. African influence is clearly apparent in Brazilian popular music, especially in the highly rhythmic sambas.

Because of the great environmental variation over this large country, there are marked regional differences in Brazilian culture. The extreme southern state of Rio Grande do Sul is known for the gauchos, the cowboys of the pampas. The southern states of Rio Grande do Sul, Paraná and Santa Catarina are known for their colonies of European farmers. The people of the progressive city of São Paulo have the reputation of being the energetic yankees of Brazil. Rio de Janeiro is known for the cosmopolitan charm of its people, spoken of as *cariocas;* for the gaiety of its pre-Lenten carnival; and, of course, for the beauty of the city and its setting at the foot of green mountains on Guanabara bay. The northeastern semidesert is characterized by another type of cowboy, the *vaqueiro,* who dresses entirely in leather for protection against the thorny bushes of the region. The Amazon valley has the lonely *seringueiro,* the gatherer of wild rubber from the tropical forest. The coffee plantations of São Paulo and Paraná states, the cocoa plantations in southern Bahia state and the sugar plantations of the northeast coast also provided distinctive settings for regional variations in the Brazilian way of life.

3. Arts.—This varied racial and cultural past of Brazil and the striking regional differences are reflected in Brazilian art, literature and music. Without doubt the outstanding artist of the colonial period was the crippled mulatto architect and sculptor, Antônio Francisco Lisboa (1730–1814), who was known simply as Aleijadinho ("the little crippled one"). His famous carvings in soapstone may be seen in the 18th-century churches of Minas Gerais state. Brazil's most famous modern artist, Cândido Portinari (1903–62), was the son of Italian immigrants and he made regional scenes the subject of many of his paintings. The internationally famous composer, Heitor Villa-Lobos (1887–1959), incorporated folk music from the Negroes and Indians into his compositions, as in his *Bachianas Brasileiras* and *Chôros*. Likewise, contemporary Brazilian architecture, stressing open terraces and large windows shuttered against the sun, has become famous throughout the world as a new school of architecture adapted to the tropical and semitropical climate.

In the field of literature, the mixed racial and cultural heritage of Brazil is also felt strongly. Joaquim Maria Machado de Assís (1839–1908), perhaps Brazil's greatest novelist, was himself of mixed ancestry. In a series of brilliant novels, including *Memórias pósthumas de Braz Cubas*, published in 1881 (translated with the title *The Epitaph of a Small Winner*), he describes the Brazilian scene at the end of the century with an acute irony and depth of psychological observation. Another novelist, José Pereira da Graça Aranha (1868–1931), in his *Canaan* told of the German colonists in Espírito Santo state and of the conflicts of the Brazilian melting pot. Perhaps the most influential book on Brazilian literature was *Os sertões* (translated as *Rebellion in the Backlands*) by Euclides da Cunha (1866–1909), originally published in 1902. It is both a historical account of the uprising of a group of religious fanatics against the newly formed republic and a brilliant study of the arid hinterland of the northeast. These three authors, writing at the turn of the century, mark the beginning of a vigorous literary movement concerned with the reality of the Brazilian scene.

A series of outstanding writers have appeared in the 20th century to continue this movement, which focuses upon regional subjects. José Bento Monteiro Lobato (1883–1948) wrote children's books, literary essays, political tracts and short stories. One of his principal characters was Jeca Tatú, the country hick of his native state of São Paulo. Through this character he called attention to the real capacities and problems of such simple Brazilians. A modern Brazilian classic is *Casa grande e senzala* (translated into English as *The Masters and the Slaves*) by Gilberto Freyre (1900–); it is a masterly social history of the Brazilian slave system of the northeast and the fusion of Indian, Negro and Portuguese social patterns into the national culture. It is in the modern novel that this literary movement, however, has been most active. Jorge Amado (1912–) writes in *Terras do sem fim* (translated as *The Violent Land*) of the frontier days of the early 20th century in the cocoa growing region of Bahia; and, in *Jubiabá*, of a heroic Negro character from the slums of Bahia. José Lins do Rêgo (1901–57), in five novels called collectively *The Sugar Cane Cycle*, describes the whole range of life revolving about the sugar-cane industry in the northeast. Other novelists, such as Rachel de Queiroz (1910–), José Américo de Almeida (1887–), Erico Veríssimo (1905–), Graciliano Ramos (1892–1953) and J. Guimarães Rosa have written novels focusing upon regional Brazilian subjects.

4. Modern Achievements.—Out of its varied past and mixed population Brazil has built a dynamic and distinctive civilization. In the 20th century, its older cities have become great metropolitan centres, and Brazil has built cities where none existed before, such as Belo Horizonte with more than 600,000 people in 1960 and Goiânia in Goiás state which was completed in 1940 and had more than 130,000 inhabitants by 1960. The new capital city of Brasilia, the construction of which began in 1957, had a population of more than 400,000 by the late 1960s. Modern universities and scientific institutions have been developed, such as the Butantan Institute in São Paulo, where important work on snake serum has been done, and the Institute Oswaldo Cruz in Rio de Janeiro, famous for its scientific work in tropical disease. Efficient and technically proficient public-health services have successfully combated yellow fever, malaria, and other diseases. Among Brazilian scientists may be noted the geographers Homem de Mello, Belfort Mattos, and Carlos Delgado de Carvalho, and the botanist João Barbosa Rodrigues. Scientific explorations of great value have been performed by Gen. Mariano da Silva Rondon.

Modern communications and systems of transportation and communications such as the press, radio, television, commercial airlines, and highways have been expanded rapidly. Brazilians have become a more sports-loving people. Thousands crowd the beautiful beaches, and hundreds of thousands attend soccer matches for which a stadium seating 200,000 was constructed in Rio de Janeiro. (C. W. Wy.; T. L. Sh.)

IV. HISTORY

A. Early Period

1. Discovery and Settlement.—The discovery and early settlement of Brazil appear in the larger perspective of history as episodes in the great movement of Portuguese colonial expansion to the east. Vasco da Gama's discovery of an all-water route to the Indies and Spice Islands by the Cape of Good Hope in 1498 led the Portuguese crown to dispatch to India an imposing armada under Pedro Álvares Cabral, whose sailing directions had been drawn up by the great Vasco himself. To avoid the calms off the Gulf of Guinea, Cabral bore so far to the west that on April 22, 1500, the mainland of South America was sighted and the region was promptly claimed by Portugal, as it lay well within the zone assigned to Portugal by the treaty of Tordesillas (1494). The coast of Brazil had been touched early in the year 1500 by the Spanish navigator Vicente Yáñez Pinzón but the Spanish crown made no effort to follow up the discovery. Portugal's new possession was at first called Vera Cruz or the True Cross, a name soon abandoned in favour of Brazil after the valuable red dyewood (*pau-brasil*) in which the country abounded. The tidings of Cabral's discovery aroused great enthusiasm and further explorations were undertaken. According to the generally accepted account the first of these expeditions, which set sail from Lisbon on May 13, 1501, had as its pilot Amerigo Vespucci (*q.v.*), who had already been once and possibly twice to the new world. As the little fleet sailed along the coast of Brazil—whose immense extent was for the first time realized—Vespucci, calendar in hand, baptized the different points on the coast with the names of the saints on whose days they were discovered. A majority of these names (*e.g.*, Cape Santo Agostinho, São Francisco river) have remained. It is probable that the spacious bay of Guanabara was entered Jan. 1, 1502, and named Rio de Janeiro ("River of January").

For over a quarter of a century following Vespucci's voyage, interest in Brazil all but ceased. No precious metals were discovered, and the energies of the Portuguese were increasingly absorbed by the establishment of a great empire in the east. Portugal's enemies and rivals, especially the French, were quick to take advantage of this neglect. Swift corsairs from Honfleur and Dieppe loaded their ships with the valuable brazilwood and even attacked Portuguese vessels returning from the Indies. Brazil became a sort of no man's land over which the Portuguese crown wielded only a shadowy control. This apathy ended, however, with the accession of John III (1521–57) and the centre of gravity in colonial affairs gradually shifted from Asia to America.

The first systematic effort to establish an organized government in Brazil was made in 1533. Brazil was divided into 15 hereditary captaincies or fiefs, extending 50 leagues along the coast and an indefinite distance inland. These grants were distributed to favoured persons, chiefly courtiers, who took the names of *donatários*. Their rights and privileges were extensive. They were authorized to found cities, issue land grants, levy internal taxes and appoint municipal officers. To the crown was reserved the right to impose export taxes and the monopoly of brazilwood and spices. The captaincy system failed to realize the hopes of the crown. Only ten of the fiefs were occupied by their owners and of these only two were really successful. The most flourishing of the settlements was that of São Vicente, south of the present city of Santos. This had been granted to Martim Afonso de Sousa, who in 1530 had explored the coast as far south as the La Plata estuary and had penetrated for some distance into the interior. By the middle of the 16th century the captaincy had a population of about 5,000, including the growing port of Santos and the town of São Paulo, over the edge of the Serra do Mar, on the fertile plateau of Piratininga. In northern Brazil, Duarte Coelho Pereira had converted the captaincy of Pernambuco into a great sugar-producing region. But the remaining captaincies were for the most part tragic failures. The *donatários* were generally incompetent and tyrannical, and the struggling settlements were powerless against attacks of hostile Indians or the depredations of French corsairs.

2. Royal Control.—At length, fully alive to these perils, King John determined to substitute for the inefficient rule of the *donatários* a unified, centralized administration. Brazil was brought directly under royal control through the appointment of a governor general. The first to hold this office was Tomé de Sousa, a Portuguese noble who had gained wide experience in India. In 1549 he took up his new duties at Bahia (Salvador) which remained the capital of Brazil for the next 214 years. The governor general was granted wide powers in civil and criminal affairs. The *donatários* were obliged to surrender their political and judicial rights, though they were allowed to keep possession of their fiefs until they were acquired by the crown. Local officials, responsible to the governor general, were placed over the captaincies, and strategic points along the coast were fortified. In the cities municipal organizations, similar to those in Portugal, were established. Brazil then began to attract settlers in increasing numbers. By 1600 Bahia and Pernambuco (Recife) each had a population of 2,000 whites, with more than twice as many Negro slaves and converted Indians.

A factor of great importance in the progress of the colony was the labour of the Jesuits. At the instance of John III several fathers accompanied Tomé de Sousa to Bahia. Among them was Manuel da Nóbrega, the first of a long line of missionaries who devoted their lives to the protection and conversion of the Indians and to the raising of the moral level of the colonists. At the site of the present city of São Paulo, Nóbrega established a school for the training of missionaries. There he was joined by José de Anchieta, whose heroic labours among the Indians won for him the title of the "Apostle of Brazil." As rapidly as the Indians were converted, they were settled in villages or *aldeias*, similar to the missions in Spanish America. The activities of the Jesuits soon aroused the antagonism of the colonists, particularly the Paulistas, the name given to the hardy and tough-fibred settlers of São Paulo. The colonists demanded an abundant labour supply, and as white labourers were lacking they proceeded to enslave the Indians and to force them to work on their plantations. Both the Jesuits and colonists appealed to the crown; the former won a partial victory by the decree of 1574, which granted to the Jesuits full control over the Indians in the *aldeias* while permitting the colonists to enslave Indians captured in legitimate warfare. In the north, the storm centre of a somewhat similar conflict was Father António Vieira, who in the 17th century established a chain of missions in the Amazon valley. The restrictions on Indian labour stimulated the introduction of Negro slaves, a movement which steadily gathered momentum after the middle of the 16th century.

3. Dutch and French Incursion.—Brazil had hardly been brought under royal authority before a determined effort was made by the French to establish a permanent colony. The prime mover in this enterprise was a French adventurer and soldier of fortune named Nicolas de Villegagnon, who contrived to enlist the support of Adm. Gaspard de Coligny and even John Calvin by the assurance that the future colony would be an asylum for Huguenots and other Protestants. King Henry II lent his sanction and in 1555 the French took possession of the beautiful harbour of Rio de Janeiro, which the Portuguese had strangely neglected to occupy. But Villegagnon failed to rise to his opportunities. He showed little skill as a colonist. His promise of religious toleration was broken. Attempts at forceful conversion to Roman Catholicism alienated the support of the Protestants. Rumours of these dissensions reached Europe and checked what might have become a great migration from France and Switzerland. Meanwhile the Portuguese had come to realize the extent of the French menace. A large force under Mem de Sá, the governor general, blockaded the entrance to the harbour and forced the French garrison to surrender. To ward off future attacks Mem de Sá in 1567 founded the city of Rio de Janeiro. Although subsequent attempts were made by the French to gain a foothold in Brazil—notably by Jean François Duclerc and Adm. René Duguay-Trouin in 1710 and 1711—the hope of establishing "France-Antarctique" as a pendant to the French colonies in North America was never realized.

From 1580 to 1640 Portugal was united to Spain, and as a part of the Spanish colonial empire Brazil was naturally exposed to attacks by Spain's enemies. Among these were the Dutch, who had just succeeded in establishing their independence. Bahia was seized and held briefly in 1624–25, and in 1630 a fleet sent out by the Dutch West India company captured Pernambuco, the metropolis of the rich sugar-growing district in the north. As governor of its new possession the company chose Count John Maurice of Nassau-Siegen, a prince of the house of Orange, and perhaps the ablest man in the Netherlands. His statesmanlike program included the creation of a great colonial empire, reconciliation between Dutch and Portuguese, the grant of religious toleration and the limited participation of the colonists in the government. Imposing public works were erected in the capital, renamed Mauritsstad. Distinguished artists and scientists were invited to make known to Europe the resources and beauties of Brazil. But the directors of the company, intent on a policy of greed and gain, refused to support their enlightened governor and he resigned in 1644. A rebellion launched by a wealthy plantation owner, João Fernandes Vieira, proved beyond the power of Maurice's incompetent successors to crush. The Dutch, who were expelled in 1654, renounced all claim to Brazil in 1661.

4. Expansion and Unity of Brazil.—Perhaps the most striking development of the colonial period was the vast expansion of Brazil beyond the line of Tordesillas (a vertical line drawn 370 leagues west of Cape Verde Islands) westward to the slopes of the Andes and north and south to the Amazon and the Río de la Plata. In the north the movement was led by missionaries, seeking to convert the Indians to Christianity, who established missions along the Amazon in the 17th century. In the northeast cattlemen from the sugar zones of Pernambuco and Bahia pushed inland into the present area of Piauí, Maranhão and Goiás in search of new pastures. However, the brunt of the "march to the west" was borne by the Paulistas. With the purpose of capturing Indian slaves and of finding gold and precious stones, they organized great expeditions into the interior, known as *bandeiras*. At times these expeditions, involving entire families, were veritable treks or migrations which lasted for a period of years. Some of the more spectacular *bandeiras* took the Paulistas as far as the silver-mining region of Peru and even to the area of Bogotá in Colombia. In the 17th century they explored the area of Mato Grosso and attacked the Indian *reducciones* (Indian missions) of Misiones and southern Brazil. For the most part they met with resistance from the Indians and their Jesuit protectors; only about the Río de la Plata, in modern Uruguay, did the Spanish settlers resist the invaders, and there eventually the Paulistas were pushed back.

The war against the Dutch, which involved not only the people of northeastern Brazil but also drew upon the manpower and resources of São Paulo, was said to mark the emergence of a Brazilian consciousness. Probably for the first time the people of Brazil collaborated in a major effort as Brazilians rather than as colonists of Portugal, for the imperial government had been willing to recognize Dutch control of Pernambuco. The movement to expel the Dutch was launched in Brazil despite initial objections by the crown. During the colonial period most of the other factors which tended to unite the people of Brazil became evident. Among the most important of these was the heritage of Portugal. The Portuguese language formed a common bond between plantation residents, cattlemen, miners, slaves (both Indian and Negro), slave hunters and city dwellers from the Amazon to the Río de la Plata and distinguished them from their Spanish-speaking counterparts elsewhere in South America. Although Tupi-Guarani served as a sort of lingua franca throughout much of the interior of the colony, Portuguese remained the official and the common language of Brazil. The expanded, patriarchal family structure, also derived from Portugal, was nearly uniform throughout Brazil, and power was exercised in all regions by the heads of those families which controlled the land, slaves, cattle and later mines that produced the wealth of the colony. Despite regional differences, Brazilian society and economy were rurally based. This pattern persisted for a century after the colonial period. The population was divided unevenly between those who possessed landed wealth and prestige and those who were dependent upon them. No great cities such as those of Spanish America grew up in Brazil during the colonial period. Moreover, contact with Portugal, although at times intermittent, was maintained with all parts of Brazil, and little trade or other regular contact existed between Brazil and neighbouring Spanish colonies. These common factors proved far stronger than regional variants when Brazilian unity was under severe stress in the second quarter of the 19th century.

The colonial economy of Brazil was marked by two major cycles, that of sugar and that of gold. As mentioned above, the sugar industry, confined primarily to the northeast, was introduced into Brazil early in the 16th century, and it was the principal basis for the wealth of the colony for over 200 years. Throughout the entire period of Portuguese control in Brazil, sugar produced substantially more revenue for the crown than any other export product, including gold. A plantation product, sugar called for a large capital investment in land, slaves and machinery, and consequently was concentrated in the hands of a relatively small number of wealthy families. Tobacco and cattle raising, conducted chiefly by independent freemen around the periphery of the sugar plantations, contributed to the wealth of the sugar zones and became important industries before the end of the colonial period. In the 18th century cotton and coffee, originally produced by small landholders, were also becoming significant export products of the coastal area.

Gold, which was sought by colonists in Brazil from the period of first settlement, was not found until 1693 in what is now the state of Minas Gerais. The deposits were the wealthiest that had been discovered to that date, and their discovery set off a gold rush which anticipated in many ways the days of 1849 in California and those of 1851 in Australia. Gold seekers followed the São Francisco river upstream from Pernambuco (Recife) and Bahia (Salvador) and surged northward from São Paulo. In the hitherto unbroken wilderness, towns sprang up as if by magic, while large sections of the littoral or coastal region were virtually denuded of their inhabitants. African slaves from the sugar plantations and directly from the gold-working regions of Africa introduced many of the techniques employed by Brazilian miners. The yield of the mines during the 18th century has been variously estimated between £50,000,000 and £200,000,000. The impact of the gold mines upon the Brazilian economy was largely responsible for the transfer of the capital of the colony from Salvador to Rio de Janeiro in 1763. The search for gold led to the discovery of diamonds in the early 18th century in Minas Gerais, Bahia and Mato Grosso. Diamonds became a royal monopoly, and although many famous stones were found no figures for the total diamond output are available. While most of the gold mines were exhausted within a century, diamond production is still significant in Brazil.

5. Colonial Reforms.—The treaties of Madrid (1750), Pardo (1761) and Ildefonso (1777) with Spain gave some legality to Portuguese claims including the conquests of the *bandeiras*. During this period Sebastião José de Carvalho e Mello, marquês de Pombal, the famous prime minister of King Joseph, introduced into Brazil a number of reforms which profoundly affected the social, administrative and religious life of the colony. The last rights of the *donatários* were absorbed by the crown, the capital was transferred from Bahia to Rio de Janeiro, the Indians were placed on a legal equality with the whites, immigration from the Azores and Madeira was encouraged, two privileged companies were created and a monopoly of the diamond fields was established. The act for which Pombal is best known was the expulsion of the Jesuits from Brazil in 1759. Through their protection of the Indians and their various commercial ventures they had stirred up widespread resentment, and when they attempted to thwart some of Pombal's reforms the all-powerful minister banished them from both Portugal and Brazil with brutal thoroughness. The value of many of Pombal's reforms is more than questionable but it can hardly be denied that they tended on the whole toward the development of the capabilities and resources of Brazil.

B. The Independence of Brazil

In 1789 the first rebellion against Portuguese authority was instigated by Joaquim José da Silva Xavier, known as Tiradentes (tooth puller) because of his occasional practice of extracting teeth. The uprising was put down and Tiradentes, later to become a national hero, was executed.

Despite its isolation Brazil could not escape the effects of the revolutionary and Napoleonic epoch in Europe. Brazil is the only instance of a colony becoming the seat of government of its own mother country. In 1807 Napoleon resolved upon the invasion and conquest of Portugal, a traditional British ally, largely in order to tighten the European blockade of Great Britain. The Portuguese prince regent Dom John, afterward King John VI, realized the futility of resistance and decided to take refuge in Brazil. After creating a regency, he sailed from the Tagus on Nov. 29, 1807, under the protection of the British fleet. He was accompanied by the royal family and a horde of nobles and functionaries. After a short sojourn at Bahia the court arrived safely at Rio de Janeiro on March 7, 1808. The colonists, convinced that a new era had dawned for Brazil, welcomed their sovereign with tremendous enthusiasm. Their expectations were in a measure realized, for the prince regent promptly decreed a number of reforms which radically altered the status of the colony. Some of these amounted to practical recognition of Brazil's position as seat of the Portuguese empire and its new requirements in view of the war in Europe. Both are evident in the abolishment of the old Portuguese commercial monopoly and the opening of Brazilian harbours to the commerce of all friendly nations. British trade with Brazil immediately took on important proportions and a number of British trading companies established offices in the colony.

To accommodate the imperial administration, and in response to local demands, a ministry with four portfolios and a council of state were installed in Rio de Janeiro, and a supreme court of justice, a court of exchequer and royal treasury, the royal mint, the Bank of Brazil and the royal printing office were established. A royal library, a military academy and medical and law schools were founded. Industries were encouraged for the first time, foreign scholars and artists were welcomed and immigrants from northern Europe were brought in at government expense. The changed status of Brazil was reflected in the decree of Dec. 16, 1815, by which the Portuguese dominions were designated the United Kingdom of Portugal, Brazil, and the Algarves, thus making Brazil coequal with Portugal. In the following year, the insane queen, Maria I, died, and the prince regent became king.

Although Dom John enjoyed a certain degree of personal popularity his government, corrupt and extravagant, aroused much opposition, which was still further increased by the fermentation of liberal ideas produced by the French revolution. In Pernambuco a revolt broke out in 1817, and was put down with difficulty after a republic had been formed which lasted for 90 days. Still more critical was the situation in Lisbon, Port. After the departure of the French, Portugal had been governed by an arbitrary and tyrannical regency. The growing discontent found vent in the revolution of 1820. The regency was swept aside and the Cortes, which had not met for over a century, was summoned for the purpose of drawing up a constitution. The presence of Dom John in Portugal was imperative if the revolutionary movement was to be kept in hand. On April 22, 1821, he appointed his son Dom Pedro regent and two days later set sail for Lisbon. The tasks confronting the young prince were truly formidable. Antagonisms between the Portuguese and Brazilians were becoming increasingly bitter, republican propaganda was active, and, worst of all, Dom Pedro had to face the responsibility of a separation of Brazil from Portugal as a result of the shortsighted policy of the Cortes at Lisbon. The majority of this assembly were in favour of restoring Brazil to its former status of colonial dependence. Without waiting for the Brazilian deputies they proceeded to undo most of the reforms introduced into Brazil by Dom John. Fearful that Dom Pedro might head a movement for independence, they ordered the prince to return to Europe "in order to complete his political education."

These acts aroused great indignation in Brazil. Supported by the majority of the Brazilians, Dom Pedro openly defied the Cortes by his refusal to return to Lisbon. In Jan. 1822 he formed a ministry in which the chief portfolio was held by the distinguished Paulista, José Bonifácio de Andrada e Silva (*q.v.*). Known as the "Patriarch of Independence," he was a scholar of European reputation and proved at this critical juncture a tower of strength to the young regent. Events followed rapidly. On June 3 Dom Pedro convoked a legislative and constituent assembly. On Sept. 7, on the plain of Ipiranga, near the city of São Paulo, he solemnly proclaimed the independence of Brazil, and on Dec. 1, 1822, was crowned emperor. With the co-operation of Lord Dundonald (Thomas Cochrane), an able British naval officer who had entered Brazilian service, the strong Portuguese garrisons were forced to return to Europe. Before the end of 1823 independence had become an accomplished fact. The United States was first to recognize the new government, on May 26, 1824. Portuguese recognition was secured in 1825. The early resumption of formal relations between Portugal and its former colony was due in large part to the influence and good offices of the British government.

C. The Brazilian Empire (1822–1889)

The first years of Brazilian independence were difficult. The nation was without experience in self-government and the emperor, though able and patriotic, was inclined to be despotic and arbitrary. When the constituent assembly, on which the nation had pinned such high hopes, proved unmanageable Dom Pedro dissolved it in 1823 and sent the radical José Bonifácio de Andrada e Silva and his two brothers Antonio and Martim into exile. Fortunately he realized that the days of absolutism were passed; a new and liberal constitution, drawn up by the council of state, was submitted to the municipal councils of the provinces and sworn to with great solemnity by the emperor on March 25, 1824. By this stroke of policy he saved himself and Brazil. The remaining years of Dom Pedro's reign witnessed a growing estrangement between the monarch and his subjects. Parliamentary government was little to the emperor's liking, and the opposition generally commanded a majority in the chamber of deputies. Brazil became involved in a disastrous war with Argentina resulting in the loss of the Provincia Cisplatina (the present republic of Uruguay). Finally, worn out and disheartened by attacks from both within and without parliament, Dom Pedro formally abdicated on April 7, 1831, in favour of the heir apparent, Dom Pedro II, then only five years of age.

1. The Regency (1831–1840).—The next decade proved the most agitated period in Brazilian history. From 1831 to 1835 a triple regency laboured in vain to put down the civil war in the provinces and check the lawlessness and insubordination in the army. In 1834 an important amendment (the so-called *Acto Addicional*) was made to the constitution. A measure of decentralization was granted the provinces through the creation of provincial assemblies with considerable local power. Provision was made for a sole regent to be elected for four years. For this office in 1835 an able and energetic priest by the name of Diogo Antônio Feijó was chosen. For two years the regent struggled heroically against the force of disintegration, but he was forced to resign in 1837 and was succeeded by Pedro de Araújo Lima. As the end of the decade approached, sentiment began to crystallize in favour of a declaration of majority of the young Dom Pedro. The Brazilians as a whole, impatient with the regency, hoped to find in the person of the emperor a symbol to which the entire nation might rally. On July 23, 1840, both houses of parliament passed a declaration that Pedro de Alcantara had attained his majority.

2. Dom Pedro II.—The reign of Dom Pedro II, with its duration of practically a half century, constitutes perhaps the most interesting and fruitful epoch in Brazilian history. To an extent true of few monarchies in the 19th century the prestige and progress of the nation were due to the enlightened statesmanship of its ruler. Yet Dom Pedro cared little for the trappings of royalty. Though not without personal distinction he was always simple, modest and democratic. He possessed an insatiable intellectual curiosity and was never more happy than when conversing with scholars. He was generous and magnanimous to a fault. One of his favourite occupations was inspecting schools. He was wont to declare, "If I were not emperor I should like to be a school teacher." Yet this kindly, genial and scholarly ruler took his prerogatives and duties as sovereign with great seriousness and in all matters of first importance he was the final arbiter. According to the "moderative power" granted to the executive under the constitution of 1824 the emperor had the right to dissolve the chamber of deputies, to select the members of the life senate from triple lists submitted by the province and to appoint and dismiss ministers of state. That parliamentary life in Brazil was pitched upon such a high plane, that the highest officials in the state generally left office poorer than when they entered it, that the machinery of government functioned smoothly year after year was due in large measure to the tireless vigilance of the emperor.

Dom Pedro's government maintained an active interest in the affairs of the Plata republics, especially of Uruguay, which it sought to control through indirect measures. Opposed in this by the Argentine dictator Juan Manuel de Rosas (*q.v.*), Brazil aided in his overthrow in 1852. In 1864 Brazil intervened in Uruguayan internal affairs and, in so doing, brought about war with Paraguay. In alliance with Argentina and Uruguay, Brazil successfully waged the costly and bloody Paraguayan war of 1864–70 (*see* Paraguay), eventually overthrowing the famed Paraguayan dictator Francisco Solano López. With occasional lapses the empire's relations with the United States and with Europe were exceedingly cordial. Pedro personally did much to cement these international friendships, visiting Europe in 1871, 1876 and 1888 and the United States in 1876.

The outstanding social and economic problems with which the empire had to grapple were intimately associated with slave-based plantation agriculture. Real political power rested, as in the colonial period, with large rural landholders who formed the core of the social and economic elite of Brazil. Industrialization, introduced in the 19th century, was still economically insignificant and, with the decline of gold mining early in the century, agriculture again was unrivaled as the source of Brazil's wealth. Cotton, and increasingly coffee, cultivated by slave labour, competed with sugar as the leading export crop. While a few large cities with European-influenced populations developed along the seaboard, the rural landholders were largely insulated from the antislavery current of the times. Although manumission was common and the number of freedmen and their descendants far surpassed the number of slaves in Brazil, the slaveowners as a group resisted pressures for the complete abolition of human servitude upon which their economy was based. Partly as a result of pressure from Great Britain, Brazil had agreed to abolish the slave trade in 1831, but it was not until 1853 that slave traffic completely ceased. In the 1860s agitation began in favour of the abolition of slavery as such. Dom Pedro was opposed to slavery but he had to reckon with the determined resistance of the slaveowners. Finally in 1871 a bill for gradual emancipation, sponsored by the viscount of Rio Branco, was passed by parliament. The importance of this act lay in the provision that henceforth all children born of slave mothers should be free. But this concession did not satisfy many of the abolitionists, who, led by a brilliant young lawyer and writer, Joaquim Nabuco, demanded that abolition be immediate and complete. In 1883 Nabuco wrote a remarkable book, *O Abolicionismo,* in which he endeavoured to prove that slavery was poisoning the very life of the nation. The propaganda began to bear fruit. In 1884 Ceará and Amazonas freed their slaves; in 1885 all slaves over 60 years of age were liberated. Finally, complete emancipation without compensation to the owners was decreed by the princess regent in the absence of the emperor on May 13, 1888. About 700,000 slaves were freed.

3. The Collapse of the Empire.—At first sight the overthrow of Dom Pedro II seems inexplicable. Under his wise guidance Brazil had made very real progress. His half century of rule had witnessed a growth in population from 4,000,000 to 14,000,000, a fourteenfold increase in public revenues and a tenfold increase in the value of the products of the empire. Railroad mileage in 1889 exceeded 5,000; the same year more than 100,000 immigrants came to Brazil. But despite this impressive economic progress there were grave causes of dissatisfaction. Propaganda in favour of a republic, launched in 1871, had gained many recruits. The great landowners, who had lost their slaves without compensation, withdrew their support from the monarchy. The clergy, another prop of the throne, had been antagonized by the punishment of several recalcitrant bishops. Isabel, the heiress to the throne, and her husband, the comte d'Eu, were unpopular. Most serious of all, important elements in the army, which had become a political force after 1870, turned against the emperor, largely because Dom Pedro insisted that they stay out of politics. A conspiracy was hatched by these disgruntled military elements and on Nov. 15, 1889, a revolt of part of the army was the signal for the collapse of the empire. Dom Pedro formally abdicated and with his family was banished to Europe.

D. The Early Republican Period

During the next few years Brazil passed through a difficult period of adjustment. The leader of the revolt against Dom Pedro II was a prominent military figure Gen. Manuel Deodoro da Fonseca (*q.v.*). For the next 14 months Brazil was ruled by a military autocracy in which Deodoro, now chief of the provisional government, was virtually supreme. Decisions of great importance were reached. Church and state were separated, civil marriage was introduced and a constituent assembly was summoned which adopted in 1891 a constitution modeled closely on that of the United States.

1. The Presidencies.—As president, Deodoro employed the same dictatorial methods that he had followed as head of the provisional regime. He kept in power an unpopular ministry and was constantly at loggerheads with congress. On Nov. 3, 1891, he forcibly dissolved this body and proclaimed himself dictator. But opposition was so widespread that on Nov. 23, 1891, he resigned in favour of the vice-president, Gen. Floriano Peixoto. But Floriano, also one of the conspirators against Dom Pedro, differed little in his methods from his predecessor. Of the meaning of constitutionalism in the strict sense he had scant understanding. The growing opposition to Floriano finally culminated in 1893 in a naval revolt and military uprising that were put down the following year only with the greatest difficulty.

The advent of a civilian as president was hailed with undisguised relief. Prudente de Moraes Barros, who assumed office in 1894, was a distinguished lawyer of São Paulo and a republican of long standing. Though his intentions were excellent and his ability and honesty unquestioned, his administration was rendered largely sterile through the opposition of the disgruntled military elements and the necessity of putting down a rebellion of the ignorant and fanatical population in the hinterland of Bahia. His successor, Manuel Ferraz de Campos Salles (1898–1902), former president of the state of São Paulo, is chiefly remembered for his striking success in saving Brazil from the financial collapse threatened by the orgy of extravagance, inflated currency and peculation which had followed the overthrow of the monarchy. While still president-elect, Campos Salles in 1898 negotiated through the Rothschilds a funding loan of £10,000,000, interest on which was to be suspended for three years and amortization payments for ten. Because of the able and economical administration of Campos Salles and the marvelous recuperative power of the country, the credit and finances of Brazil were again placed on a sound foundation. Francisco de Paula Rodrigues Alves (1902–06), likewise a Paulista, is generally regarded as Brazil's ablest civilian president. During his term of office the capital was transformed into one of the world's most beautiful cities. Under the direction of the distinguished physician and scientist, Oswaldo Cruz, Rio de Janeiro was completely freed from yellow fever. Some of Brazil's most thorny boundary controversies were settled during the presidencies of Campos Salles and Rodrigues Alves by the able minister of foreign affairs, the baron of Rio Branco, son of the viscount of the same name.

Pres. Affonso Augusto Moreira Penna (1906–09) took an important step toward the stabilization of the exchange through the creation of the so-called Caixa de Conversão, or Bank of Conversion, whose function was to redeem inconvertible paper currency through the issue of convertible notes secured through the deposit of gold. Unfortunately this project had to be abandoned on the outbreak of World War I. Penna died in 1909 and was succeeded by the vice-president, Nilo Peçanha. The campaign of 1910 was fought with great bitterness. The official candidate, Gen. Hermes da Fonseca, the nephew of Deodoro da Fonseca, was opposed by a civilian, Ruy Barbosa, a noted lawyer and publicist. Though the conviction was general that Barbosa had received a majority of the votes cast, the official machine easily secured the election of Hermes da Fonseca. The administration of the new president (1910–14) represented a step backward. The high standards set by the first three civilian executives were largely abandoned.

2. World War I and After.—A change for the better came with the election of Wenceslau Braz (1914–18), a former governor of Minas Gerais. His administration was closely associated with Brazil's reaction to and participation in World War I. From the outset the sympathies of most Brazilians inclined toward the Allies. On April 11, 1917, Brazil broke off relations with Germany following the torpedoing of the steamer "Paraná" off France. On June 1 Brazil revoked its decree of neutrality in the war between Germany and the United States as a mark of continental solidarity and friendship with the United States. Following the sinking of more Brazilian ships, war was declared on Oct. 26. Brazil's participation in the war was confined to the dispatch of a part of its fleet to European waters and the sending of a medical mission and a number of aviators to the western front. Its chief contribution was the placing of its food supplies and other resources unreservedly at the disposal of the Allies. Brazil participated in the peace conference and was given a temporary seat on the council of the League of Nations.

In the election of 1918 a new precedent was established in Brazilian political life by the re-election of Rodrigues Alves. The new executive was too ill to accept office, however, and died on Jan. 16, 1919. In the new election, in April, the successful candidate was Epitácio da Silva Pessôa, a lawyer of note and head of the Brazilian delegation at the Versailles conference. His presidency, coinciding with the wave of postwar prosperity, was an era of reckless expenditures accompanied by an immense increase in both the internal and foreign debt. Large sums were absorbed by the Brazilian Centenary exposition, which was celebrated with great brilliance in 1922. The presidency of Arthur da Silva Bernardes (1922–26) was beset with difficulties. The collapse of the boom found Brazil in financial extremities. The new executive endeavoured to carry out a policy of strict economy. Governmental expenses were cut down, the prosecution of costly public works was postponed and new sources of revenue, such as the income tax, were created. The success of this program of retrenchment and reform was compromised by a dangerous flare-up of militarism. In the closing weeks of Pessôa's administration a military group made a desperate but fruitless attempt to prevent Bernardes' inauguration. Another revolt was launched in July 1924 at São Paulo city. This, too, was suppressed, but only after heavy loss of life and much property damage. In 1926 Washington Luís Pereira de Sousa, minister of justice in the two preceding administrations, was elected president without a contest.

In retrospect it is apparent that the shift from empire to republic produced little immediate change in Brazil's basic political or social institutions. Under the constitution of 1891 state and municipal governments were granted somewhat greater freedom from central control than had been the case under the empire, with a consequent increase in the power of local bosses. However, no significant new elements were added to the political spectrum and the bulk of the population remained outside the political process. Rural landholders, particularly in the states of São Paulo and Minas Gerais, adjusted to the loss of slave labour and retained their pre-eminence under the republic. In São Paulo state massive immigration from the Mediterranean area in the years before World War I provided a new source of rural labour for the expanding coffee industry. Coffee became the outstanding export crop and source of government revenue early in the 20th century. Diversification of agriculture, and expansion and diversification of the mining industry provided economic stimulus in Minas Gerais. The problems of rapid urban growth and industrialization, as well as the cultural assimilation of the immigrants, did not become acute until about 1930. The old areas of Bahia and Pernambuco gradually declined in political significance and were eventually replaced by the increasingly important state of Rio Grande do Sul. However, the latter did not successfully challenge the political hegemony of the central states until 1930. Thus, economic and political power was effectively concentrated in São Paulo and Minas Gerais during the first four decades of the republic, and national policies usually reflected the interests of those states.

The principal new factor introduced with the republic was the politically active role of the military. After 1889 the armed forces asserted their claim as guarantors of the constitutional process, and served usually as a check upon the civilian administrations. The military also provided the leadership of occasional protest movements. As indicated above, the first stirrings of social unrest and vaguely expressed demands for a modification of the institutional patterns of the republic were voiced by young military officers, the *tenentes,* in the mid-1920s. The movement which they headed culminated in the revolution of 1930 which marked the end of the so-called "old republic."

3. The Vargas Era.—Following the election of 1930, when the administration-sponsored presidential candidate was officially declared winner, a revolt broke out. This successful rebellion was led by Getúlio Vargas, a figure who was to remain central in Brazilian national life until his suicide in 1954.

Vargas held office as chief executive on two occasions—1930–45 and 1951–54. Early in the first of these periods, the country's difficulties were essentially economic, accentuated by a policy of subsidizing coffee production. The tremendous powers which the states possessed also served as steady irritants to the country as a whole. In 1934 a new constitution, which gave the central government greater powers, was promulgated. Three years later, as the country prepared for new presidential elections, President Vargas suddenly seized practically absolute power and set up still another constitution, under which he continued as president. The new administration was known as the *Estado Novo* ("new state"). This so concentrated power in Vargas' hands that he was able to suppress not only disorders but all manifestations of popular will as well. Brazil had never been truly a democracy, but Vargas stripped it of most of the trappings through which it might eventually hope to become one. Press and mail censorship was imposed, and many regarded Brazil as on the threshold of totalitarianism. On the other hand, considerable social legislation was enacted, with positive benefits to the labouring man.

Vargas' policy, from his accession to power, was one of increasing curtailment of states' rights, of emphasis on nationalism and, in effect, the transfer of the locus of power from the country to the city. More and more the states were subordinated to the central government, politically, economically and socially. The ruinous coffee policies of the past were done away with; manufacturing was encouraged, as was diversification of agriculture.

After the outbreak of World War II in 1939, Vargas' government supported inter-American solidarity; in Jan. 1942 it broke relations with the Axis powers, and on Aug. 22, 1942, declared war against Germany and Italy. Besides participating in the defense of the South Atlantic against Axis submarines, Brazil sent an expeditionary force to Italy in July 1944 under the command of Gen. Mascarenhas de Moraes. The Brazilian troops distinguished themselves in several battles, especially that of Monte Castello. Brazil also granted the United States the right to use certain Brazilian naval and air bases during the war. A number of agreements were signed between the two governments for the economic development and production of raw materials.

On Oct. 29, 1945, President Vargas was overthrown in a bloodless revolution. For some time there had been unrest and dissatisfaction with his regime, and when it appeared that the president intended to continue indefinitely in power, a group of high army officers forced him to resign, transferring the government to Chief Justice José Linhares on an interim basis.

ELLIOTT ERWITT FROM MAGNUM

ELABORATELY COSTUMED REVELERS DURING ANNUAL CARNIVAL IN RIO DE JANEIRO

E. Politico-Social Changes After 1945

1. Dutra and Vargas.—On Dec. 2, 1945, Gen. Eurico Gaspar Dutra, the former war minister and long a loyal friend of Vargas, was elected president by a large majority of the popular vote. He was inaugurated Jan. 31, 1946, for a five-year term. The following month a constituent assembly met at Rio de Janeiro and adopted a new constitution, which was promulgated on Sept. 18, 1946. It confirmed and strengthened the civil and personal liberties and the multiparty system of representative democracy that had been in effect since the overthrow of the *Estado Novo* (*see* above). As customary in Brazilian constitutions, it recognized the armed forces as permanent national institutions and the guarantors of constitutional powers. Dutra's administration was characterized by a sincere determination to govern the country in harmony with the measures of the new constitution. He outlawed the Communist party as an undemocratic, foreign-based organization in May 1947 but did not otherwise interfere with the free play of political expression or political party activities.

Construction of the Paulo Afonso dam on the São Francisco river, to provide electric power to much of the underdeveloped area of northeastern Brazil, and the opening of an all-weather highway linking that region with the industrial zones of Minas Gerais and São Paulo were major accomplishments of the Dutra administration. Attempts to stem inflation and the rising cost of living were only partially successful.

In the general elections of Oct. 3, 1950, former President Vargas emerged as the chief candidate to succeed Dutra. The result was a substantial victory for Vargas. While he failed to secure a clear majority in the four-way race, he polled one and a half million more votes than the runner-up and nearly as many as the combined total for the three rival candidates. Accordingly, despite serious reservations by the military leaders who had deposed him in 1945, he was installed in the presidency once more on Jan. 31, 1951. Vargas' second period in power contrasted sharply with his first, for he was unable to dominate the political forces of the country or to exploit social and economic trends to his advantage. He endeavoured to abide by the constitution of 1946 and was criticized in some quarters for weak leadership. Lacking a firm majority in the congress, he could neither enact his own program nor resist the contradictory pressures of his supporters and opponents. The most serious continuing problem was economic. Brazilians were agreed upon the need for more rapid industrial development and measures to ameliorate the effects of gradual monetary inflation which persisted as government expenditures consistently outran revenues. Vargas maintained a precarious balance between the advocates of greater state intervention in the economy and those who insisted upon a favourable climate for domestic and foreign private investment. The situation was complicated by the simultaneous emotional, antiforeign campaign to nationalize the natural resources of the country. The Communist-inspired slogan, "the oil is ours," became a national rallying cry endorsed by some elements in all political parties. The campaign culminated in the creation of the national petroleum corporation, Petrobrás, in 1953.

For three years Vargas' great personal popularity largely protected him from attack by political adversaries, who directed their criticism against members of his administration. The most controversial target was João Goulart, Vargas' young protegé and vice-president of the Brazilian Labour party (P.T.B.), who became minister of labour in 1953. Goulart was accused of using his office to transform organized labour into a political machine loyal to Vargas. His sponsorship of the decree doubling the minimum wage, thus strengthening labour-administration ties and contributing to the inflationary spiral, led to his dismissal at the insistence of the armed forces in Feb. 1954. A series of crises followed, climaxed on Aug. 5, 1954, by the murder of an air force officer and the attempted assassination of opposition newspaper editor Carlos Lacerda. Investigation by the air force revealed that the assassins had been hired by the president's personal guard. The exposure of widespread corruption within the administration, which Vargas himself described as a "sea of mud," caused a wave of revulsion against the former dictator. A group of army officers presented Vargas with a demand for his resignation. Vargas complied on Aug. 24, 1954, and later that day committed suicide.

2. Kubitschek Administration.—Vice-Pres. João Café Filho was elevated to the presidency to serve out the unexpired portion of Vargas' term. His cabinet included military leaders who had been instrumental in removing Vargas and civilian moderates who generally favoured political democracy, limited social change, and an orthodox approach to the nation's economic ills. Gen. Henrique Teixeira Lott, a highly respected professional soldier not identified with any political group, was made war minister. Much of the Café administration was occupied by preparations for the presidential election of Oct. 3, 1955. After the failure of attempts to find a single candidate around whom all major political parties might rally, three strong candidates for the presidency emerged: former Minas Gerais state governor Juscelino Kubitschek, popularly regarded as Vargas' political heir; former São Paulo state governor Adhemar de Barros, with broad backing from financial and commercial groups; and Gen. Juárez Távora, considered as the representative of conservative military and civilian groups. The election was a close contest. Kubitschek was the victor with slightly more than one-third of the total vote. Távora ran a close second and De Barros was a somewhat more distant third. In the separate election for the vice-presidency, João Goulart won with a large plurality. The election returns were widely interpreted as a popular vindication of the Vargas position. The illegal but active Communist party, which had thrown its unsolicited support to Kubitschek, claimed to have provided his margin of victory. Rumours immediately circulated that the Café administration was preparing to use unconstitutional means to prevent the inauguration of Kubitschek and Goulart. The existence of such a plot was not proved, but the doleful lamentations of the conservative press—which regarded Kubitschek as a dangerous radical—added to the state of tension, and a series of unfortunate coincidences combined to persuade key military commanders of the validity of the rumours. President Café suffered a mild heart attack and on Nov. 8, 1955, transferred power temporarily to his constitutional successor, Carlos Luz, speaker of the chamber of deputies. The following day, Luz indicated that he would dismiss General Lott to resolve a conflict of authority between the executive and the war minister. This was interpreted as the signal for a *coup d'état* by anti-Kubitschek forces. Thus, early on Nov. 11, 1955, war minister Lott and Gen. Odilio Denys, commander of army troops in Rio de Janeiro, staged the so-called "countercoup" to guarantee Kubitschek's inauguration. Luz was deposed, his constitutional successor, Sen. Nereu Ramos, was installed as interim president under a state of siege, and Lott remained as war minister and the strongest figure in the government. Kubitschek and Goulart took office as scheduled and without incident on Jan. 31, 1956.

During his term of office Kubitschek endeavoured to fulfill his campaign pledge of "fifty years' progress in five." He encouraged the widespread spirit of nationalism, appealing to the popular demand for economic development and to the belief, which in many quarters amounted to conviction, that Brazil was destined to become a great power among the nations of the world. Kubitschek represented those who felt that the national government should play a vital role in economic areas unattractive to private capital. Thus, his administration undertook ambitious developmental programs for the construction of interregional highways and vast hydroelectric power projects, the expansion of iron, steel, petroleum and coal production and assistance to the rapidly growing private industrial sector. The outstanding accomplishment of the Kubitschek administration was the construction of Brasília, a geographically remote and futuristic city on an inland plateau 580 mi. N.W. of Rio de Janeiro. Although not yet completed, Brasília was dedicated as the official capital of Brazil on April 21, 1960. When Brasília was inaugurated, the former federal district at Rio de Janeiro became the state of Guanabara. The purpose of Brasília was to focus the attention of Brazilians on the interior of the country and to hasten settlement of the region and the development of its largely untapped resources. The new capital was denounced by residents of Rio de Janeiro as a costly folly, but Brazilians elsewhere generally regarded it as a symbol of the nation's future greatness. In the area of inter-American relations, the Kubitschek administration proposed the adoption of Operation Pan America, a cooperative program for the economic development of Latin America which foreshadowed the Alliance for Progress.

The material progress registered in Brazil during the Kubitschek period was truly spectacular, but it was achieved at a high cost in terms of inflation and repeated foreign borrowing. The cost of living and the volume of currency in circulation tripled between 1956 and 1961, while Brazil's large foreign debt nearly doubled. The gross national product rose to unprecedented levels, but living standards for much of the population remained stationary or actually declined. At the same time, indications of large-scale graft and favouritism in public office reached heights to disturb even the normally tolerant Brazilian electorate.

3. Quadros and Goulart.—This situation was vociferously debated in the electoral campaign of 1960. Again there were three candidates for the presidency: Gen. Henrique Teixeira Lott, who had served as Kubitschek's war minister for more than four years; Jânio Quadros, the unorthodox former governor of São Paulo and at that time congressman from the state of Paraná; and Adhemar de Barros, then mayor of the city of São Paulo. It was soon clearly a race between Lott and Quadros. Lott received official backing and campaigned on the Kubitschek record. Quadros, who was not a regular member of any political party, was supported by the largest conservative party, the National Democratic Union (U.D.N.), and a heterogeneous grouping of lesser political factions. With a new broom as his symbol, he caught the public's imagination as the candidate of the common man. He promised a scrupulously honest administration, curbs on inflation, effective economic development, dignity for the individual and an aggressively "independent" foreign policy. Goulart was once more a candidate for the vice-presidency. At the polls on Oct. 3, 1960, Quadros won election with a plurality of 48% of the popular vote. He received more than 5,600,000 votes, the largest number ever cast for a presidential candidate in Brazil. Goulart, a political enemy of Quadros, won a narrow victory in the vice-presidential race, polling slightly more than 4,000,000 votes. Quadros and Goulart were inaugurated on Jan. 31, 1961.

The election of Quadros was hailed as a revolution by ballot. For the first time in three decades, anti-Vargas political groups controlled the presidency. Quadros took office in an atmosphere of popular expectation of profound changes in domestic and foreign policies, but almost immediately he encountered resistance from the congress, where parties loyal to the Vargas tradition still commanded a large majority. His arbitrary and autocratic manner, which soon alienated many of his former adherents, further reduced the possibility of enacting a meaningful reform program or effective measures to retard the inflationary spiral. In the field of foreign affairs Quadros was more successful in imposing his will. His foreign policy, which was applauded by ultranationalists and deplored by moderates, seemed designed to move Brazil into the camp of neutralist nations and away from the traditionally close ties with the United States. He staunchly opposed any inter-American action to censure the Castro regime in Cuba and initiated proceedings to resume or establish diplomatic and commercial relations with the Soviet Union and its European satellites. On Aug. 25, 1961, after less than seven months in office, Quadros unexpectedly resigned, alleging that "terrible forces" had prevented him from leading Brazil along the path to "political and economic liberation." The congress promptly accepted Quadros' resignation and installed Paschoal Ranieri Mazzilli, speaker of the chamber of deputies, as temporary president. Vice-Pres. João Goulart, the constitutional successor, was then in Singapore, en route home from a state visit to Communist China.

Quadros' resignation pushed Brazil to the brink of civil war. Many military commanders and conservatives regarded Goulart as too radical to be entrusted with the nation's highest office, while the great majority of civilian political leaders, even including bitter enemies of Goulart, upheld his constitutional right to the presidency. War minister Odilio Denys, who in 1955 had taken part in the *coup d'état* to prevent an unconstitutional succession, now emerged as the chief spokesman of the anti-Goulart forces. General Denys demanded that the congress declare the office of vice-president vacant and hold new elections. The congress refused. In southern Brazil, the commanders of the powerful army and air force units defied orders from the capital and sided with Goulart. At this point, Goulart arrived in Pôrto Alegre insisting that he was already president of Brazil. Faced with the imminent prospect of armed conflict, the congress and the anti-Goulart group in the military agreed upon a compromise solution. Goulart should be allowed to take office but only as a figurehead. On Sept. 2, 1961, the parliamentary system of government was adopted by constitutional amendment. Most presidential powers were transferred to the newly created post of prime minister. Provision was also made for a national plebiscite to endorse or reject the parliamentary experiment before the end of the presidential term. Goulart accepted these conditions and was formally confirmed as president on Sept. 7, 1961.

The basic problems that had faced Quadros were not resolved with the introduction of the parliamentary system. Once the immediate crisis of the presidential succession was settled, the political parties resumed debate on pressing national issues but postponed significant legislation pending the outcome of congressional elections in Oct. 1962. When these failed to indicate a clear mandate for or against the administration's reform proposals, the opponents of parliamentarianism, led by Goulart, demanded a quick return to presidential rule. On Jan. 6, 1963, a national plebiscite by a margin of more than five to one restored Goulart's full presidential powers. The congress, however, remained divided, and Goulart was unable to secure majority support for his legislative program. Repeated cabinet changes and the successive introduction of new plans for economic and social development did nothing to restrict inflation and soaring living costs, which reached alarming proportions under Goulart. During the two and one-half years of his administration, there was a tenfold drop in the dollar value of the currency, the cost of living tripled and the growth of the gross national product, which had been rising by 6% to 7% yearly, was brought to a complete halt.

4. Military Intervention.—As the situation grew more desperate, cooperation between the regime and its critics became more difficult. Each group blamed the other for blocking effective governmental action on fiscal reform and social welfare and drifted toward an extraconstitutional solution to the impasse. The administration identified itself increasingly with the ultranationalistic left, while most of the military officer corps sympathized with the moderate and conservative opposition. Goulart surrounded himself with extremist advisers, including Communists, and permitted extensive Communist penetration of trade unions, student organizations and official agencies. He sought to neutralize the armed forces by frequent command changes and by developing a personal following among noncommissioned officers and enlisted personnel. After failing to obtain authorization for a state of siege, which would have given him enhanced powers, Goulart appealed directly to the people for support. At a mass rally in Rio de Janeiro in March 1964, he issued decrees instituting a controversial agrarian reform and nationalizing certain privately owned oil refineries. Many military officers and opposition political leaders had already become convinced that Goulart was seeking to establish a dictatorship of the left. During 1963 active plotting began among separate civilian and military groups in different parts of the country. Gov. José de Magalhães Pinto of Minas Gerais state and Gen. Humberto de Alencar Castelo Branco, chief of staff of the army, emerged as the chief coordinators of the conspiracy. An attempt was made to find a formula to prevent a *coup d'état* by the president and still permit him to complete his term in office. At the same time, plans were made to overthrow the regime if necessary. The administration's refusal to suppress a strike by naval enlisted men in late March 1964 was regarded by the opposition as intolerable, for if military authority and discipline were undermined, the last check on Goulart's alleged ambitions would be removed. On March 31, 1964, Gov. Magalhães Pinto proclaimed a revolution against the government by the civil and military forces in Minas Gerais. The following day he was joined by the political leaders of the states of São Paulo and Guanabara and by the armed forces throughout most of Brazil. On April 2, 1964, Goulart fled into exile, and two days later he arrived in neighbouring Uruguay. The congress declared his office vacant and designated Paschoal Ranieri Mazzilli, speaker of the lower house, as interim president until a successor could be chosen to serve out the remainder of the term.

With the fall of the Goulart regime, real power passed to the leaders of the victorious revolution, who instituted the most sweeping political changes in Brazil since the overthrow of the *Estado Novo*. The objectives of the revolutionary commanders were to restore economic and financial order, to eliminate Communist infiltration and to achieve a moral regeneration of Brazilian political life through a purge of corrupt and subversive elements. At the same time they desired to retain constitutional, representative democracy and to give the new government the respectability of legal status. On April 9, 1964, these goals were combined in the Institutional act, a modification of the constitution of 1946 promulgated by the new war, air, and navy ministers. The executive was granted temporary authority to cancel the mandates of elected officials, to dismiss public servants and to revoke for ten years the political rights of those found guilty of subversion or misuse of public funds.

During the six months these provisions were in effect, thousands were arrested, and hundreds of persons—including trade union officers; bureaucrats; local, state, and national legislators; mayors; state governors; and former presidents Goulart, Quadros and

Kubitschek—were deprived of political rights. The congress was retained as a legislative body with power to debate and amend, but not to reject, proposals submitted to it by the executive. On April 11, 1964, Humberto de Alencar Castelo Branco, who had resigned from active military duty with the rank of marshal, was elected by the congress as president of Brazil. José Maria Alkmim, who had been finance minister during the Kubitschek administration, was chosen as vice-president. Castelo Branco and Alkmim were inaugurated on April 15, 1964. On July 22 of that year the congress extended their term of office to March 15, 1967.

(L. W. Be.; A. S. G.; G. I. B.; R. E. P.)

Castelo Branco's extended term was regarded by the revolutionaries as a transition period during which sweeping political as well as economic reforms should be enacted before the nation could again be entrusted to a popularly elected government. It was generally agreed by the new leaders that such alleged shortcomings of the political process as the multiplicity of small, regional, and personalist parties, opportunistic electoral coalitions, and the separate election of president and vice-president must be corrected, but they were divided over the best means to attain these ends. The president's determination to achieve reform by legislation, while permitting normal political activities and full freedom of expression by critics of the regime who had survived the initial purge, was challenged by civilian and military extremists who called for dissolution of Congress, abolition of political parties, and suspension of all partisan activities until the revolutionary regime had consolidated its power.

The test came in October 1965, when gubernatorial elections were held in 11 states. Although candidates endorsed by the national government won office in nine states, opposition candidates were elected by substantial majorities in the key states of Minas Gerais and Guanabara. The extremists interpreted the results as a great setback for the revolutionary government. Accusing Castelo Branco of not pressing the revolutionary reform program with enough vigour, they blamed him for the defeat of their candidates and demanded that he annul the two contests. When he refused to comply with their demands, insisting that all elected candidates would be installed in office, they plotted a coup d'etat. At this point, Gen. Artur da Costa e Silva, the minister of war, intervened and persuaded the dissident leaders to keep the peace in return for Castelo Branco's promise to take stronger measures to enact the revolution's reform program.

Consequently, on Oct. 27, 1965, Castelo Branco signed the Institutional Act N.2, which suspended all existing political parties and restored the president's emergency powers for the remainder of his term, including the authority to cancel the political rights of individual citizens for ten years. In addition, Institutional Act N.2 set Oct. 3, 1966, as the date for new presidential elections. Under Castelo Branco's leadership an artificial two-party system was also imposed upon the country. The new political parties were the Aliança Renovadora Nacional (ARENA), sponsored by the government, and an opposition party, the Movimento Democrático Brasileiro (MDB). Even though the creation of a third party was theoretically possible, as a practical matter all political factions still active in Brazil were required to function within those two parties. ARENA soon attracted a heterogeneous grouping of proadministration elements in the Congress and in the various states, while the MDB came to be comprised largely of former followers of João Goulart and of some politicians who had broken with the revolutionary regime. Neither party enjoyed strong grass-roots support, although the MDB was expected to draw a large vote among those who were dissatisfied with the economic austerity measures and the political authoritarianism of the government. In these circumstances, ARENA leaders urged Castelo Branco to intervene further in the political process. On Feb. 5, 1966, after consulting with the National Security Council, he promulgated Institutional Act N.3, which provided for indirect elections of new state governors and mayors of state capitals in September 1966 and for president and vice-president in October 1966. Because the presidential election was by the Congress, in which ARENA held a two-thirds majority, the opposition party refused to nominate candidates. The administration candidates, Costa e Silva and Pedro Aleixo, the minister of education, were elected president and vice-president respectively and inaugurated on March 15, 1967.

TROELLER FROM BLACK STAR

BRAZILIAN PARLIAMENT IN SESSION, BRASÍLIA

Before leaving office Castelo Branco in December 1966 called an extraordinary session of Congress to approve a new constitution drafted by a government-appointed commission. By a 2–1 margin Congress approved the new document, which was promulgated on Jan. 24, 1967. It incorporated much of the revolutionary reform program enacted by the Castelo Branco administration since 1964, and confirmed the expansion of the power of the executive at the expense of the legislature and of the central government at the expense of the states. The most important changes from the 1946 charter included the indirect election of the president and vice-president from a single ticket; reduction of the presidential term from five to four years; the use of military courts to judge civilians charged with violation of national security laws; the granting of authority to the president to issue emergency decrees with little need to consult Congress; and denial to the Congress of the right to delay action on legislation requested by the executive.

The Castelo Branco administration engaged in economic planning on a scale unprecedented in Brazil in order to contain inflation and to revive the flagging economy. It employed emergency powers to limit and regulate sources of credit, to restructure the tax system and collection procedures, and to impose stringent wage and salary controls. Such austerity measures affected all sectors of society, but bore most heavily on urban labour and white-collar workers, whose real income was held below the rising cost of living. The adverse effects were partially offset by tax incentives to encourage increased industrial and agricultural productivity. At the same time the government poured substantial investments into the sectors of electric power and transportation, to provide a continuing basis for orderly economic development. Although the administration did not achieve all of its goals, Brazil's credit rating abroad was firmly reestablished, the annual rise in living costs fell from 86% in 1964 to 41% in 1966, and the increase in the gross national product rose significantly from 3.1% to 4.4% in the same period. With the notable exception of labour, every major sector of the Brazilian economy was on the upswing when Castelo Branco left office.

Artur da Costa e Silva assumed the presidency with the promise to "humanize" the revolution, and it was widely expected that he would soon relax the more severe political and economic policies of the outgoing regime. His freedom to pursue a softer line was enhanced by the death of Castelo Branco in an airplane crash in July 1967. Yet Costa e Silva did not depart markedly from the course set by his predecessor. In the political sphere his administration rejected petitions for a general amnesty, resisted all proposals to amend the new constitution to restore direct elections, squelched attempts by Carlos Lacerda and others to form a second opposition party, and employed force to suppress student disturbances which combined virulent political dissent with protests against an inadequate university system. More serious political opposition, however, was muted in part by the government's achievements in the economic field. During Costa e Silva's first year in office the rate of inflation was held below 25% for the first time in a decade, while the increase in the gross national product surpassed 5%, its highest level in five years.

The political situation deteriorated rapidly late in 1968. Faced with a resurgence of public and congressional criticism of the regime and the army's role in it, President Costa e Silva, under strong pressure from the armed forces, seized emergency powers. A new Institutional Act issued on December 13 suspended all legislative bodies indefinitely, authorized the executive to rule by decree, and provided the legal basis for a new purge of outstanding political critics.

In certain respects, the phase of Brazilian political history that began with the overthrow of the *Estado Novo* and the election of a president and Congress responsible to the electorate ended with the revolution of 1964. The latter event dispelled any lingering doubts that the armed forces were the strongest political organization in Brazil, able and willing to protect what they regarded as the national interest even against the president and other elected officials of the state. The ease with which military leaders assumed and retained power clearly revealed the failure of the postwar political parties to develop into cohesive national bodies capable of winning the respect and allegiance of the voting public and of resolving the critical problems of economic development and social justice. The ineffectiveness of populist civilian administrations in the early 1960s paved the way for the retreat after 1964 to paternalistic rule by a narrow elite, confident of its own ability to interpret and execute the national will.

Yet, in a deeper sense, fundamental economic and social trends that were encouraged by the Vargas regime after 1930 were only slightly modified by the revival of representative democracy in 1945 or by the revolutionary governments that held power after 1964. The fact that the political forces that had just regained freedom of expression in 1945 were unanimously agreed upon the need for a new national charter dramatically illustrated their awareness that a return to the pre-1930 status quo was impossible. While the constitution of 1946 borrowed heavily from that of 1891 in certain exterior forms, a comparison of the two charters reveals the nature and extent of the socioeconomic transformation that Brazil experienced after 1930. The constitution of 1891, despite its positivist trappings, was essentially a 19th-century liberal document that stressed the rights of the individual and of state governments as opposed to the national administration. The 1946 constitution largely reaffirmed the concentration of power in the central government which Vargas had accomplished at the expense of the states and acknowledged the responsibility the federal government had assumed to maintain and foster economic development and social welfare programs beyond the restricted capacity of the various state administrations. These trends were accelerated in the new national charter of 1967.

The changes in the political structure indicated above reflect basic socioeconomic developments that gave new dimensions and added complexity to Brazilian politics. For more than a generation Brazil has been experiencing tremendous population growth and even more dramatic increase in urbanization and in the number of people participating directly or indirectly in the political process. In 1930, when Vargas took office for the first time, Brazil had a total population of about 33,500,000, of whom at least three-fourths were rural and illiterate. By 1945 the population had risen to about 46,000,000. Two-thirds of these were rural and largely outside the political arena. In 1964 the population surpassed 80,000,000 and was divided equally between rural and urban inhabitants. The proportion of literates was also about 50%, but at least half were under voting age. During these years the increase in the size of the electorate considerably outpaced the expansion of cities and the growth of the population as a whole.

In 1930 scarcely 1,500,000 voters, less than 5% of the population, cast ballots for the two presidential candidates. By 1945 the electorate had increased fourfold, and General Dutra alone received more than 3,250,000 votes. Approximately 12,000,000 voters cast ballots in the 1960 presidential elections, while more than 11,000,000 of Brazil's 18,500,000 eligible voters took part in the national plebiscite in January 1963. Thus, while the total population more than doubled and the urban sector rose by about five times in less than 35 years after 1930, the effective voting population showed an eightfold increase and the number of eligible voters multiplied by twelve. Natural population growth and the enfranchisement of women accounted for much of the increase, but even when these factors are taken into account it is apparent that important new groups, whose voices had been at best dimly heard before 1930, had come of age and were in a position to influence the course and policies of government by 1964. Although subsequent changes in the electoral laws tended to insulate officeholders from the direct influence of the voters, the number of individuals qualified to vote and concerned with the political life of the nation continued to expand each year. In 1969 there were over 90,000,000 Brazilians, of whom more than half were city dwellers. Again, over half of these were literate and of voting age.

By the late 1960s there had been no thorough analysis of the electorate by economic or social status. It appeared certain, however, that the bulk of the voters enfranchised since 1930 belonged to the urban working-class and government bureaucracy.

With the formation of government-directed trade unions in the 1930s, the urban working-class became a vocal element on the Brazilian political scene. But the rise of a politically conscious urban proletariat did not signify the emergence of a true labour-based political movement. No authentic labour party had appeared by 1964, nor had any aspiring political leaders from the working class yet achieved national prominence in Brazil. Leadership of this new political force had been contested by the traditional elite, principally landowners and large-scale merchants, and by a new middle class composed of industrial, commercial, and professional elements who, in an environment of sustained industrialization and urban growth, had gained elite status. The governments in office after 1964 followed the practice of controlling labour organizations in an effort to channel labour support for the administration while discouraging the formation of an autonomous and potentially dissident labour movement.

The new middle class also was yet to acquire the cohesion and strong sense of class consciousness that would permit it to regard itself as a distinct element in Brazilian society. Thus, it is not surprising that before 1966 it did not seek political expression in a party oriented solely or principally toward a single social or economic group. Rather, it vied with the traditional ruling groups for control of existing political organizations. Members of both groups were found in the leadership of virtually every party for two decades after 1945, although the predominantly urban-oriented parties grew consistently at the expense of more traditional, rural-based parties. By and large the middle class endorsed the revolution of 1964, but many of its political spokesmen later broke with the revolutionary regime, with the result that middle-class political leaders were found in each of the new political parties created in 1966.

Extension of the franchise to illiterates would approximately double the size of the electorate and increase the influence of the lower class on Brazilian politics. It would also enhance the political power of rural society at the expense of the city dwellers. But even though most of the rural lower class was still unable to read and write, and was therefore still denied the vote, the political consciousness of the peasantry in large areas of Brazil had been awakened. Through the illegal "peasant leagues," founded in the late 1950s, and legitimate rural unions, which were authorized in 1962, many impoverished peasants were able for the first time to make their needs known to the political leaders of the country. Before the 1964 revolution, Communists, a few clergymen, and members of nearly all of Brazil's legal parties were competing for the allegiance of the rural masses, appealing to their demands for social justice and higher living standards. Although most of the peasant organizations were abolished and numerous "agitators" were jailed or exiled by post-1964 regimes, some limited measures were enacted by the federal government to assuage rural unrest. In the late 1960s, however, the peasantry remained potentially the most powerful political force in Brazil, one whose demands and desires could not be ignored indefinitely by state and national administrations.

The Roman Catholic Church in Brazil, which had usually eschewed political activity, gradually assumed a new role in national politics after the 1964 revolution. As one of the few effective institutions organized on a nationwide basis in Brazil, the Church was drawn into the partial political vacuum caused by the purge of populist civilian leaders and the abolition of the established political parties. Inspired by the encyclicals of Popes John XXIII and Paul VI, several bishops, including Msgr. Helder Câmara in Recife, led the secular and regular clergy in denouncing the government's apparent indifference to the vast inequities in Brazilian society. Increasingly they criticized the low level of federal support for public health and welfare, education, and agrarian reform. Outspoken clerics also served as champions of the political right of dissent, with the result that by the late 1960s the Church was coming to be regarded as a rallying point for political opposition.

Ultimately, the armed forces are the final arbiters of the political process in Brazil, although they are neither blind nor indifferent to the objectives of the new groups that have entered the political scene since 1945. The traditional alliance of the military and conservative rural landholders has long since been replaced by an informal situation in which military officers and urban middle sectors usually share similar points of view. The armed services have been consistent defenders of centralized government, rapid industrialization, and the development of an efficient, organized labour force. They have been quick, however, to resent the exploitation of organized labour by political leftists as a counterweight to the political influence of the military. Between 1945 and 1964 no single political party was able to elect a president of Brazil or a majority in Congress, a situation that encouraged political irresponsibility. In this situation, and always at the behest of civilian political elements, the armed forces intervened on four occasions to protect national institutions against the effects of what they considered civilian incompetence. Since 1964, in contrast to their earlier practice, military leaders have retained direct command of the government, removed corrupt and undesirable politicians from office, and initiated a major revision of the political system which, in their view, would make it impossible for men who placed partisan interest before the national welfare to come to power in Brazil. The military may be expected to remain in or near the centre of the political stage until a truly national party which enjoys their trust and is capable of controlling the presidency and a congressional majority appears in Brazil. (R. E. P.)

V. POPULATION

1. Number and Distribution.—Carefully planned and well-executed modern censuses showed the population of Brazil to be 41,236,315 in 1940, and 51,944,397 in 1950. The 1960 population was 70,967,185. The manner in which the inhabitants were distributed among the various states and territories is shown in Table II. Except in São Paulo and Rio Grande do Sul the population has remained concentrated to a large extent in the zone lying within about 200 mi. of the coast. Since 1960 the population has continued to increase by an average of about 2,400,000 annually.

2. Composition.—The white elements predominate in the racial composition of Brazil's population; other groups are Negroes and the mixed (*pardo* or "brown") category. South American Indians were not classified separately, so undoubtedly the mixed group includes millions of persons who are largely of Indian stock, as well as the crosses of both white and Indian and white and Negro. The Japanese, immigrants and their children, constitute almost 1% of Brazil's people. Whites predominate to the greatest extent in the southern states of São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul where the people are largely descendants of Portuguese, Italian, Spanish, German, and Polish immigrants. Negroes and mulattoes are found in the highest proportions in all of the old sugar-plantation districts, and especially those in the states of Bahia, Rio de Janeiro, Pernambuco, and Paraíba. They also make up high percentages of the populations of such cities as Salvador (or Bahia), Rio de Janeiro, Recife, and São Luis. Indians and mestizos are relatively numerous throughout the Amazon Basin and in the states of Maranhão, Goiás, and Mato Grosso. The Japanese are mostly in the state of São Paulo, in northern Paraná, and along the railroad which crosses southern Mato Grosso. (See *The People: Ethnic Composition,* above.)

TABLE II.—*Area, Number of Inhabitants and Density of Population in Brazil by Major Civil Divisions.*

State or territory by regions	Area (sq.mi.)	Population		
		1950	1960	Density per sq mi. (1960)
Brazil	3,265,476*	51,944,397	70,967,185†	21.7
North				
Rondônia (territory) .	93,839	36,935	70,783	0.8
Acre	58,915	114,755	160,208	2.7
Amazonas . . .	604,032	514,099	721,215	1.2
Roraima (territory) .	88,843	18,116	29,489	0.3
Pará	481,869	1,123,273	1,550,935	3.2
Amapá (territory) . .	54,161	37,477	68,889	1.3
Northeast				
Maranhão . . .	126,897	1,583,248	2,492,139	19.6
Piauí	96,886	1,045,696	1,263,368	13.0
Ceará	57,149	2,695,450	3,337,856	58.4
Rio Grande do Norte .	20,469	967,921	1,157,258	56.5
Paraíba	21,765	1,713,259	2,018,023	92.7
Pernambuco . . .	37,946	3,395,185	4,136,900	109.0
Alagoas	10,707	1,093,137	1,271,062	118.7
Fernando de Noronha (territory) . . .	10	581	1,389	138.9
East				
Sergipe	8,492	644,361	760,273	89.5
Bahia	216,612	4,834,575	5,990,605	27.7
Minas Gerais‡ . .	226,707	7,717,792	9,798,880	43.2
Espírito Santo‡ . .	17,605	861,562	1,188,665	67.5
Rio de Janeiro . .	16,568	2,297,194	3,402,728	205.4
Guanabara . . .	524	2,377,451	3,307,163	6,311.4
South				
São Paulo . . .	95,713	9,134,423	12,974,699	135.6
Paraná	77,048	2,115,547	4,277,763	55.5
Santa Catarina . .	37,060	1,560,502	2,146,909	57.9
Rio Grande do Sul. .	108,951	4,164,821	5,448,823	50.0
Central-West				
Mato Grosso . . .	475,501	522,044	910,262	1.9
Goiás	247,912	1,214,921	1,954,862	7.9
Distrito Federal . .	2,245	. . .	141,742	63.1

*Total area excludes 20,994 sq.mi. of inland water. †Preliminary census figures. ‡The boundary dispute between the states of Minas Gerais and Espírito Santo over Serra dos Aimorés was settled as of Dec. 12, 1964. Of the disputed area 1,515 sq.mi. went to Minas Gerais, 2,405 sq.mi. to Espírito Santo.

As a result of the high birth rate and the high death rate which have prevailed in Brazil, the nation's population is highly concentrated in the younger ages. Thus, according to the 1960 census, the proportions in the three large age groups were as follows: under 15, 42.6%; 15–64, 54.5%; and 65 and over, 2.9%. The sexes, though, are approximately equal in number, the ratio in 1960 being 99.7 males per 100 females.

Brazil ranks high among the nations in the extent to which persons born and reared elsewhere have been incorporated into its population. During the period 1874 to 1960 approximately 5,000,000 immigrants were admitted, of whom about one-half settled in the state of São Paulo. More than 4,000,000 immigrants arrived prior to 1930 and about 500,000 after 1945, mostly from Portugal, Italy, Spain, Japan, Germany, Syria, and Poland.

3. Growth of Population.—Throughout the 20th century the population of Brazil has increased rapidly. In 1900 the rate of increase was approximately 2% per annum, but by 1960 it had risen to above 3%. A large excess of births over deaths undoubtedly has been responsible for this rapid growth of population. The death rate appears to have fallen sharply, or from about 30 deaths per 1,000 population in 1900 to less than 12 per 1,000 for

1960 and subsequent years. Since 1930, immigration has had no appreciable effect upon the rate of population increase.

(T. L. Sh.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution.—The regimes that have governed Brazil have been of five kinds: colonial, imperial, republican, dictatorial, and military. When World War II and the dictatorship of Getúlio Vargas ended, the Brazilians in 1946 adopted a new constitution, their fifth since they achieved independence. This was overthrown in April 1964 by the military, whose power was institutionalized in a new structure at the beginning of 1967. These facts contain a pattern and present a problem. The country's form of government exhibits an evolutionary development, but the impermanence of the forms suggests an underlying instability. What is the explanation of the changes, and why so many?

A clue is provided in the two key words of Brazil's national motto "Order and Progress." "Order" has meant the preservation of established tradition; "Progress," the departure from it. The politics of modern Brazil have been marked by conflict between these tendencies. In the colonial period, which lasted until 1822, the social order, and therewith the system of government, was cast in a definite mold whose effects continued after the causes had disappeared. Brazil had a stratified society composed of three ethnic groups and their intermixtures. At the top, the great clans of the plantation owners made up an oligarchy of privilege. At the bottom were the slaves imported from Africa for their labour. The harshness of social distance was somewhat mitigated, however, by a tolerance for colour, by the practice of miscegenation, and frequently by parental education and support for illegitimate half-caste children. Thus, the Portuguese legacy in government was the paternalism of a dominant elite, benevolent at its best, selfish and soft at its worst.

Such was the "Order" which "Progress" has sought to challenge. Each of the constitutions inaugurated from 1824 to 1967 met this problem differently, though in one respect they were all alike. The inspiration for reform was drawn from outside; the models were foreign. This was as true of the British-inspired empire of Dom Pedro II as of the republican constitution that Ruy Barbosa in 1891 modeled upon the United States, and the *Estado Novo* of the 1930s which Vargas patterned upon Mussolini's corporatism. In this respect, too, the constitution of 1946 resembled its predecessors. It was Brazil's second try to govern itself after the fashion of the United States, but with safeguards against a coup by a second Vargas. The safeguards, however, as events proved in 1964, were no match for the Brazilian army, which departed from its own tradition for the first time and imitated various of its neighbours by installing its own direct rule.

2. The Electorate.—Because reform in Brazil has had to overcome a tenacious tradition, the constitution of 1946 in retrospect must be interpreted with caution. Much of what the document prescribed was excellent intention which never became an accomplished fact. For example, the constitution not only established a republic but also incorporated the political principles of liberal democracy. Thus, art. i affirmed that "all power emanates from the people and shall be exercised in its name." But who were the people? For all effective purposes, the people in a democracy are those who, at election time, can vote for their political representatives. Hence the qualifications for the franchise are a crucial index to the degree of democracy. The 1946 constitution provided for universal, direct suffrage with a secret ballot and conferred voting rights on all citizens of both sexes at the low age of 18. However, it denied the vote to illiterates, so that popular participation in elections was tied to the spread of education. Since about 50% of the nation was illiterate in the 1960s, undoubtedly the denial of voting rights to illiterates reduced the potential electorate by at least 50%.

3. Political Parties.—The difficulty of converting a dominant oligarchy to the forms and spirit of a representative democracy could also be seen in the party system. When political freedom was regained in 1945, many parties were quickly organized. Only five, however, had any national significance. The Social Democrats (PSD) were the official party of Pres. Eurico Gaspar Dutra's period and included many adherents who gained preferment at that time. From 1950 to 1962 they normally won approximately one-third of the seats in the house of deputies. The National Democratic Union (UDN), which mobilized opposition to Vargas at the end of the dictatorship, continued thereafter to organize the right of centre. Besides wealth, it contained members who were leaders in the professions and highly educated. The Brazilian Labour Party (PTB) was created by Vargas to represent the urban and industrial workers and to be a spokesman for nationalism. The Social Progressives (PSP) were founded by Adhemar de Barros and were strongest in the state of São Paulo, of which he was governor. The Communist Party made some striking electoral gains between 1945 and 1947, but then, with the development of the Cold War, followed the Stalinist line. Since then, it has been outlawed, legalized, and outlawed again, and has split into two factions that follow the Soviet Union and China, respectively. In general, the Brazilian parties were amorphous, and the whole system remained fluid. *Personalismo,* or the cult of personality, was as important as a program, and the parties often had less influence on policy than such pressure groups as the industrial workers, the importers, the army, and the Church.

4. The Presidency.—It was in this political context that the institutions of government functioned. These consisted until April 1964 of a federal union, a chief executive who was outside the legislature, and a judicial review of legislation. Among the institutions of the union, the presidency supplied the natural link between traditional Brazil and the principles of republicanism. The president, while embodying the appeals of *personalismo,* also continued the symbolism of emperorship which Brazil did not abandon until 1889. The candidate with a national plurality was elected for a term of five years by direct popular vote. He could serve more than one term, but not successively. The vice-president was elected simultaneously with the president, but on a separate ballot, and the voting for the two offices was far from identical. The executive departments were headed by ministers who could be members of the legislative branch and could be required to appear before it.

5. Congress.—The National Congress was bicameral, the Chamber of Deputies being more potent than the Senate. The members of the former (more than 400 in the mid-1960s) were elected simultaneously by proportional representation for a term of four years. Although seats in the Chamber were distributed among the states and territories according to population, the apportionment was so weighted as to favour the areas that had few inhabitants. In the Senate, three seats were assigned to each of the 22 states. They were elected for eight years, their terms being staggered. Because of the number of parties and the lack of strong discipline, the Congress was hard to organize. Leadership from the president and from within was subject to challenge, and the outcome of proposed legislation was often in doubt.

6. Federalism.—The experiment with federalism contrasted, in form at least, with the centralization that prevailed under the colonial and imperial regimes and the dictatorship of Vargas. Although the federal system was imported from North America, it did conform to some basic conditions of Brazilian society. Because of Brazil's size, historical evolution, racial mixture, and economic diversity, the regional differences are profoundly marked. In literature and art, in politics and the idioms of daily speech, these facts and feelings are expressed by such terms as *cariocas, paulistas, sertanejos, gauchos, mineiros,* etc. The country is, therefore, naturally fitted to a federal form of government. But to operate these institutions has not been easy because Brazil's various regions are so dissimilar in resources and in cultural and economic development.

The union, then called officially Estados Unidos do Brasil, was composed of 22 states, some federal territories, and the federal district containing the new capital of Brasília. When the constitution of 1946 was drafted, care was taken to prevent undue centralization. Modernization had proceeded in Brazil most unevenly. Glaring contrasts existed between the advanced states of the south and those of the northeast and west, and also between Rio de Janeiro and the state capitals, on the one hand, and the smaller towns and rural areas, on the other. Hence the intention of the constitution-framers was to ensure that, as the nation progressed, the benefits would be more uniformly spread. Thus, the union was required to transfer fixed percentages of the yield of designated taxes on a proportional basis to state and local treasuries. The states likewise were obligated to distribute a share of certain of their revenues to the local units and especially to those other than the state capital. The constitution also recognized a national interest in two regional problems which transcended the resources of the states directly concerned, namely the economic development of the Amazon Valley and the periodic droughts in the *sertão* of the northeast.

As it actually functioned, Brazilian federalism existed more in form than in fact. The national government wielded such predominant powers over the economy that in a period of rapid industrialization all aspects of national life depended on the planning, or lack of it, at the centre. For almost two decades the Brazilian government stumbled along in a condition of external bankruptcy and internal inflation that the states were powerless to remedy. The latter, moreover, were so disparate in population and resources that only a few were really equipped to undertake the functions of a modern government. The state of São Paulo was disproportionately strong, and Guanabara (formerly the federal district of Rio de Janeiro), Minas Gerais, and Rio Grande do Sul were also effective entities. Almost all of the others depended heavily on grants from the central government.

7. Taxation.—The inequalities in the economy made it difficult to ensure an equitable system of public finance. Not only was a large share of the national revenue collected in the cities of São Paulo and Rio de Janeiro but the burdens of taxation were by no means fairly distributed in the past. Traditionally, the richer individuals were favoured, as well as the richer regions, and too much of the revenue was raised by indirect taxes which fell heavily on consumers with modest means. Some attempt was made to correct this situation by increasing the yield from the graduated income tax, but the urban middle class was too hard hit by price inflation to make long-range plans or to feel any security.

8. Military and Police.—Before 1964, except for the period of the Vargas dictatorship, Brazil was not governed as a police state. Its politics have been less affected by violence and coups d'etat than has been the case in neighbouring countries. Independence, emancipation, and republicanism were peacefully accomplished. Even the dictatorship of 1930–45 was moderated by the national flair for effective ridicule. The armed forces were never without influence in civic affairs, but their actions were generally restrained and often assisted the constitutional regime. The Army helped to stabilize the infant republic in the 1890s and was instrumental in procuring Vargas' resignation in 1945. Along with the Air Force, it contributed to the events that led to his downfall and suicide in 1954 and ensured that President Kubitschek would take office in 1956 after the interregnum.

The attitude of the Army leaders to civilian authority altered, however, when João Goulart became president upon the resignation of Jânio Quadros in August 1961. During the ensuing two and one-half years the rift between social classes widened into a gulf. Deriving much of his support from the political left, Goulart, himself a wealthy landowner, proposed a series of economic and political changes (including redistribution of land) which required revisions of the constitution. The parties of the right, backed by the big landowners, the urban rich, and the governors of the leading states, resisted reform and charged the president with preparing a coup. In March 1964 the Army rose in revolt and seized control of the government. Its leaders then conducted a political purge and installed a retired marshal as president, empowering him to govern by decree if necessary. Many prominent persons, including former Presidents Kubitschek, Quadros, and Goulart, were deprived of their civil rights.

In this manner, the year 1964 witnessed the end, at least temporarily, of Brazil's faltering experiment in federalism, constitutionalism, and democracy. The demands for a social revolution encountered an unyielding reaction, and between these pressures the constitution was broken. Among the declared objectives of the military rulers were the elimination of leftists and corruption and the control of inflation. As the regime consolidated itself, its outlines took shape until they hardened into the constitutional changes which were forced upon a purged, yet reluctant, Congress in January 1967.

Authoritarianism and centralism were the guiding principles; the presidency, their formal embodiment. Henceforth, the president was to be picked by an electoral college, whose choice would be predetermined since normal political opposition was no longer tolerated and the old parties had been dissolved. Besides possessing wide emergency powers, the president had exclusive competence in finance and could require the submission to referendum of proposed constitutional amendments which the Congress rejected. Military tribunals were granted jurisdiction over civilians and severe penalties could be imposed on the press for ill-defined offenses. Further, to emphasize the unitary character of the new system, the country's official title was shortened to plain Brasil (anglicized Brazil), and the president was empowered to remove the governor of a state who defied central authority, as indeed Marshal Castelo Branco had done more than once between 1964 and 1966.

Under such institutions, having submitted to order, Brazilians awaited progress.

9. Living Conditions.—As may be expected in a country where economic inequality is still the rule, living standards vary so widely that national statistics must be used with caution. In Guanabara, São Paulo, and the three southern states, the standard of living approximates that of Eastern Europe. In the northeast and the sparsely settled areas of Mato Grosso and the Amazon, the conditions are closer to those of Asia. Even within the more advanced centres, squalor and luxury are but a stone's throw apart. In Rio de Janeiro, the beaches are fringed with massive new apartments that exude an ostentatious wealth. But overlooking them, atop the rocky hills, are the festering *favelas*. In the rural areas, except for the temperate south, the wealth of a few coexists with mass poverty.

In general, the prospects for the individual are best in the cities, next best in the suburban areas, and worst in the rural districts. Indeed, there are parts of Brazil where to go inland 100 mi. is to go back in time 100 years. Since the mid-1930s, the occupational group that advanced most rapidly was the industrial workers. Vargas' lasting achievement, and the source of his political strength, was to care for their welfare, which had been neglected by his more conservative predecessors. The social gains of his dictatorship were not abandoned under the subsequent republic. Working conditions were controlled in detail by law and by the bureaucracy of the Ministry of Labour, so that an extensive code embraced hours and wages, the settlement of grievances, job security, pensions, and health and welfare benefits. The system was well intentioned, but suffered from two defects. The workers were protected too much by the state and too little by their unions, which were mostly the creatures of the state. Also, the chronic inflation, to which the policies of successive governments contributed, made it impossible to stabilize wages and caused many strikes.

10. Health and Education.—The same may be said of health and education as of other social conditions. There have been tremendous obstacles to overcome. Considerable headway has been made. But the progress has been uneven, and much remains to be done. In both fields, the greatest advances have occurred in the south and principal cities. Notable achievements were the work of Oswaldo Cruz in eradicating yellow fever from Rio de Janeiro, and of the National Malaria Service which, between 1945 and 1951, drastically reduced the number of deaths from malaria by spraying with DDT. But in rural Brazil, and in the north, northeast, and west, the expectancy of life is still short. Resistance to disease is lowered by malnutrition, the diet of most Brazilians being seriously deficient in vitamins and low in calories.

In education, the results are subject to interpretation according to which statistics one takes and how they are understood. In absolute numbers, more primary and secondary schools have been built each year and the pupils in attendance have steadily increased. Also, in the universities more students have been enrolled both in general courses and professional schools. By the 1960s more Brazilians were literate, and more had received higher degrees, than ever before in the country's history. But the rate of development in education did not match the rapidity of industrial expansion. In fact, the conquest of illiteracy barely kept pace with the growth of population, so that by the mid-1960s less than 50% of the children were attending school. Shortages of trained teachers, of buildings, books, and equipment have detracted from the quality of much of the education that is given. At the highest level, however, individual Brazilians have continued in the present, as in the past, to attain international eminence in various fields—for instance, Heitor Villa-Lobos in music, Cândido Portinari in painting, Oscar Niemeyer in architecture, and Gilberto Freyre in sociological scholarship. (See *The People: Arts,* above.) (L. Lip.)

VII. THE ECONOMY

Brazil is still overwhelmingly an agricultural country with approximately 60% of the labour force in agriculture and related employments. The percentage of the population engaged in agriculture has steadily declined since 1940, indicating increasing urbanization and industrialization. Rapid economic development is a feature characteristic especially of the south of Brazil where the state of São Paulo produces approximately one-third of the national income and as much as one-half of the country's exports. São Paulo stands out both as an agricultural centre, producing about 50% of Brazil's coffee, and as an industrial region of rapidly growing importance.

Great economic advances have been made in spite of many obstacles. Out of the low per capita income only a fraction can be saved and invested in capital. The mere maintenance of the average capital equipment of a rapidly increasing population places a formidable strain on Brazil's available resources. Economic development is further hampered by the inadequate transportation system and by the tight power supply.

The government is an active promoter of accelerated economic development, which is considered most urgent in the fields of health, food production, transportation, and energy resources. The policy of monetary restraint which the government pursued in the 1960s, however, decelerated the rate of growth of the economy and reduced it to almost zero in per capita terms.

As diversified economic activities come to the fore, Brazil is gradually reducing the dependence of its economy upon foreign trade and a single commodity, be it coffee, as in the most recent phase of its economic history, or such other products as brazilwood, livestock, sugar, gold, and rubber, which have been of similar importance in different periods of the past. See *History,* above.

A. Production

1. Agriculture.—Only a small proportion of the large area of Brazil is under permanent cultivation. Much larger regions consist of pastures and forests. Of the cultivated area, approximately 14% is used for coffee, 12% each for cotton and rice, 10% for beans, 4% for wheat, and 5% each for manioc (cassava) and sugarcane. Coffee contributes about a quarter of the value of crop production, followed by rice and corn. Together these three represent well over half the total value of crops. The most significant expansion of crop production is in wheat, the output of which more than doubled in the 1950s.

Brazil is by far the largest producer of coffee in the world. Next to Ghana and Nigeria, it is the world's largest producer of cacao and is second to the United States as the largest producer of corn. In the Americas, it is the largest producer of rice, and as a producer of cotton is outranked only by the United States. Because of its rapidly growing population, Brazil needs to expand food production.

In many ways, methods of farm production have changed little over the years. Total consumption of industrial fertilizers, although on the increase, is only 1%–2% of that used in the United States. In 1948 there were fewer than 100,000 plows and 6,000 tractors in the whole of Brazil. Since then, tractors and other farm machinery have been imported in substantial volume, and domestic production of tractors began. In 1963 about 110,000 tractors were in use. There is regional concentration of land ownership, and land reform, or the distribution of large estates among small holders, has become an important political issue.

EMIL SCHULTHESS FROM BLACK STAR

CHILDREN IN A PUBLIC PLAYGROUND AT BRASÍLIA

Throughout Brazil the rural economy rests on a foundation of cattle raising. More than 90,000,000 cattle are raised, mostly in the agricultural zone of the semideciduous forests, and more than 60,000,000 hogs. Experts hold that the Brazilian livestock economy can be greatly expanded and that the country could become an outstanding meat exporter. The cattle population ranks fourth in the world, and the hog population second.

2. Forestry.—Brazil has huge forest resources, but those which are readily accessible have been badly depleted because of charcoal production and the widespread use of wood as fuel. In terms of solid volume of roundwood (without bark), the annual production exceeds 100,000,000 cu.m., that is, about 10% of the world's total. Of the thousands of different species of trees, the Paraná pine is commercially the most important.

3. Mining.—Brazil is endowed with an abundance of minerals including manganese and iron ore, bauxite, magnesite, beryllium, bismuth, lead, cobalt, copper, chrome, tin, molybdenum, nickel, rutile, wolframite, scheelite, corundum, and carbonado. In the ancient crystalline rocks of the Brazilian highlands there are gold, gem stones, and industrial metals—concentrated in the state of Minas Gerais (which means "general mines"). Gold was discovered in 1698, and for a century thereafter Minas Gerais was one of the world's major sources of gold, providing great wealth for the Portuguese crown. By the end of the 18th century the richest placer deposits had been worked over. One vein mine, the deepest in the world, has been operated by a British company for more than a century at Morro Velho. In 1729 diamonds were discovered, also in Minas Gerais. Although Brazil is not so well known for gem diamonds as is South Africa, it remains a major source of industrial diamonds. Gem stones also include aquamarine, topaz, and many others. Brazil is the world's chief source of quartz crystals for use in radios, and a leading producer of tantalite, thorium, and mica.

Brazil's endowment of industrial metals is one of the world's richest. In Minas Gerais is one of the world's major sources of high-grade iron ore, about 35,000,000,000 tons of highest quality ore. The largest manganese deposits in the Western Hemisphere are in Brazil. A large manganese mining development has taken place in Amapá, near the mouth of the Amazon. Another source is near Corumbá on the upper Paraguay River.

4. Fisheries.—Brazil's fish catch, the largest in South America, comes to more than 400,000 short tons per year. There are thousands of different species of fish, almost 2,000 in the Amazon River system. Commercial exploitation is hampered by primitive equipment and lack of seagoing craft, but considerable modernization has taken place in recent years.

5. Power.—The inadequacy of power resources is one of the principal problems of the Brazilian economy. Domestic coal is of inferior quality and contains so much sulfur that special grates are required to burn it; the deposits are scarce and not easily accessible. There is active prospecting for petroleum, but the known reserves are small. At mid-20th century, the only oil field actually in operation was located in the Recôncavo lowland of Bahia. The exploitation of petroleum resources is by law reserved for Petrobrás (Petróleo Brasileiro), a mixed corporation which excludes foreign equity participation.

In recent years, increasing reliance has been placed on hydroelectric power, of which the potential is large, being estimated at 15,000,000 kw. Approximately 30% of the installed generating capacity is accounted for by the Brazilian Traction, Light, and Power Company, a Canadian concern with significant American and British participation. The continued operation of foreign concerns is affected by government programs calling for the transfer of privately owned utilities to public ownership.

6. Industries.—A rapid rate of growth of many lines of manufacturing production is the most impressive symptom of economic progress in Brazil. The census of 1960 listed 110,000 industrial establishments, most of them small, with 1,500,000 employees. One out of three establishments was in food processing. The textile industry, with improved equipment, is becoming more important. In 1936 there were 74,000 hand cotton looms and only 7,000 automatic ones; 20 years later, there were 72,000 hand looms and 40,000 automatic ones. Other impressive advances have occurred in the pulp and paper, cement, and steel industries.

The carnaúba palm tree is the basis of an important wax industry in the northern states of Ceará and Piauí. The high-grade wax is exported and used in the manufacture of polishes, carbon paper, explosives, and phonograph records.

The production of crude steel, 101,000 short tons in 1938, had increased over eight times by 1950 and almost 18 times by 1960, when it satisfied the bulk of domestic requirements. Much of the steel is produced in the Paraíba Valley in the modern Volta Redonda Mill, which was constructed with the help of credit from the Export-Import Bank of the United States.

B. Trade and Finance

1. Foreign Trade.—Imports as well as exports, while considerable, have not expanded as rapidly in recent years as has production for domestic use, and their proportion to the national product shows a declining trend, reaching 5% to 6% in the mid-1960s. The major classes of imports are machines and vehicles, raw materials, and foodstuffs. The two largest single import items are wheat and petroleum (crude and derivatives), which together constitute about one-fourth of the value of all imports.

Of the exports, two-thirds are foodstuffs and one-third raw materials. Close to 50% of the value of all exports is coffee, with cotton holding second rank, contributing about 10%. More than half of the coffee is exported to the United States.

Among the trading partners of Brazil, the United States holds first rank, followed, though at a considerable distance, by West Germany, Argentina, the Netherlands, Great Britain, and France. Ordinarily Brazil has export surpluses with the United States and Great Britain. The proceeds earned therefrom are used for debt service, other invisible imports, and the payment of commodity import surpluses incurred in the trade with Argentina (wheat), the Netherlands Antilles (petroleum), West Germany, and other countries.

2. Foreign Debts and Investments.—While the external debt owed to private creditors has declined, there has been considerable lending in Brazil by such public-credit institutions as the International Bank for Reconstruction and Development and the Export-Import Bank of the United States, mostly for economic development or liquidation of commercial debts. Although a number of restrictions are placed on the operations of foreign business firms in Brazil, there are important foreign business investments. These were, until the late 1920s, predominantly British. In later years, United States business investments came to exceed all others. United States economic assistance to Brazil from 1961 through 1966 amounted to $1,300,000,000 out of a total of $4,700,000,000 for all Latin America.

3. Banking and Currency.—In the late 1960s more than 300 banking firms were engaged in business in Brazil, with about 7,500 offices and branches. In addition, there are hundreds of branches of savings banks and credit cooperatives. The largest bank is the Banco do Brasil, whose loans and discounts are a multiple of those of all other banks together. Until 1965 this bank, controlled and partly owned by the government, was the official bank, and acted as a lender of last resort, fulfilling some other central-banking functions. There was then no full-fledged central bank. In 1965 a Central Bank of Brazil came into existence and assumed certain functions hitherto fulfilled by the Banco do Brasil and other agencies. Other monetary authorities include the National Monetary Council and the Treasury.

Besides bills of exchange and promissory notes, Brazil has another credit instrument, the *duplicata*, a copy of the invoice which the law considers as a bill of exchange.

The Brazilian monetary unit reflects the chronic inflation which for long has been in existence in Brazil. The monetary unit of colonial times, the real, which in 1822 bought the equivalent of one-tenth of a United States cent, was gradually replaced by the milreis, which was equivalent to 1,000 units of the former currency. Since 1942 the unit of money has been the cruzeiro, which is equal in value to the milreis. One milreis (or cruzeiro), worth about $1 in the 1820s, was worth about 5 cents in the mid-1940s, and since then has continued to fall to less than one-tenth of one cent. In February 1967 the "new cruzeiro" was made the currency unit, divided into 100 centavos and equal to 1,000 old cruzeiros. In January 1968 the official free-market rate of exchange was set at 3.20–3.22 new cruzeiros for the dollar. A complicated system of foreign exchange control has long been in force.

The fall of the value of Brazilian money in terms of foreign exchange is paralleled by the decline in its domestic purchasing power. Prices are on the rise virtually at all times. They increased about 13 times from 1840 to 1940. Between 1940 and 1945 they doubled, to double again by 1952, 1956, 1960, 1962, and 1964. Later a stabilization program was in effect, and the increase in prices was more moderate—40–50% in 1965 and 1966, and 25% in 1967.

4. National Finance.—There is usually a government deficit, facilitated by the federal treasury's monopoly of note issue. The federal government's share in total revenues, less than half of the total, is on a decline relative to that of the states. Local revenues, less than 10% of the total, are heavily concentrated among the state capitals, which receive over 40% of local government revenue although their population is only about one-tenth of the national total.

Among the federal taxes, excise and income taxes are the most important. Import duties have lost much of their former significance as sources of revenue. The most important state tax is a transaction tax, which falls due whenever goods change hands.

C. Transport and Communications

1. Roads.—One of Brazil's major problems of economic development is its inadequate transportation. Part of the lack of good inland transportation can be laid to the difficulty of climbing the Great Escarpment; but a part also is the result of a scarcity of domestic capital. The deficiency of other means of transportation has given considerable stimulation to highway construction. This development was accompanied by a substantial increase in the number of motor vehicles in use, of which there were over 2,000,000 in the late 1960s. Highway construction is financed with the help of a gasoline (petrol) tax.

The great bulk of the roads are unpaved, and many are in disrepair. Because of these conditions, the operating costs of the trucking (road haulage) industry are very high. This is important also from the viewpoint of Brazil's international financial position, because an estimated 70% of the operating costs of the trucking

(LEFT) HANS MANN, (ABOVE) DAVIS PRATT FROM RAPHO GUILLUMETTE

(LEFT) HOUSEBOATS CLUSTERED ON THE NEGRO RIVER OFFSHORE FROM MANAUS. (ABOVE) LOADING ICE ONTO FISHING BOATS DOCKED AT THE PORT OF BELÉM

industry requires foreign exchange to pay for gasoline, lubricating oil, spare parts, etc.

Inadequate railroad service has been responsible for the use of trucks for purposes which could more economically be served by railroad transportation, such as the movement of timber, cereals, and sugar, which not infrequently are shipped by truck over highways that run parallel with railroads, at double the expense.

2. Railways.—The large area of Brazil is served by a railroad network of only about 23,000 mi. This is distributed among some 40 lines, many of which are inadequately interconnected. There are more than three gauges. With only a few exceptions the lines are poorly built, badly maintained, and inefficiently operated. Routes often are tortuous, with many curves and steep grades. The equipment is old and poorly maintained, and over 50% of the locomotives are more than 30 years old. Many freight cars are of all-wooden construction.

Traffic density, while light in the northeast, is very high in the south of Brazil. The failure of the railroad system to expand with the growth of the Brazilian economy places it under a considerable strain. Approximately one-half of the railroads, with about 80% of the mileage, are owned by the federal government. The states, private companies, and mixed state and private organizations account for the rest.

3. Shipping.—Coastwise shipping is of great importance in Brazil, since it is the only means of communication for many regions. The total volume of freight thus carried is more than 9,000,000 tons per year. In terms of ton-miles of cargo, the Brazilian coastal fleet carries about as much as the railroads. There are two government-owned shipping companies, Lloyd Brasileiro and Companhia Nacional de Navegação Costeira, which together handle about 50% of all shipping operations. The remainder is distributed among one relatively large firm and a host of smaller companies. The government-owned concerns operate 86 ships of a total of 328, which includes many small vessels.

The hub of the coastwise shipping is Rio de Janeiro. Except for the Amazon, which is open to ships of all nations, Brazilian coastal commerce is restricted to Brazilian-owned ships, but numerous foreign shipping lines connect Brazil with the rest of the world.

The extensive Brazilian river system has a total navigability of about 27,000 mi. The inland waterways, especially the Amazon, São Francisco, and Jacuí rivers, provide important communication and shipping routes.

4. Air Transport.—Commercial aviation came to the fore during the 1940s and 1950s. During the same period, air freight, though still less than 1% of the ton-miles handled by the railroads, also increased. The lack of alternative facilities has led to the use of airplanes as carriers of some bulk commodities, including certain minerals. There are more than 1,000 airports in Brazil, but only a small number have paved runways or are large enough for four-engine planes.

5. Telecommunications.—There are radiotelephone connections between Rio de Janeiro, São Paulo, and Brasília and the major cities of North America, South America, and Europe. Submarine cables also link Brazil with countries of the Northern Hemisphere.

Television was introduced in 1950 in São Paulo. Seventeen years later there were 118 television stations in the larger cities, with an estimated 2,500,000 television receiving sets.

See also references under "Brazil" in the Index. (H. W. Sl.)

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BRAZING: *see* SOLDERING.

BRAZZA, PIERRE PAUL FRANÇOIS CAMILLE SAVORGNAN DE (originally BRAZZA SAVORGNANI) (1852–1905), French explorer and administrator and founder of the French Congo, was born near Rome, Jan. 26, 1852. He was educated in Paris, naturalized French (1874) and subsequently joined the French navy. When his ship was serving off the Gabon he was attracted to the possibility of exploring the Ogooué or Ogowé river which he thought might be the lower course of the Lualaba. This expedition began from the Gabon, Oct. 1875, penetrated beyond the Ogooué basin, discovered the Alima and Likona rivers and returned to the coast, Nov. 1878.

Brazza's intention was to obtain some of the Congo territory for France, but the French government decided that his activities should be directed to the Niger basin to compete with British interests which were then being forwarded by Sir George Goldie (then Goldie-Taubman). The expedition left for west Africa in late 1879, but at Lisbon was given instructions to proceed to the Congo instead. Brazza reached the Gabon in early 1880, traveled up the Ogooué, founding Franceville, and reached the Congo at Stanley pool, where Brazzaville was later founded. Treaties were made with the chiefs placing the country under French protection and Brazza then returned down the Congo meeting Stanley, who was traveling upstream making similar treaties. After further exploration in the hinterland of the Gabon he returned to France in June 1882 and in November his treaties were ratified. In 1883 he returned to the Congo with official financial backing to open up the colony and in 1886 was made commissioner general. He remained in this post until recalled in 1897. Brazza died at Dakar, Senegal, on Sept. 14, 1905. (R. M. P.)

BRAZZAVILLE, the principal town and capital of the People's Republic of the Congo and former capital of French Equatorial Africa, is situated on the right bank of the Congo below Stanley pool. Pop. (1962 est.) 135,632.

The town grew without plan; under French administration African quarters were Potopoto on the east and Bacongo on the west; European quarters comprised the Plateau, Chad, the Plain on marshy ground to the east and Aiglon, the most modern quarter, on the road to Maya-Maya airport. Brazzaville was founded in 1883 on the site of Ntamo, a village bought by France. The village was replaced by the Plateau, where the governor's palace, administrative offices and colonial-style residential quarters mingle with modern buildings of concrete mixed with the local violet-coloured sand; many shops replaced the former factories. Chad is a military quarter adjoining the Plateau. The Plain is the commercial quarter, and along the river extends the industrial area of M'Pila, with its machine shops, tanneries, and factories for building materials and matches. Aiglon, originally the home of the missions, has become a residential quarter and includes the new hospital. Bacongo and Potopoto contain the former African "concessions," in regular squares of 20 sq.m., separated by hedges and shaded by palm trees or multicoloured cassias; the huts are usually of mud or mud brick. Bacongo is the smaller and houses mainly the Balali (about 25,000), the aboriginals, who keep much to themselves. Potopoto contains groups of Africans of varied origin. The women cultivate the market gardens, and the men travel by truck to the workshops.

The river port forms the terminus of the Congo-Océan service (321 mi. [517 km.]). A motorboat service links it with Kinshasa (formerly Léopoldville) in the Democratic Republic of the Congo across the pool. (J. D.)

BREAD. The forms of bread vary throughout the world. In the United States and most Western countries, bread is a product resulting from the baking of a dough made from one of the cereal grains. In most instances, this dough has been fermented with yeast so that the carbon dioxide formed will be trapped in the dough to give a cellular, light product. In other varieties, however, bread may be an unleavened product, flat in nature and generally made from a cereal flour dough. Such a product may be made on a griddle rather than in an oven.

TYPES OF BREAD

The various breads are characterized by the cereal flour or flours employed, the processing method used, or the use of some ingredient in the dough to give the bread a unique characteristic. The dough of the usual enriched bread in the United States is baked in a pan to give the customary round-top loaf. If that dough is sliced lengthwise after it has risen in the pan, a split-top loaf of bread results. The character of the bread may be changed by additional ingredients, *e.g.,* raisins, eggs, whole milk, or butter. If the sugar and shortening levels are reduced and the dough is baked directly on the hearth rather than in a pan, any one of the numerous hearth breads can be produced, depending on how the dough is shaped.

In general, breads of the Old World are made from formulas that require one or more cereal flours, water, yeast, and salt. In the United States bread is generally produced from richer formulas containing also sugar, shortening, and milk solids. Salt-rising bread, a unique white bread, is produced in limited quantities by some retail bakers. No yeast is used in its manufacture, but leavening is accomplished by a bacterium that forms hydrogen and methane, causing the dough to rise. Sourdough bread is leavened with dough from the previous day's bake. Wild yeasts and acid-forming bacteria produce the typical sour flavor. This was the only method of bread production available to the isolated prospector of the American West, thus accounting for the name "sourdough" being applied to him.

Although the number of variations is nearly endless, each culture has tended to develop a characteristic bread. As cultures have intermingled, the favourite breads of different ethnic groups have provided a great variety.

In Germany, the U.S.S.R., and the Scandinavian countries, rye breads are predominant. Most of them contain some wheat flour, which provides a gluten to permit retention of gases and the production of a light product. True pumpernickel, which is a favourite in Germany, is a heavy dark bread produced from rye meal as the sole starchy ingredient. Favourite bread types in the Scandinavian countries, other than the moist, fresh-raised rye breads, are flatbreads ranging in thickness from about one-quarter inch to the thickness of heavy paper. These are dry breads that have excellent keeping qualities.

Japan is traditionally a rice-eating country, but after World War II the Japanese baking industry became an important part of the economy. Japanese products are similar to those produced in the United States and are made, for the most part, by U.S. breadmaking processes. Growth of the Japanese baking industry has created an important market for American wheat exports.

Tortillas, made chiefly from corn, are thin, flat cakes made on a griddle. A native food of Mexico and other Latin-American countries, tortillas have continued in popularity despite the influence of European settlers.

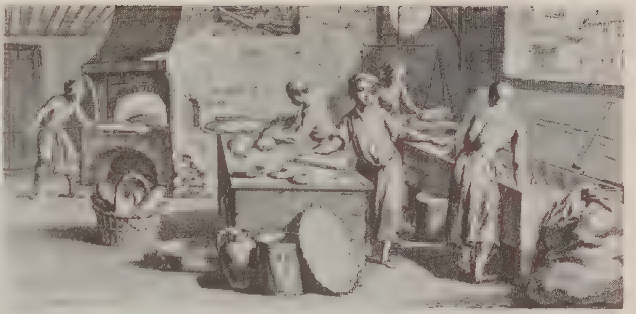
Breads of the Middle East and India, though yeast-leavened, are apt to be dry flatbreads. Armenian breads of this type are highly regarded in many U.S. restaurants. Although British rule greatly influenced the baking industry in India, *chapaties*, thin cakes made from rough ground wheat, are still a staple food in the villages. In India and other Asian and African countries, millet cakes are also favoured. Matzo is an unleavened bread related to the Jewish holiday of Passover.

In Ethiopia, two types of bread are popular. *Injerra* is a flat, leavened bread made of flour from *teff*, a high-protein-content grain grown only in that country. The second bread is made from the ensete, or "false banana." The ensete is ground, made into a dough, and "cured" in the earth, where it is also stored until needed.

The soda bread of Ireland contains no yeast but is leavened with baking soda and buttermilk. The carbon dioxide released from the baking soda reacting with the lactic acid in the buttermilk causes the bread to rise. Oatcakes and bannock (produced from either oats or barley) are favourites in Scotland.

History.—It is not known when seeds were first ground to form a rough meal that could be mixed with water to produce a crude bread. Rubbing stones dating back 75,000 years have been interpreted to mean that even then man had begun to grind seeds for food. If so, however, the resulting product must have been an unimportant food source, because the stones were not large enough to accommodate any quantity of meal. Not until about 12,000 years ago in the Azilian times in Europe did man produce rubbing stones and crude mortars sufficiently large to indicate that seeds had become an important part of man's diet. As long as 10,000 years ago, the Oak Grove Indians in southern California are known to have ground acorns and other seeds to produce a crude bread as food. Evidence indicates that at about the same time the Swiss Lake Dwellers had developed a primitive baking art. Swiss finds, dated about 2500 B.C., show that club wheat (a true bread wheat) was the predominant species.

Wheat and barley from which bread could be made were the first domesticated plants, occurring in the area bounded by the Zagros Mountains in Iran-Iraq, the Taurus Mountains in southern Turkey, and the Galilean Uplands of northern Palestine. The original wheats were wild emmer and einkorn, and later, through natural selection, emmer and einkorn. These wheats were not free-threshing and thus had to be parched so the glume could be removed. The earliest known village farming community at Jarmo, Iraq, dating back 9,000 years, yielded wheats of these species. Undoubtedly the first breads made from these ground seeds were flat cakes formed from the meal mixed with water. These cakes were either dried in the sun or cooked on a hot stone.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INTERIOR OF AN 18TH-CENTURY FRENCH BAKERY, LITHOGRAPH BY AN UNKNOWN ARTIST: 1763

Our first good picture of primitive baking has been derived from the tombs of ancient Egypt. Scenes from the 5th dynasty tomb of Ti, 2600 B.C., are frequently reproduced because they show the milling and breadmaking process from the removal of the grain from the granary through the grinding on saddle stones and sifting, to the mixing and kneading of the dough and subsequent baking of the bread in large pots. The Egyptians discovered the art of producing leavened bread, which led them to the development of the beehive oven so that bread could be thoroughly and uniformly baked. In the milling of flour, the use of sieves separated the whiter, finer flour from the coarser, darker meal. White bread was baked for the elite; the dark-meal bread was used by the lower classes.

The art of baking first became highly developed in early Greece, where unique ingredients were added to the dough to produce many types of bread. Athenaeus in his *Deipnosophistai* describes many different kinds of bread available in ancient Greece. Greeks taken captive by the Roman legions served as the slaves who perfected the baking art in ancient Rome.

Milling and baking were twin arts and were practised in the home. Commercial baking, begun in Rome, was made possible by the development of the hourglass mills, which permitted the production of sufficient flour to support a commercial effort. At about the time of the birth of Christ, Rome had one mill-bakery for every 2,000 inhabitants. One such Roman bakery subsequently became large enough to use 50,000 lb. of flour daily in its breadmaking—a sizeable establishment even by modern standards.

A food dole was first established in Rome in 123 B.C. Initially it consisted of free grain but, by the 4th century A.D., the dole was given in bread, soon leading to the nationalization of the baking industry. The role of the baker was so important that milling and baking equipment accompanied the Roman legions on their campaigns of conquest. Emperor Trajan, in the 2nd century A.D., organized a "College of Pistors" which bound the bakers to their work and established their duties and privileges, leading to a system of industrial serfdom.

The advent of water mills and, later, windmills led to the formation of two distinct crafts, and by A.D. 1000, in most places, bakers and millers were completely separated. There is evidence that a guild of bakers was formed in London in 1155 and received a charter in 1307. Guilds closely controlled competition and the training of young men who entered the craft. The guilds set prices and wages and worked closely with city governments, which occasionally passed laws for the regulation of the baker's guilds.

Yeast, in the form of the froth of beer, was introduced in Italy toward the end of the 16th century, though as early as the

1st century A.D. Pliny had written that the Gauls and Spaniards used the froth of beer to produce bread that was lighter than that produced by the usual leaven. Until the establishment of a bakers'-yeast industry, and even afterward, barm procured from the brewer served both the baker and the housewife.

Early commercial ovens were made from brick and mortar. The floor of the oven was known as the hearth, and on this surface the fire was built. When the oven had reached a sufficiently high temperature, the coals were raked out, the oven floor was swabbed, and then the bread was placed directly on the hearth through the use of long-handled wooden paddles called peels.

The first mechanical oven was invented by Vice Admiral Isaac Coffin in 1810 to satisfy the baking needs of the British Navy. That oven was a precursor of today's band ovens but was so inefficient in its use of fuel that such mechanical ovens did not attain wide usage until the beginning of the 20th century.

BREAD MANUFACTURE

The principles of breadmaking have changed little since the Egyptians discovered how to make leavened bread. Many refinements, however, have been introduced because of the development of industries that furnish the necessary raw materials and equipment. The development of new milling techniques in the early 19th century provided a more highly refined flour of uniform baking quality. The development of pure strains of yeast, made available in compressed form to the housewife and the baker, offered a dependable source of leavening. Additional ingredients, *e.g.*, sugar, shortening, and milk, became part of the bread formula. These advantages, provided originally only in centres of population, were utilized even in the most remote places in the second half of the 20th century. Viable dry yeast, which requires no refrigeration; flour packaged in multiwall paper bags; milk solids in dry form; and shortening of high stability permit the production of fine bread all over the world.

The production of good bread starts with the mixing of the dough. Unlike many mixing operations, whose only function is to distribute the ingredients evenly, dough mixing has the additional function of development of the gluten so that the dough will have the proper degree of elasticity and extensibility. Only flour from wheat contains the proteins that will form such an extensible and elastic gluten. Thus, only flour from wheat will provide a well-risen loaf of bread. Hand mixing of doughs, even in commercial bakeries, was the common practice until the 20th century, although scenes from the tomb of M. Vergilius Eurysaces, a miller-baker of ancient Rome, show that he employed a dough-kneading machine driven by an ass. Electricity has permitted the development of many unique systems of dough making that have eliminated the drudgery of hand mixing and kneading.

After the dough has been mixed it must be fermented before it is divided and made up into individual loaves. The activity of the yeast cell responsible for fermentation is greatly influenced by the temperature of its environment. During the early history of the baking industry there was no way to accurately control the temperature of fermentation and only a fine craftsman could judge when a dough was ready for makeup so that quality bread would result. Modern temperature controls permit standardized fermentation periods so that production can be maintained at a uniform rate over the entire production day. One of the greatest advances in the art of baking has been the development of ovens whose temperature can be controlled and whose capacity can be made great enough to accommodate the dough pieces mass-produced by the modern mechanical equipment.

Perhaps the greatest reason for the growth of the baking industry has been the housewives' revolt—against the drudgery of mixing and kneading doughs, the uncertainty of the fermentation because of variable temperature in the home, and, until recent times, the vagaries of the home oven which lacked temperature control. In those parts of the world where home baking still is common, more time is spent on the preparation of bread than on any other food.

Commercial Baking.—More than 90% of the bread consumed in the United States is produced in highly mechanized wholesale bakeries. Most of the remainder of the bread consumed is produced by the retail baker in small batches. Although the retail baker has mechanical mixing and well-controlled ovens, he still depends largely upon hand makeup and the manual skills of craftsmen.

In a modern wholesale bakery, bulk handling of the ingredients is common practice. Flour is delivered to the bakery in specially designed railroad cars or trucks that are unloaded into bins or silos in the bakery with pneumatic flour-handling equipment. Shortening is delivered in tank cars, then melted and pumped to storage tanks where it is kept liquid through controlled elevated temperature. Yeast is delivered twice a week either in compressed cakes of one pound or more in weight or in granules packaged in plastic bags. This yeast is stored under refrigeration until used. Sugar may be purchased in dry form in multiwall paper bags or handled in bulk in the form of a syrup. Corn syrups and dextrose made from corn are more commonly used in bread production than is sugar made from cane or beet. The minor ingredients, such as salt, are purchased packaged. Packaged ingredients are palletized and handled with lift trucks or are transferred from unloading docks to storage areas by conveyors.

Bread may be produced either by batch process or by a continuous-mixing process. In either method the formula for white enriched bread will require: for each 100 lb. of flour, about 60–65 lb. of water, 2¾ lb. of yeast, 2 lb. of salt, 6–7 lb. of sugar, 3–4 lb. of nonfat dry milk or a milk substitute consisting of soya flour and dry whey, 3 lb. of shortening, 1 enrichment wafer, and 6 oz. of yeast food. The yeast food is a mixture of calcium salt to harden the water, an ammonium salt to serve as a ready source of nitrogen for the yeast, and an oxidizing agent such as potassium bromate to improve the gluten structure of the dough.

Batch Process.—In the production of a single dough, as much as 1,200 lb. of flour may be used. The batch process consists of mixing a sponge, fermentation of the sponge, and subsequent mixing of the fermented sponge with the remainder of the ingredients to form the dough. The sponge consists of 60–70% of the flour and water, all of the yeast, yeast food, and the enrichment factors. The flour is conveyed pneumatically to a weighing hopper above the mixer where it is automatically scaled to the desired weight. Water of the proper temperature is metered directly into the mixer. The yeast, the yeast food, and the enrichment factors are suspended in a measured quantity of water and added by hand on top of the flour. The sponge is mixed to uniformly incorporate all of its ingredients. The resulting sponge is ejected into a greased metal trough and is then conveyed to a temperature- and humidity-controlled fermentation room where it is permitted to ferment for about four hours.

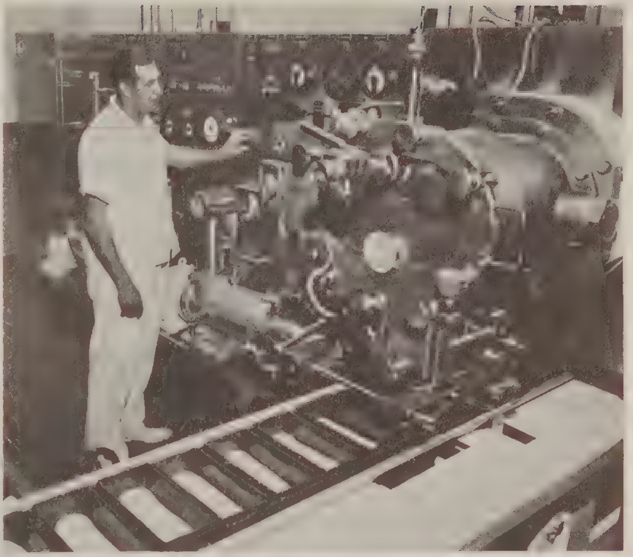
During fermentation the elaborate enzyme system of the yeast converts the maltose of the flour into carbon dioxide and alcohol. Diastatic enzymes in the flour split some of the starch to maltose, thus assuring a constant supply of this food for the yeast. Other substances are formed by yeast action that mellow the dough and contribute to the characteristic flavour of bread. The carbon dioxide causes the sponge to rise and, later in the breadmaking process, is responsible for the rising of the dough in the pan.

After the sponge is fermented it is conveyed back to the mixing room. A hoist lifts the trough and dumps the sponge into the mixer. The remainder of the flour is scaled on top; the proper amounts of water, sugar syrup, and shortening are metered into the mixer, and the remainder of the minor ingredients, which have been hand scaled, are added manually. The dough is then mixed, care being used in this mixing to get proper gluten development. Since heat is generated due to the friction of mixing and it is desired that the dough have a temperature of 80° F (26.7° C) when mixed, the walls of the mixer contain cooling coils to remove the heat of friction. The dough is then ejected into the trough, is permitted to stand for 20–30 min., and is sent to the divider. Here again, a hoist raises the dough trough and dumps the dough into the hopper of the divider, which mechanically divides the large dough mass into pieces of the proper weight for each loaf. Dough pieces for a one-pound loaf weigh about 17½ oz. to allow for the moisture lost during the baking process. From the divider, the dough pieces are conveyed continuously to the rounder which molds the dough pieces into balls. The rounder consists of a spinning cone, which spins the dough piece against a pressure track, thus giving it its round form. The rounded dough pieces are conveyed to the intermediate proofer, a temperature-controlled cabinet through which the dough pieces are conveyed in canvas-covered trays. The short ride through the proofer provides additional fermentation to give the dough piece the relaxation required so that it can be molded into a loaf. Each dough piece drops from the proofer into the molder, where it passes between a series of rolls that form it into a flat sheet which then is curled up automatically into a roll. The formed dough pieces are panned automatically and the panned dough is conveyed through the proof box. The proof box is a temperature- and humidity-controlled chamber where a temperature in excess of 90° F (32.2° C) stimulates the yeast action so that the dough rises in the pan before it is sent to the oven. The risen dough emerges from the proof box directly into a traveling oven, where it is conveyed through the baking chamber to the far end. The temperature is purposely varied from one section of this chamber to another, the average temperature in the oven being approximately 450° F (232° C). The baked loaves exit from the far end and are automatically depanned onto a belt conveying the bread to the cooler. The cooler employs the countercurrent principle, with cool filtered air being forced in the direction opposite to the flow of the hot bread. After passing through the cooler, the bread is conveyed to the slicer and either wrapped or bagged automatically. The wrapped loaves are packed in cartons or trays so that they can be loaded on trucks for distribution.

Continuous Mixing.—Rising labour costs and the desire for increased efficiency forced industry in general to adopt continuous-processing methods wherever possible, and the baking industry is no exception. In the late 1960s it was estimated that about 40% of the bread produced in the United States was produced by a continuous-mixing process in which the liquid component and the dry components flow continuously into and through a mixer. Flow is automatically controlled by weight so that proper proportions are maintained at all times. Except for the materials-handling equipment, the proof box, the oven, and the equipment following the oven, the continuous-mixing process employs none of the conventional equipment employed in bakeries using batch mixing. Continuous dough mixing eliminates the divider, the rounder, the intermediate proofer, and the molder, and, therefore, the labour required to tend these pieces of equipment.

The liquid component contains all of the water, sugar, milk substitute, yeast, salt, and yeast food, and may or may not contain a substantial amount of the flour—though after the introduction of this system to the baking industry most bakers felt there was great advantage in incorporating flour in this fermenting "broth" at levels up to 60% of the total flour used. After about two and one-half hours of fermentation, the broth is pumped continuously along with flour, the melted shortening, and a solution of oxidizing agent consisting of potassium bromate and potassium iodate or azodicarbonamide to a premixer. The premixer makes a rough dough from these components, which is pumped into a developing head. The developer consists of an impeller, which rotates rapidly within a casing to form the dough of proper development. The dough is extruded from the developing head in a ribbon that is cut automatically into pieces of the proper weight. The pieces drop into the pans and are conveyed through the proof box. Although this method of breadmaking had been introduced into several countries, by the late 1960s most countries except the United States and Canada had abandoned it.

Bread Staling.—Dry, crisp breads retain their palatability and freshness for long periods of time. The moist breads, such as French bread and the enriched white bread of the United States, stale rapidly. French bread loses most of its palatability within about six hours out of the oven. Enriched pan bread is almost completely stale four or five days out of the oven. At least two important changes occur in bread to account for its staling. One is the migration of moisture from the crumb of the bread to the crust. In freshly baked bread the moisture content of its crumb is about the same as that of the dough from which the bread was made, while its crust will contain only 8–9% moisture. As bread stales, the moisture of the crumb decreases while that of the crust increases even though the package is moistureproof. The reason hearth breads, such as French bread, stale faster than pan bread is because hearth breads carry a greater proportion of crust and thus moisture transfer takes place more rapidly. The other important part of bread staling is the retrogradation of the starch in the crumb of the bread. After baking, the starch slowly crystallizes and this crystallized (retrograded) starch causes the crumb of the bread to harden. The movement of the water from the crumb to the crust causes the crumb to become harsh and dry. Staling of bread can be reversed by moistening the crust and placing the bread in a hot oven until the crust has become dry and crisp. This method of refreshening, of course, can be used only within intact loaves or with sliced bread whose slices are held in place by a heat-stable overwrap.



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PANS OF AUTOMATICALLY CUT DOUGH COMING FROM A DOUGH DEVELOPER

Freezing of bread and its storage at 0° F (−17.8° C) or below prevents the staling process. The marketing of frozen bakery products represents a great advance in that it assures the customer a strictly fresh product at the time of purchase. Because of the low profit margin afforded by bread and the cost of the freezing process, however, only a limited amount of premium breads is marketed in this fashion.

Regulations and Standards.—The commercial manufacturer of bread has been subject to some regulation since the days of ancient Rome, when bakers were required to meet certain standards of weight and quality. Sanitation has received much attention since the first Bakehouse Regulation Act of 1863 in the United Kingdom.

In the United States there are federal and state regulations covering food processing applicable to the baking industry. These regulations are aimed not only at sanitation but at practices that might tend to defraud the consumer. An important part of the federal and most state regulations is a provision for the development of standards of identity for various food items. Federal standards of identity for bread were promulgated in 1952 after extensive public hearings. These standards of identity cover white bread, enriched bread, milk bread, raisin bread, and whole wheat bread, and their counterparts in rolls and buns. The standards prescribe the ingredients that must be used to produce these breads and also list optional ingredients the baker may employ at his own discretion. Bread is defined as being made by baking a kneaded dough consisting of flour, water, yeast, and salt. The standards of identity also permit as optional ingredients about a hundred food materials and additives.

No bread is produced containing all the optional ingredients; but one or more of them may be used to change the character of the loaf, to compensate for some deficiency in the flour, or to make it easier to produce bread of uniform quality. Nonfat dry milk or any one of several other milk derivatives is commonly employed as an optional ingredient in the production of enriched bread. Diastatically active malt syrup or enzymes derived from other prescribed sources are frequently used to compensate for a deficiency in the enzyme content of the flour. Calcium propionate is almost universally used to inhibit the growth of molds during the summer months. Yeast food contains three of the optional additives: calcium sulfate, ammonium sulfate, and potassium bromate. As is true of all food additives, none is permitted until evidence of safety has been established.

Certain states automatically adopt the federal standards of identity for foods so that bread made in those states, even though not sold outside the state, must comply with the federal standards. A few states have designed their own standards of identity, differing in minor details from the federal standards. Many states have weight laws for bread. Thus in one state it may be possible to sell bread in 8-oz., 1-lb., 1¼-lb., 1½-lb., and multiples of pound units while in an adjacent state the law may specify 1-lb., 1½-lb., and multiples of pound units. Weight laws have been developed to protect those who do not read labels and thus make it impossible in those states where weight laws exist for a baker to sell a loaf that appears to be a pound loaf but weighs only 14 oz. —even though the label clearly states that the product's net weight is 14 oz.

Ninety-two percent of the white bread sold in the United States is white enriched bread. Standards of identity for enriched bread differ from the white bread standards only in that they prescribe minimum and maximum levels of certain nutrients which must or may be furnished by the bread. Enriched bread can be produced through the use of enriched flour as the sole farinaceous material or it may be produced from unenriched flour, in which case the baker adds the proper amount of thiamine, riboflavin, niacin, and iron during the processing of the bread. Enriched flour and enriched bread contain the following amounts of the required nutrients per pound:

	thiamine	riboflavin	niacin	iron
White flour	2.0–2.5 mg.	1.2–1.5 mg.	16–20 mg.	13–16.5 mg.
Bread	1.1–1.8 mg.	0.7–1.6 mg.	10–15 mg.	8–12.5 mg.

Enriched flour and enriched bread may contain as optional nutrients the following:

	calcium	vitamin D
White flour	500–1,500 mg.	250–1,000 U.S.P. units
Bread	300– 800 mg.	150– 750 U.S.P. units

In the late 1960s 30 states had laws requiring the enrichment of all white bread, rolls, and buns. Even in the other 20 states, however, most of the white bread, rolls, and buns were enriched because of the value of enrichment to public health.

Nutrition.—Bread continues to be an important part of the diet from the standpoint of the nutrients furnished. Eight ounces of bread furnishes 55% of the thiamine, 30% of the riboflavin, 50% of the niacin, and 40% of the iron required daily by an adult. The nutrient contributions of some breads are listed below. The protein quality of bread has been subject to criticism because when bread is fed as the sole article of diet to young weanling rats, growth response is poor. The addition of 0.25% lysine markedly improves the growth responses of experimental animals. It has been demonstrated through human feeding studies, however, that when bread is the sole source of protein in the diet, nitrogen balances are maintained by the adult over the entire length of such studies. It has also been demonstrated that diets containing mainly bread and only nominal quantities of high quality protein foods support excellent growth and good health in children 5–15 years of age. These studies also tend to disprove the concept that whole wheat bread is more nutritious in the mixed diet than bread made from refined flour.

Emphasis, however, is being directed toward further improvement of nutritional value of bread in at least two ways. Bread is being considered as a carrier for additional iron because of the high incidence of iron-deficiency anemia among females of childbearing age. It has been established that increasing the iron content of bread poses no production problem nor does it adversely affect the acceptability of the product. There is also an effort to improve the nutritional value of bread for low income groups who, because of lack of purchasing power, must obtain most of their nutrients from the more economical cereal foods. Bread made with a mixture of 70% straight-grade white flour and 30% purified mill-run middlings, which are recovered in the conversion of wheat to white flour, has high nutritional value. Its protein content and quality is equivalent to that of a bread made with 12% nonfat dry milk, and because of the high concentration of the B vitamins and vitamin E in the straight-grade middlings, such bread has a vitamin content even higher than that of enriched bread.

In the United Kingdom all white flour sold must be enriched; but, in this instance, the white flour is enriched at levels far lower than those used in the United States, and therefore it and the bread made from it are not nutritionally equal to the enriched flour and bread of the United States. In the Scandinavian countries, enrichment of white flour similar to that of the United States is required by law. Niacin is not a required nutrient in enriched flour in those countries but calcium is, and the riboflavin content of enriched flour in the Scandinavian countries is about twice the level required in the U.S. Nutritionists in general have attempted to encourage the enrichment of cereal foods including bread and flour in developing nations where the increased distribution of these nutrients is urgently needed. Cereal foods used in the U.S. Agency for International Development (AID) program are all enriched products.

Economic Aspects.—In general, in the more prosperous countries of the world, increased consumer spending power has resulted in decreased per capita consumption of low-cost bread items in favour of the more costly foods of animal origin. In dollar value of products shipped, the baking industry in the United States ranks third among food industries. Its employment is highest among the food industries and eighth among the major industries of the country. The annual wholesale value of its products in the late 1960s was estimated at $7,500,000,000, about half of which represented bread, rolls, and buns.

Composition of Some Breads—Edible Portion (100 grams)

Food and description	Water (%)	Food energy (cal.)	Protein (g.)	Fat (g.)	Carbohydrate		Ash (g.)	Calcium (mg.)	Phosphorus (mg.)	Iron (mg.)	Sodium (mg.)	Potassium (mg.)	Vitamin A value (I.U.)*	Thiamine (mg.)	Riboflavin (mg.)	Niacin (mg.)	Ascorbic acid (mg.)
					Total (g.)	Fibre (g.)											
French or Vienna, Enriched	30.6	290	9.1	3.0	55.4	0.2	1.9	43	85	2.2	580	90	trace	0.28	0.22	2.5	trace
Raisin	35.3	262	6.6	2.8	53.6	0.9	1.7	71	87	1.3	365	233	trace	0.05	0.09	0.7	trace
Rye																	
American (⅓ rye, ⅔ clear flour)	35.5	243	9.1	1.1	52.1	0.4	2.2	75	147	1.6	557	145	(0)	0.18	0.07	1.4	(0)
Pumpernickel	34.0	246	9.1	1.2	53.1	1.1	2.6	84	229	2.4	569	454	(0)	0.23	0.14	1.2	(0)
White Enriched, made with 3–4% nonfat dry milk	35.6	270	8.7	3.2	50.5	0.2	2.0	84	97	2.5	507	105	trace	0.25	0.21	2.4	trace
Whole wheat, made with 2% nonfat dry milk	36.4	243	10.5	3.0	47.7	1.6	2.4	99	228	2.3	527	273	trace	0.26	0.12	2.8	trace
Corn bread (degermed cornmeal, enriched)	50.2	224	7.1	6.0	34.7	0.2	2.0	109	156	1.4	591	157	150	0.17	0.24	1.1	1

*International Units.
Source: Bernice K. Watt *et al.*, "Composition of Foods—Raw, Processed, Prepared," *Agriculture Handbook No. 8*, U.S. Department of Agriculture, (rev. Dec. 1963).

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BREADALBANE, JOHN CAMPBELL, 1ST EARL OF (*c.* 1635–1717), Scottish politician, chiefly remembered for his alleged complicity in the "massacre of Glencoe," was the son of Sir John Campbell of Glenorchy, Bart. (d. 1686), and of Mary Graham, daughter of William, earl of Airth and Menteith. He took part in the royalist rising under the earl of Glencairn in 1654, and was one of those who urged George Monck to declare a free parliament to facilitate the Restoration. As principal creditor of the 6th earl of Caithness (d. 1676), he obtained a conveyance of that earl's dignities, lands and heritable jurisdictions in Oct. 1672; he was created earl of Caithness and viscount of Breadalbane on June 28, 1677. He had married in 1657 the daughter of the 1st earl of Holland, Mary Rich, with a dowry of £10,000. She died in 1666, and by marrying in 1678 Mary, widow of the earl of Caithness, he saved the alimentary provision which he had undertaken to pay. He invaded Caithness in 1680 and dispossessed the earl's male heir, but the latter was later confirmed in his lands and titles, whereupon Campbell obtained a new patent (Aug. 13, 1681) as earl of Breadalbane and Holland, viscount of Tay and Paintland, Lord Glenorchy, Benederaloch, Ormelie and Weick, with special power to nominate his successor from among the sons of his first wife.

Breadalbane, who had sat in the Scottish parliament under Charles II and had supported the administration of the duke of Lauderdale by sending 1,700 Highlanders to overawe the disaffected southwest in 1678, became a member of the Scottish privy council in 1685. He was described as having "neither honour nor religion but where they are mixed with interest" and as "of the gravity of a Spaniard, cunning as a fox, wise as a serpent but as slippery as an eel." To gain the support in the Highlands of a man of such qualities, possessed of wide estates and related by marriage to several leading families, was of high moment to William III. Breadalbane did not commit himself to Lord Dundee, or join his rising, and after the battle of Killiecrankie (July 1689) he was entrusted by the government to offer a large sum of money to secure the submission of the clans. On June 30, 1691, he met the Jacobite chiefs and prevailed on them to agree to an armistice until October: not, however (so it was alleged), by expending the money but by holding out the hope that he might later join them. When asked to render an account, he is said to have replied, "The money is spent, the Highlands are quiet, and this is the only way of accounting between friends." On Aug. 27, 1691, indemnity was offered to all taking the oath of allegiance before Jan. 1, 1692, while all refusing were threatened with the penalties of treason. MacIan, the chief of the MacDonalds of Glencoe, postponed his submission till Dec. 31 and was prevented from taking the oath till Jan. 6, 1692, through the absence of a magistrate at Fort William. Subsequently, in the "massacre of Glencoe" (Feb. 13, 1692), a number of the MacDonalds were butchered in cold blood by troops to whom they had given hospitality. Opinion was strong against Breadalbane, who may well have welcomed the opportunity of destroying a clan which had for generations lived by plundering his lands and those of his neighbours, but although he was aware that violent action was planned it is less likely that he was personally involved in organizing the massacre. No real evidence against him was disclosed, and his imprisonment (Sept. 1695) was on the ground of his earlier dealings with the Jacobite chiefs. He was released when William III announced that he had acted with royal approval.

Breadalbane did not vote for the union of England and Scotland in 1707, but was a representative peer in the parliament of Great Britain (1713–15). He maintained his contacts with the Jacobites, whom he encouraged in 1708, without, however, committing himself on paper. At the time of the Jacobite rising in 1715 he excused himself (Sept. 19) from obeying a summons to Edinburgh on the ground of his age and infirmities; but the next day he visited the earl of Mar's camp at Logierait and afterward the camp at Perth, his real business being, according to the master of Sinclair, "to trick others, not to be trickt," and to obtain a share of French subsidies. He is said to have promised and taken money for 1,200 men in the Jacobite cause, but he sent only 300 or 400, who acquitted themselves well at Sheriffmuir (1715) but were withdrawn after that battle. Breadalbane's son was imprisoned, but he himself escaped any punishment for his part in the rising because of his age. He died on March 19, 1717.

See William A. Gillies, *In Famed Breadalbane* (1938). (GN. D.)

BREADFRUIT. The staple food of the South Pacific, cultivated less commonly in other parts of the tropics, is the fruit of *Artocarpus altilis*, a tree of the family Moraceae.

The tree is extremely handsome. It reaches a height of 40 to 60 ft., and has large, oval, glossy green leaves entire toward the base and three- to nine-lobed toward the apex. Male and female flowers are borne in separate inflorescences on the same tree: the staminate or male ones appear in dense, club-shaped catkins; the female or pistillate, which are very numerous, are grouped together and form a large prickly head upon a spongy receptacle. The ripe fruit, which is composed of the matured ovaries of these pistillate flowers, is roundish, commonly four to eight inches in diameter, greenish to brownish-green externally, with white and somewhat fibrous pulp.

There are two distinct forms of breadfruit, one seedless, the other (sometimes known as breadnut) containing many seeds resembling chestnuts.

The seedless form is the most valuable and the one usually grown. It has been cultivated in the Malay archipelago (where the species is held to be indigenous) since remote antiquity. From this region it spread throughout the tropical South Pacific region in prehistoric times. Its introduction into the new world is connected with the memorable voyage of Capt. William Bligh in H.M.S. "Bounty," a voyage recommended by Capt. James Cook, who had seen the breadfruit in the Pacific islands and considered that it would prove highly useful as a foodstuff for Negro slaves in the West Indies.

After the failure of this voyage, a second was carried out which resulted in the successful establishment of the tree in Jamaica, where, however, it failed to live up to expectations, because the Negroes preferred bananas and plantains.

The breadfruit is not a fruit in the popular sense of the term, but a product containing considerable amounts of starch. It is rarely eaten raw. Methods of preparation for the table vary. It can be boiled or baked and served with salt, butter, gravy, or sirup; sliced and fried like potatoes; the seeds can be boiled or roasted, tasting a great deal like chestnuts.

In the West Indies and on the American mainland from Mexico to Brazil the breadfruit tree is grown in dooryards and the fruit appears upon the market. Propagation of the seedless forms is by means of root suckers or root cuttings.

Numerous varieties are cultivated in the Pacific islands, but these are not known in tropical America. The tree withstands no frost and has not been successful even in the southernmost parts of Florida.

In the South seas, cloth is made from its fibrous inner bark; the wood is used for canoes and furniture; and a glue and calking material are obtained from the viscid milky juice which exudes from incisions in the trunk.

See W. Popenoe, *Manual of Tropical and Subtropical Fruits* (1920); J. H. Julien, "Breadfruit Propagation," *Rev. Agr. Maurice* 24:31 (1945). (W. Po.)

BREADNER, LLOYD SAMUEL (1894–1952), Canadian air force officer and, during World War II, air officer commanding the Royal Canadian Air Force (R.C.A.F.) overseas, was born on

July 14, 1894, at Carleton Place, Ont., and was educated at the Collegiate institute in Ottawa. He had a distinguished record in World War I, becoming a flight sublieutenant in the royal naval air service in 1915. He later transferred to the royal naval air force, and by Nov. 1918 had attained the rank of major (equivalent to the later rank of squadron leader). From 1920 Breadner was associated with the R.C.A.F. In 1922 he became director of civil aviation and had much to do with shaping civilian and commercial flying in Canada between World Wars I and II. From 1928 onward Breadner was drawn into military aviation, serving as acting director of the R.C.A.F. until 1932. In 1936 he became air staff officer at National Defense headquarters and in 1940 was made air vice-marshal and chief of air staff. He became air marshal in 1941 and on Nov. 11, 1943, was named air officer commanding the R.C.A.F. overseas. He was created a companion of the Order of the Bath in 1943. In 1945 Breadner retired as air officer commander in chief of the R.C.A.F. and was advanced to air chief marshal, the first to hold that rank in the R.C.A.F. He died in Boston, Mass., on March 14, 1952. (J. I. C.)

BREAKWATER, a barrier constructed for the purpose of providing protection from waves. Breakwaters are used to create harbours on open coasts, to provide supplementary protection for natural harbour areas, to reduce wave action and sedimentation at inlets to navigable waterways and to prevent shore erosion. The term breakwater is usually reserved for offshore structures which may or may not be connected to the shore line at one end. Breakwaters built perpendicular to the shore line for the purpose of protecting an inlet are called jetties. Shorter structures of the same type, often used to prevent shore erosion, are known as groins. Barriers built parallel to the shore line and in contact with it are called sea walls or bulkheads. The size, shape and method of construction of a breakwater depend upon the depth of the water, the severity of the local wave forces, the availability of the various types of construction materials, the use for which it is being constructed and the nature of the foundation conditions. The presence of a breakwater affects the shore processes, and care must be exercised in planning its size, location and orientation. The most effective location and orientation of a breakwater at any site is determined by means of an engineering analysis of the physiographic features and the characteristics of the waves and currents at the proposed location. In most cases the best solution can be determined only by the construction and study of a model. The various factors that must be considered in planning and designing breakwaters are presented under the following topics: *Waves; Shore Processes; Types of Breakwaters; Harbours;* and *Wave Forces.*

Waves.—By far the major portion of the water waves which attack shore and harbour areas are those generated by the wind. Wind-generated waves may continue their violent, periodic pounding for hours or even days. As the waves approach the shore their energy must be reflected or dissipated or the resultant powerful forces and high water velocities may seriously damage unprotected vessels or shore structures. Breakwaters are designed to withstand such violent conditions.

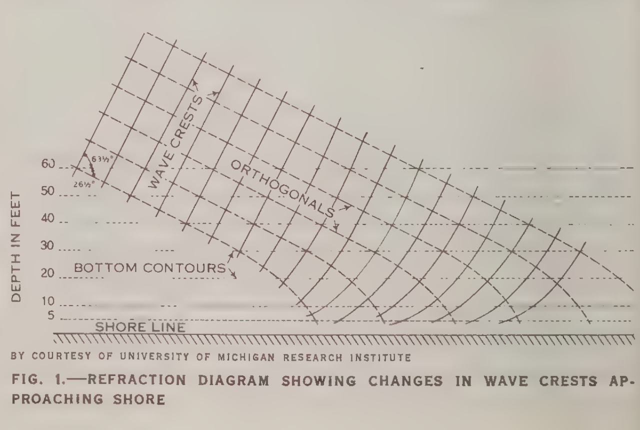
Waves may also be generated by a sudden change in barometric pressure over a limited area of water surface or by an underwater seismic or volcanic disturbance. The latter are called seismic waves or tsunamis and are often mistakenly referred to as tidal waves. Barometric pressure changes or seismic disturbances usually create only a small number of relatively low waves. Damage resulting from such waves is primarily due to the fact that they often arrive without warning and quickly inundate low-lying coastal areas.

The distinguishing characteristics of a wave are its height (the vertical distance from a trough to a crest), its length (the horizontal distance between successive crests) and its period (the time between the arrival of successive crests at a fixed point). These characteristics are determined by the velocity of the wind, the length of time that the wind continues at this velocity (duration of the wind) and the distance over which the wind is in contact with the water (fetch). In general, the greater the velocity and duration of the wind and the larger the fetch, the greater will be the height and period of the waves. Wind-generated waves are called oscillatory waves because the water particles oscillate in nearly circular or elliptical paths, only the wave form moving forward. This motion of the water is similar to the wave motion produced in a rope when one end is fastened and the other end is moved rapidly up and down. The wave velocity is the rate at which the wave form moves forward and may be found by dividing the wave length by the wave period. The actual velocity at which particles of water move in their circular or elliptical orbits is much less than the wave velocity.

As waves enter shallow water the wave length decreases while the wave height first decreases and later increases. The relative decrease in wave length is greater than the change in height, with the result that the water surfaces on either side of the crests become much steeper as the waves approach the shore. This change begins when waves reach depths less than half the wave length and culminates in a breaking wave at the location where the depth is approximately equal to the wave height. Upon breaking, the waves lose their oscillatory characteristics and become waves of translation or surges. In surge-type waves, the volume of water in the wave moves forward at the wave velocity, which may be very high. Breakwaters located at the point of breaking are subject to the full impact of this uprushing mass of water.

In addition to the change in shape undergone by waves as they enter shallow water, previously described, waves approaching the shore at an angle have their crests bent into a curve which tends to make the waves more nearly parallel to the bottom contours and shore line when they enter the breaker zone. This effect, called refraction, is caused by the fact that the wave velocity is smaller in shallow water. Therefore, that portion of a wave which reaches shallow water first slows down and permits the portion still in deeper water to catch up to some extent. This is illustrated by the refraction diagram shown in fig. 1. The orthogonal lines, shown in the figure, are lines which are perpendicular to wave crests. When waves approach a bay formed by two points of land, refraction causes the waves to turn toward the two points and away from the centre of the bay. As a result wave heights and wave energy are high at the points and low in the bay area. Thus currents are generated which flow along the shore (littoral currents) from each point toward the centre of the bay and thence outward toward deep water. Such outward currents are called rip currents and in many cases are the ones commonly referred to as undertow. When waves encounter a breakwater or headland, that portion of the wave which passes the end of the breakwater or headland bends and directs some of its energy into the quiet water in the sheltered area. This effect is called diffraction. Waves entering a harbour entrance diffract some energy into the lee of both of the breakwaters forming the harbour.

Waves generated in storm areas may travel thousands of miles across the oceans, gaining energy from favourable secondary fetches or losing energy in regions of calm or opposing winds. An expanse of relatively calm water through which waves pass is known as a region of decay. In general, an important characteristic of wave decay is an increase in wave period, hence in length. The wind-generated waves in the ocean are divided for convenience



BY COURTESY OF UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE

FIG. 1.—REFRACTION DIAGRAM SHOWING CHANGES IN WAVE CRESTS APPROACHING SHORE

into three categories: sea, swell and surf. The term sea refers to waves under the direct influence of generating winds; swell, to waves which have left the generating area and are subject to decay in regions of weak winds or calms; the breakers which result from waves moving into shallow water comprise surf.

Waves have been found to obtain a maximum height measured from trough to crest of about 20 ft. in the Mediterranean and in the Great Lakes of North America, 25 ft. in the Bay of Biscay and 40 ft. in the Atlantic ocean; waves of 50 to 60 ft. in height are said to have been observed in the South Atlantic ocean off the Cape of Good Hope where the expanse of sea reaches a maximum. The length of large waves bears no definite relation to their height. The length of storm waves in the Atlantic seldom exceeds 600 ft., while waves from 600 to 1,000 ft. long are regarded as of common occurrence in the Pacific ocean during storms. The large waves observed in mid-ocean do not, however, reach the coast, because their progress is checked and their height and length are reduced by encountering the shelving sea bottom on approaching the shore. Where outlying sandbanks stretch in front of a coast, large waves cannot approach the land, for they break on the sandbanks outside. Waves always break when, on running up a shoaling beach, they reach a depth of water approximately equal to their height; and the largest waves which can reach a shore protected by intervening sandbanks are those which are low enough to pass over the banks without breaking. Waves often break in depths of water greater than their own height, and any sudden change in the level of the sea bed over which a wave is traveling may bring about its disruption even in water of considerable depth. The height and consequently the destructive force of waves are increased on running up a funnel-shaped bay by the increasing concentration of the waves in the narrowing width. This effect is intensified when the bay faces the direction of the strongest winds.

The velocity of wave travel depends upon the wave length. For waves of 600-ft. length the wave velocity in deep water is about 33 knots, and for a 1,000-ft. wave the velocity is about 43 knots. Waves generated by earthquakes (tsunamis), have been recorded as traveling at the rate of 430 knots. (*See* also WAVES OF THE SEA.)

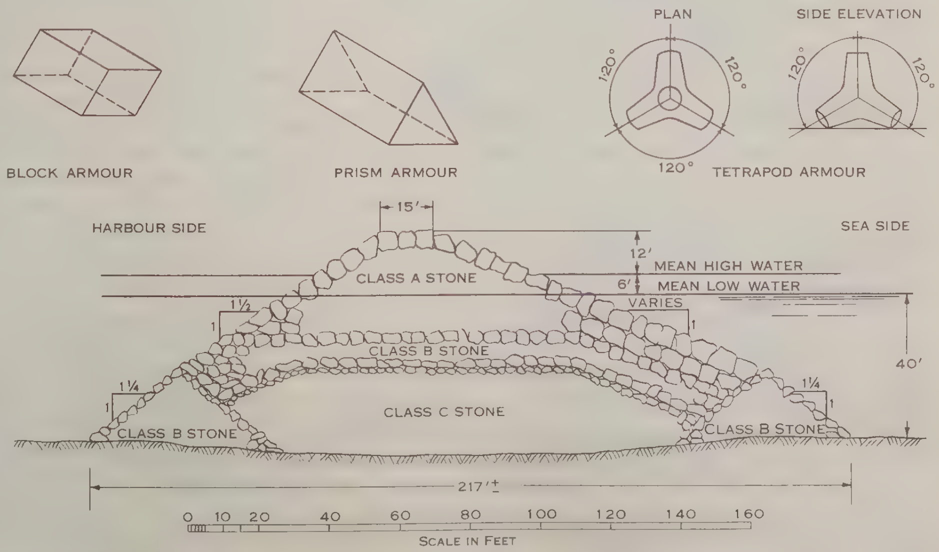
Shore Processes.—The action of waves and longshore currents causes a nearly continuous movement of bottom and beach material. The wave motion creates turbulence which places material in suspension and the currents carry the suspended material and roll the heavier bottom material from place to place. During severe storms the violent action of the waves and currents may displace vast quantities of material, often much more than the quantity moved by months of more normal wave motion. The direction of longshore movement of beach material (littoral drift) varies with the direction of the wind. However, on most coasts there is a prevailing direction which can be determined from typical formations of the coast. At any particular location this movement of the beach material may not be obvious because the material carried away is replaced by similar material from the updrift direction. However, there must be a source of supply somewhere in the updrift region. This could be an eroding headland, sediment deposits from rivers or material carried shoreward from deep water. In general, erosion is most severe when large waves occur during high water levels while similar wave action during low water may build beach. On inland lakes, high water levels may be caused by excessive rain or by the drag of the wind. On the oceans, high levels result from a combination of lunar tides and wind. Storm waves are more likely to cause erosion than long-period swell, which may carry material shoreward.

When the natural drift of shore material is intercepted by a deep-water inlet or by a breakwater, the region on the downdrift side of the obstruction is deprived of its natural replenishment, with the result that an erosion area may be created. Many of the most serious shore erosion problems occur on the downdrift side of breakwaters or jetties protecting inlets. When breakwaters are built to create harbours on open coasts, they are often kept disconnected from the shore in order to permit beach material to pass and prevent erosion.

The best protection against wave action is the presence of a beach upon which the waves break and dissipate their energy before attacking the higher inland areas. Short jetties or groins are often used to intercept and hold shore material and thus create stable beaches at erosion sites. At locations where no littoral drift is present the beach material must be supplied by filling artificially. Where severe erosion threatens high-value locations, offshore breakwaters parallel to the coast may be used to prevent the erosion and build beach. The presence of the breakwater not only prevents the larger waves from reaching the shore, but also creates a quiet area in which littoral drift is deposited in the same manner as in the case of a deep inlet. In fact, care must be exercised in planning a breakwater for this purpose to avoid such a large deposition as to cause complete interception of all littoral drift and thus create another erosion area.

The construction of protective structures at the shore line (sea walls and bulkheads) is usually less expensive than the construction of offshore breakwaters. Such structures may be used in areas where property very near the water front requires protection. However, the presence of sea walls and bulkheads tends to increase the turbulence and currents generated by the wind with the result that beach erosion may be accelerated.

Types of Breakwaters.—Breakwaters may be divided into three general types: rubble-mound, composite and vertical-face. The rubble-mound type, illustrated in fig. 2, consists of a pile of natural or artificial stone protected with an armour of larger stones. The composite type of breakwater (fig. 3) consists of a rubble base and a suitable superstructure. There are two classes of composite breakwaters, those whose superstructures are founded near or above low water and those whose superstructures extend sufficiently far below low water to reduce disturbances of the rubble base. Vertical-face breakwaters (fig. 7) present a vertical face on the sea side extending to a sufficient depth to prevent the breaking of maximum-height waves.



BY COURTESY OF U.S. NAVY

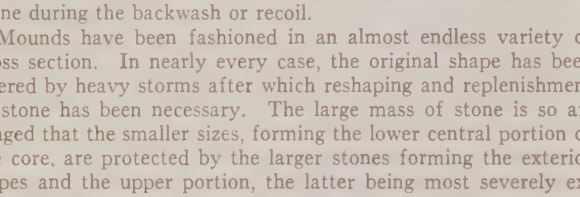
FIG. 2.—RUBBLE-MOUND BREAKWATER

Rubble-Mound Breakwaters.—The rubble-mound type is indicated where there is an abundant supply of rock. It is particularly adapted for locations with small tidal range and depths of water up to perhaps 60 ft. It has the advantage that storm damage or vertical settlement caused by a poor foundation site may be repaired by renewing or replacing the dislocated stone. The earliest breakwaters were unformed piles of stone of a size that could be handled with the limited equipment available at the time. It soon became evident that the sea slopes were not adequate nor the stones of sufficient size to resist the forces delivered by storm waves. Heavy wave action lowered the top of the mound and flattened the seaward slope. It was necessary to replenish the mound constantly until an equilibrium slope was reached. This slope was often found to vary from 1 to 5 to 1 to 10 on the seaward side within the range of the worst storm attack. Below this level the slope to the bottom was often as steep as 1 to 1. The portion of the mound above low water is extremely vulnerable to injury by storm waves in either one or both of two different actions. The first is the raising and forward transport of the stone by the incoming waves; the second is the withdrawal and lowering of the stone during the backwash or recoil.

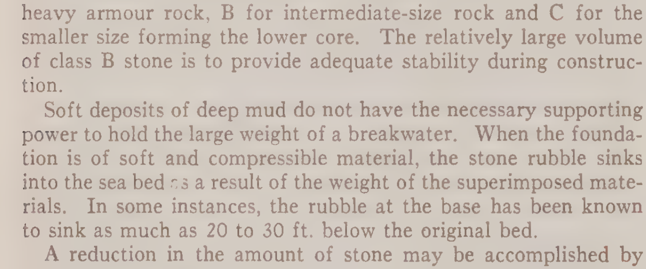
Mounds have been fashioned in an almost endless variety of cross section. In nearly every case, the original shape has been altered by heavy storms after which reshaping and replenishment of stone has been necessary. The large mass of stone is so arranged that the smaller sizes, forming the lower central portion of the core, are protected by the larger stones forming the exterior slopes and the upper portion, the latter being most severely exposed to direct wave action. The stone is classified by size into three categories, conventionally designated A for cap rock and heavy armour rock, B for intermediate-size rock and C for the smaller size forming the lower core. The relatively large volume of class B stone is to provide adequate stability during construction.

Soft deposits of deep mud do not have the necessary supporting power to hold the large weight of a breakwater. When the foundation is of soft and compressible material, the stone rubble sinks into the sea bed as a result of the weight of the superimposed materials. In some instances, the rubble at the base has been known to sink as much as 20 to 30 ft. below the original bed.

A reduction in the amount of stone may be accomplished by removing the soft material with an ocean-going hopper dredge and replacing it with a sand blanket, or a sand blanket of extra width and thickness may be deposited on the bottom without dredging. A protective blanket of clay or quarry waste chips and fines may also be deposited to prevent leaching of the sand core. Where the bottom is firm but susceptible to erosion, a blanket of quarry-run rock may be deposited to protect the natural bottom.



A. SOLID SUPERSTRUCTURE NEAR WATER LINE



B. SOLID SUPERSTRUCTURE BELOW WATER LINE

BY COURTESY OF U.S. NAVY

FIG. 3.—COMPOSITE BREAKWATER

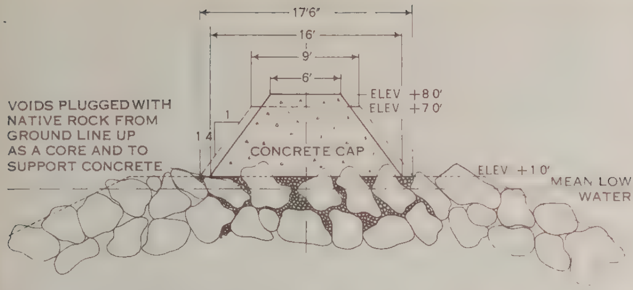
The larger stones forming the exterior slopes in the upper portion may be of natural stone or of concrete formed into blocks, prisms or other special shapes. The tetrapod (*see* fig. 2) is a cast concrete form with four symmetrically spaced legs, each shaped like a truncated cone, radiating from a central body. Tetrapods, deposited by random dumping, are self-interlocking, add hydraulic roughness to the breakwater facing without losing porosity, and develop a progressive wedging action under wave pressure. The heaviest armour is placed on the top of the mound and down the seaward face to a plane 10 to perhaps 30 ft. below the low-water level, depending on the intensity of wave attack. The heaviest natural stone armour weighs from 10 to 20 tons, and concrete blocks have been cast in sizes up to 40 tons. The general range of weight for the class B material is from 1 to 10 tons and that for the class C material from ¼ lb. to 1 ton, with the greater portion less than 100 lb. Class C and class B material is always dumped at random. The class A rock and cap rock may be placed pell-mell, semiset or accurately set in neat lines to form a dense facing.

Rubble-mound breakwaters are constructed by means of pile-supported trestles for support of railroad tracks, by the use of a floating plant or by the truck-and-crane method, employing the top of the breakwater as a roadway. Trestles are generally used at sites subject to frequent heavy sea action, where the use of floating equipment is impracticable. A single-track trestle will ordinarily suffice for the construction of moderately sized breakwaters, but two parallel trestles may be necessary for the portions of major breakwaters in deeper water. At locations where the wave action is not too severe, a floating plant may be used to advantage. The smaller material is moved to the site in bottom dump barges, and the larger material is handled by floating derrick equipment. The truck-and-crane method is best suited to small-and moderate-size breakwater projects. It consists essentially of building the structure outward from the shore with material dumped from trucks, the larger pieces being placed in final position by means of a crane. Modern heavy-duty truck-and-crane equipment materially increases the usefulness of this method.

Composite Breakwaters.—Full-height rubble mounds are not feasible at deep-water sites or at locations having large tidal variations. The composite type of breakwater, consisting of a rubble base and suitable superstructure, has found extensive application in such areas. The rubble mound provides a base, accommodates itself to irregularities in the bottom and may be deposited in deep water and allowed to stand, thus obtaining a large part of the total settlement before the superstructure is placed.

The solid superstructure reduces the amount of material required, according to the depth at which it is founded, and the solid capping also serves to protect the top of the mound from the action of the waves. In the case of a mound breakwater, portions of the highest waves generally pass over the top of the mound, and their force is also to some extent expended in passing through the interstices between the blocks or stones, whereas a superstructure presents a solid face to the impact of the waves. A superstructure, accordingly, must be strongly built in proportion to the exposure and to the size of the waves liable to reach it. Special care has to be taken to prevent the superstructure from being undermined, because storm waves dash up against this nearly vertical solid obstacle and recoil down the face, scouring and displacing the materials at the superstructure's outer toe. This risk is especially great when the superstructure is founded on the mound near low-water level (*see* fig. 3[A]), and there is no adequate cushion of water above the mound to withstand the recoil. Because of this danger and the growing need for breakwaters in great depths of water, it has become more usual to carry superstructures down well below low water.

In view of the increased depths at which superstructures are now founded upon rubble mounds, causing the breakwaters to approximate more and more to the vertical-wall type, it may seem at first


17'6"
16'
9'
6'
ELEV +8.0'
ELEV +7.0'
VOIDS PLUGGED WITH NATIVE ROCK FROM GROUND LINE UP AS A CORE AND TO SUPPORT CONCRETE
1
1.4
CONCRETE CAP
ELEV +1.0'
MEAN LOW WATER

FROM "SHORE PROTECTION PLANNING AND DESIGN," TECHNICAL REPORT NO. 4 (1954); REPRODUCED BY PERMISSION OF BEACH EROSION BOARD, U.S. ARMY CORPS OF ENGINEERS

FIG. 4.—SECTION OF CONCRETE-CAPPED JETTY

that the rubble base could be dispensed with and the superstructure founded directly on the sea bed. Two factors, however, still render the composite form of breakwater indispensable in certain cases: (1) the great depths to which breakwaters sometimes extend, reaching 60 ft. below low water at Peterhead, Scot., 117 ft. below mean sea level at Naples, Italy, and 180 ft. at Valparaiso, Chile; and (2) the necessity, where the sea bottom is soft or liable to be eroded by scour, for a wide base between it and the upright superstructure.

The injuries to which composite breakwaters appear to have been especially subject must be attributed primarily to the greater exposure and depth of the sites on which they have been frequently constructed as compared with rubble mounds or upright walls; but the direct cause of damage and even destruction has in many cases been the insufficient depth at which superstructures have been founded.

The superstructures of composite breakwaters may consist of a solid concrete cap (*see* fig. 4), formed concrete blocks (fig. 3[A]), concrete caissons filled with stone or concrete (fig. 3[B] and 6), rock-filled timber cribs (fig. 5), or an asphaltic concrete cap. The selection of the type best suited to any location depends upon such factors as the relative costs at that location, the severity of the wave conditions, the depth of the water and the speed with which completion of construction is desired.

In most locations, the rubble-mound foundation will continue to settle for several years after being placed, and there may be additional settlement when the weight of the superstructure is added. Where such settlement is severe, a solid concrete superstructure or a superstructure consisting of horizontal layers of blocks may be impractical unless the foundation is allowed to settle for several years before adding the superstructure. Although from the point of view of resisting wave forces it is desirable to use massive units or blocks in forming such structures, the problem of transporting and placing very heavy blocks somewhat limits their size. This problem is solved to some extent by using hollow concrete blocks or caissons. The most extreme example of a hollow block would be a relatively thin-walled, reinforced concrete box with no bottom. When either a temporary or permanent bottom is placed on such a box, it is called a caisson. Caissons may be floated into place and then lowered by filling them with water or stone. Single units of caisson superstructures can be made much larger than any that could be handled by mechanical equipment. Concrete blocks or caissons are sometimes supported on piling (fig. 6) to avoid damage due to settlement.

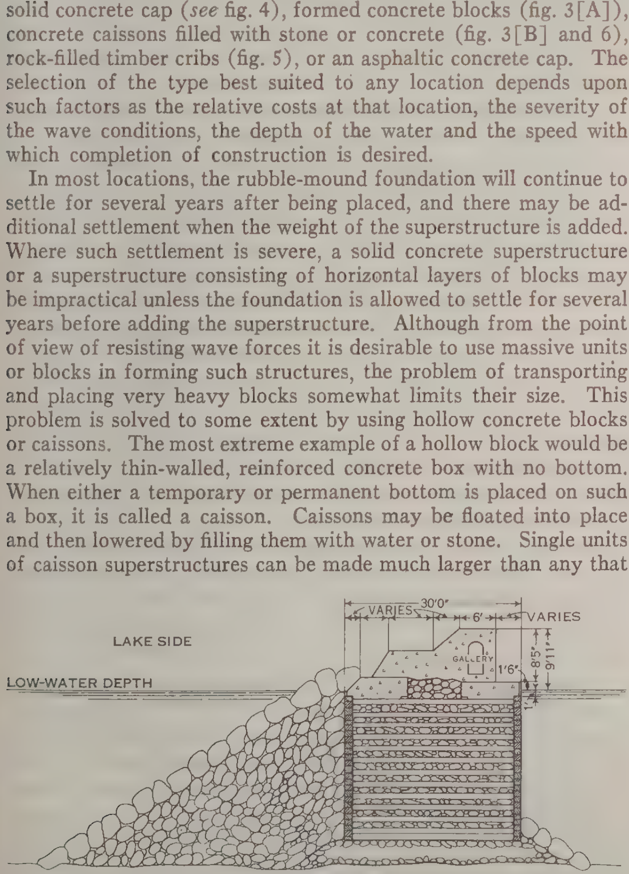


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FIG. 5.—ROCK-FILLED TIMBER CRIB BREAKWATER

During World War II, caissons of 204-ft. length, 60-ft. width and 60-ft. height were towed across the English channel and sunk in rapid succession to form the artificial harbour at Arromanches-les-Bains for the invasion of northern France.

The composite breakwater at Bilbao harbour, Spain, probably was one of the most difficult to construct because of its great exposure to the Atlantic waves. The original design consisted of a wide rubble mound up to about 16 ft. below low water, a mound of concrete blocks up to low water and a solid masonry superstructure. The repeated damage to this wall by successive winter storms led to the abandonment of the original design and the construction, on a widened rubble base, of a superstructure protected to some extent by the outlying concrete-block mound. The modified superstructure was formed of iron caissons partially filled with concrete which were floated out, sunk in position and filled with concrete blocks and mass concrete. The caissons measured about 43 ft. in width across the breakwater, 23 ft. in length and 23 ft. in height and weighed about 1,400 tons when filled. They form the base of a concrete wall founded at half-tide level and carried up to 8 ft. above high water. Although some difficulties were brought about by the settlement of the rubble foundation, they were overcome, and the breakwater successfully resisted the attacks of the heavy Atlantic rollers. A modern concept of this type of construction is shown in fig. 3(B) in which the caisson is of reinforced concrete.

Rock-filled timber cribs are suitable for use as superstructures on rubble-mound foundations in fresh water. In salt water the activity of marine borers makes the life of a timber structure too short to be economically feasible. The portion of the timber near the water surface which is subjected to alternate wetting and drying may rot in time, but that portion which is continuously submerged may be expected to last for many years. Timber structures have the advantage of being somewhat flexible and thus able to adjust themselves to a settlement of the foundation. A common procedure is to place a concrete cap on the timber cribs after all settlement has ceased. An example of timber-crib breakwater is shown in fig. 5.

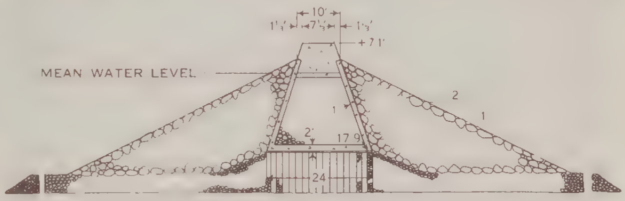

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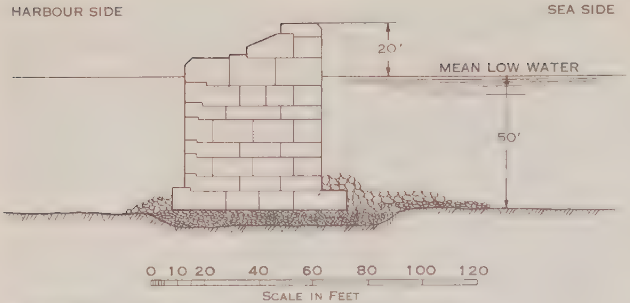
FIG. 6.—COMPOSITE BREAKWATER WITH CONCRETE CAISSONS

Vertical-Face Breakwaters.—This type of breakwater is placed directly on or embedded into the sea or lake bottom without the use of a rubble-mound foundation. This type includes structures varying in their nature from single walls of wood or steel sheeting to massive concrete gravity-type structures (fig. 7). As the name implies, gravity-type structures depend upon their own weight to resist both overturning and sliding. Such structures must be built in locations where the bottom consists of sufficiently solid rock to support the weight of the structure and to resist erosion at the base of the structure. In order to avoid the excessive forces and erosive action of breaking waves, such structures are usually placed outside the breaker zone. This means that they must be built in water depths no smaller than about 1.3 times the height of the maximum waves to be expected at that location. Any of the types of construction described previously for the superstructures of composite breakwaters might be used for the gravity type of vertical-face breakwaters.

The Admiralty pier at Dover, Eng., which was begun about the middle of the 19th century, is an early and notable example of a vertical-face breakwater resting upon a hard chalk bottom. It

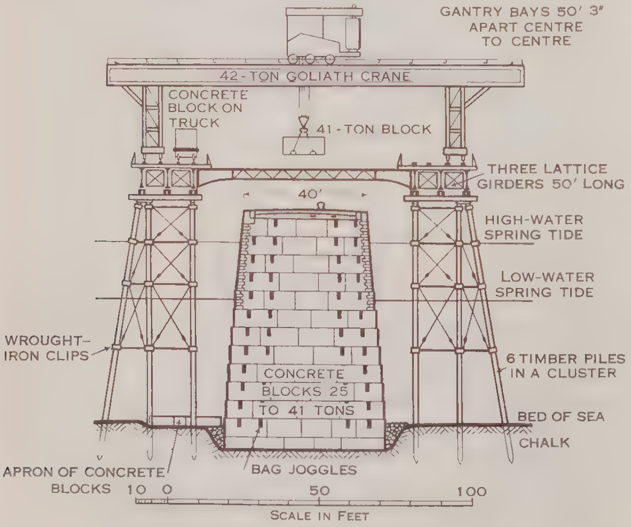


BY COURTESY OF U.S. NAVY

FIG. 7.—VERTICAL-FACE BREAKWATER

was subsequently extended in connection with the works for forming a closed naval harbour at Dover, which included the construction of an eastern breakwater and a detached south breakwater. They are founded on the hard chalk underlying the surface layer of the sea bed, leveled by men in diving bells. The breakwaters were built of concrete blocks in bonded courses, the outer blocks above low water being faced with granite masonry (fig. 8). The face blocks were joggled together, and above low water the block work was set in cement mortar and the vertical-face joints grouted. The blocks were laid by goliath traveling cranes running on temporary staging supported by clusters of timber piles driven into the chalk bottom. Four goliaths on each staging were used for excavating, for preparing foundations with diving bells and for block setting. The deepest foundation is 53 ft. below low-water springs. The rise of the spring tide being $18\frac{3}{4}$ ft., the average depth is approximately 66 ft. at high tide, necessitating a pressure of about 30 lb. per square inch which is near the limit at which men in diving bells could work continuously without injurious effects. All the breakwaters are protected from scour along the outer toe by an apron of concrete blocks.

The stability of breakwaters made of single rows of sheet piling depends primarily upon the resistance of the soil into which the piling is driven. Although such walls must be designed for the wave and foundation conditions at each location, for average conditions it is usually found necessary for the piling to be embedded approximately twice as far as it projects above the bottom. Such walls may be strengthened by buttresses or, in the case of steel piling, by arranging the piles in a manner which provides some additional stability. Walls of single sheet piling are suitable only for shallow water depths and for locations where soil conditions permit piles to be driven. Where the soil is heavy clay or rock, or contains large stones, it is usually necessary to use a gravity-type structure.



BY COURTESY OF MESSRS. COODE, FITZMAURICE AND WILSON

FIG. 8.—CROSS SECTION OF SOUTH BREAKWATER, DOVER HARBOUR, ENGLAND, ILLUSTRATING THE METHOD EMPLOYED IN THE CONSTRUCTION OF THE THREE BREAKWATERS AT DOVER HARBOUR

One of the most commonly used forms of vertical-face breakwaters, the cellular type, combines the gravity and sheet-piling types described above. In its simplest form this type consists of two parallel sheet-pile walls filled with stones as shown in fig. 9. The walls are usually tied together and the space between may be divided into cells by cross walls. Concrete caps or parapets may be placed on top of the walls. A more elaborate type of cellular wall is made by forming circular or elliptical cells of sheet piling. These are connected by curved or straight segments of wall and all the cells are filled with stone or gravel.

Harbours.—One of the most important functions of breakwaters is in the development of quiet water for the mooring or loading of ships. This is accomplished either by supplementing natural protective features of a coast line or by the creation of a completely artificial harbour. In either case, the breakwater arrangement must be such as to provide the maximum amount of quiet area together with easy-entrance conditions, at a minimum cost. The intensity of wave conditions inside a harbour depends on the direction and size of the waves approaching the entrance, the size and location of the entrance and the orientation, height and shape of the breakwaters. The nature of the waves at a harbour location must be determined from wind records because virtually no long-term wave records are available. The sizes and periods of waves computed from wind records are for deep-water conditions.

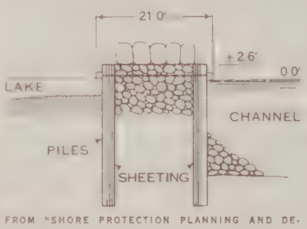


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FIG. 9.—CELLULAR TYPE, VERTICAL-FACE BREAKWATER

Because harbours are usually constructed at depths less than half a wave length, the orientation and shape of the waves are affected by refraction before reaching the harbour entrance, as described earlier. Refraction diagrams must, therefore, be drawn to determine the modified form of the wave at the harbour entrance. Although methods of computing the diffraction of waves as they pass through a harbour entrance have been developed, these are applicable only to the most simplified cases. As a result, the design of the harbour entrance and the arrangement of the breakwaters are nearly always determined by means of hydraulic model studies. Models are built at scale ratios varying from 1:50 to 1:125. In general, the larger the model the more accurate will be the results obtained. This is because viscosity and surface tension influence the results obtained from very small models. The size of the model is usually limited by cost and the amount of space available. The natural refraction outside the harbour is reproduced in the model by constructing the bottom topography to scale. Waves of selected sizes and orientations are generated by means of a wave machine and projected toward the harbour. Many different breakwater arrangements can thus be studied and the most effective arrangement can be selected.

One of the problems which model studies help to solve is the reflection of waves within the harbour. Often a slight rearrangement of breakwaters or docks will completely change the reflection pattern. Waves reflect from vertical walls with virtually no loss of energy; therefore, rubble-mound breakwaters are far more desirable than vertical-faced ones.

The harbour entrance is usually arranged in such a manner as to prevent the entrance of waves generated by the prevailing winds. However, other wind directions will always project some waves into the harbour. Wave absorbers consisting of beaches or baffle walls must be arranged to dampen such waves and prevent harbour surging. (*See* also HARBOURS.)

Wave Forces.—In addition to determining the best location of breakwaters from a functional point of view, the civil engineer must design the structures to withstand the wave forces to which they are subjected. The size of the waves to be expected at the location of the breakwater is determined from wind records and refraction diagrams as described in the sections on *Waves* and *Harbours*. The manner in which wave forces attack breakwaters depends on the shape and location of the structure. Extensive model tests enable the engineer to design a rubble-mound structure which will resist the wave forces at any location as economically as possible.

Vertical-faced breakwaters and the superstructures of composite breakwaters must be designed to resist overturning and sliding as the result of forces produced by the waves.

When vertical-faced or composite structures are located in the breaker zone, they are subjected to dynamic forces resulting from the impinging mass of high-velocity water. Violent scouring action at the toe of the structures is also associated with these conditions. The violent action of the water is accentuated by the entrapment of air pockets in the waves which burst upward at the face of the wall, carrying spray many feet into the air. Analytical methods are of little help in predicting the forces resulting from breaking waves. However, laboratory and field tests with pressure cells have provided some data. Perhaps of even greater value for this purpose are computations of wave force based on observations, made during storms, in which breaking waves have displaced known amounts of concrete or rock.

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(J. R. As.; R. C. Ss.; E. F. Br.)

BREASTED, JAMES HENRY (1865–1935), U.S. Orientalist and historian, whose influence as translator and promoter of research on the ancient Orient was powerful, was born in Rockford, Ill., on Aug. 27, 1865. After graduate studies at Yale University and the University of Berlin, he began teaching Egyptology at The University of Chicago in 1894. On an expedition to Egypt and the Sudan in 1905–07 he copied inscriptions from monuments which previously had been inaccessible or were perishing. In a five-volume work, *Ancient Records of Egypt* (1906), he published translations of all the old historical texts. His *History of Egypt* (1905) and his high school textbook, *Ancient Times* (1916), both lucidly written, enjoyed extraordinary success. A pioneer work in a specialized field was *Development of Religion and Thought in Ancient Egypt* (1912). In 1919, Breasted organized at The University of Chicago the Oriental Institute. During the next 40 years the institute sent more than 20 archaeological expeditions to the Near East and issued more than 125 scholarly publications. Breasted died in New York, N.Y., on Dec. 2, 1935.

See Charles Breasted, *Pioneer to the Past; the Story of James Henry Breasted, Archaeologist* (1943). (J. A. Wi.)

BRÉAUTÉ, FALKES DE (d. 1226), a Norman adventurer and professional soldier, probably taking his name from Bréauté (Seine-Inférieure), who gave loyal military and administrative service to King John of England but was hated by contemporaries who attacked him as an upstart and self-seeking governor. He was given command in Glamorgan in 1207, and led expeditions against the Welsh; he conducted embassies in Flanders in 1213, and by 1215 was a seneschal of the king's household. In the war between King John and his barons (1215–16), Falkes was one of the chief royal commanders, and was made sheriff of six counties and custodian of three castles. Although already rewarded with extensive estates in the honour of Gloucester, he received in marriage (1216) Margery, widow of Baldwin de Redvers, earl of Devon, and by 1221 he had acquired custody of the lands of his stepson.

After King John's death (1216), Falkes gave less steady allegiance to the regents of the young Henry III and in 1223–24 had to surrender his midland counties and castles (except Bedford) as part of a redistribution of office aimed against the aliens and their supporters. Complaints against his conduct of local government were made as early as 1220. His brother William ambushed a royal justice and imprisoned him at Bedford in 1224. The castle was taken and the garrison hanged. Falkes was held responsible, and had to submit to the king and go into exile. He appealed to the pope with no success, and died in 1226. (J. C. Ho.)

BRÉBEUF, SAINT JEAN DE (1593–1649), French Jesuit and patron saint of Canada, was born at Condé-sur-Vire, Normandy, on March 25, 1593. He entered the Society of Jesus in 1617, was ordained priest in 1623 and arrived in New France in 1625. Assigned to Christianize the Huron Indians between Georgian bay and Lake Huron, he lived in danger of death until forced by the British to return to France in 1629. Back again in "Huronia" in 1634, Brébeuf laboured for 15 years in primitive surroundings. He was the veteran of 18 missions in 1647 when the French-Iroquois peace was made. The Iroquois, however, continued their fierce war against the Hurons and destroyed all villages and missions in 1648. They seized Brébeuf and his fellow Jesuit, Gabriel Lalemant, and tortured them to death near the French Fort St. Ignace, March 16, 1649. Brébeuf endured stoning, slashes of knives, a collar of redhot tomahawks, a "baptism" of scalding water and burning at the stake. Because he showed no sign of pain, his heart was eaten by the Iroquois. He was canonized with other Jesuit martyrs in 1930, and their feast day in the Roman Catholic Church is Sept. 26. St. Jean de Brébeuf's writings are source materials for historians and ethnologists. He composed a grammar and catechism in Huron. His annual narratives are translated in R. G. Thwaites' *The Jesuit Relations and Allied Documents,* 73 volumes (1896–1901). (J. V. J.)

BRECCIA is a rock made of coarse, sharp, angular fragments embedded in a matrix. The matrix may be similar in origin to the fragments and differ only in size of grain, or it may be an infiltration product—a precipitate of mineral matter from solution. Breccias differ from conglomerates in the angularity of their fragments and in a greater diversity of origin (*see* CONGLOMERATE). The sedimentary breccias have been designated sharpstone conglomerates.

Because of their polygenetic nature, breccias are a diverse group of rocks. Volcanic breccias include those rocks composed of lava fragments imbedded in lava and also those composed of poorly sorted blocks in a tuffaceous (formed from volcanic ash or dust) matrix. The first type is the product of the break-up of a solidified lava crust by further movement of the flow (fluxion breccia); the second is a product of volcanic action (*see* also AGGLOMERATE).

Sedimentary breccias form in several ways. Common are the intraformational breccias formed by the fragmentation of a sediment that has been partly lithified and the incorporation of these materials, unmodified by transport, in a similar or related sedimentary matrix. Fragmentation is due mainly to desiccation on mud flats, either tidal or floodplain. Reef breccias composed of blocks of reef rock in finer debris form on the seaward side of coral reefs. Breccias also form by travertine (calcium carbonate) cementation of talus or rock debris and by dripstone—cementation of rock falls in caves.

Tectonic or structural (crush) breccias form by earth movements along fissures or faults or by folding. Fault breccias are commonly cemented with vein calcite and quartz or less commonly with the sulfides and other vein minerals. The folding of thin beds of mixed character and unlike competency or strength produces a fold breccia (reibungsbreccia).

See W. H. Norton, "A Classification of Breccias," *Jour. Geol.*, 25:160–194 (1917). (F. J. P.)

BRECHT, BERTOLT (EUGEN BERTHOLD FRIEDRICH; 1898–1956), German poet, playwright, and theatrical producer and theoretician, dominated the European theatre of the 1950s and '60s, though his main work was done some 30 years earlier. (For various aspects of his dramatic theory and practice *see* ACTING, DIRECTION AND PRODUCTION: *Direction;* DRAMATIC CRITICISM: *The 20th Century;* GERMAN LITERATURE: *The 20th Century: Expressionism;* STAGE DESIGN: *History: Epic Theatre;* and THEATRE: *20th Century: Germany.*)

Till 1924 Brecht lived in Bavaria, where he was born (Augsburg, Feb. 10, 1898), studied medicine (Munich, 1917–21), and served in an army hospital (1918). From this period date his first play, *Baal* (produced 1923); his first success, *Trommeln in der Nacht* (Kleist Preis, 1922; *Drums in the Night*); the poems and songs collected as *Die Hauspostille* (1927; *A Manual of Piety,* 1966); his first professional production (*Edward II,* 1924); and

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BRECHT, PHOTOGRAPHED IN 1940

his admiration for Wedekind, Rimbaud, Villon, and Kipling.

In Berlin (1924–33) he worked briefly for the directors Max Reinhardt and Erwin Piscator, but mainly with his own group of associates. With the composer Kurt Weill (*q.v.*) he wrote the satirical, successful ballad opera *Die Dreigroschenoper* (1928; *The Threepenny Opera*) and the opera *Aufstieg und Fall der Stadt Mahagonny* (1930; *Rise and Fall of the Town of Mahagonny*). He also wrote what he called *"Lehr-stücke"*—baldly didactic works for performance outside the orthodox theatre—to music by Weill, Hindemith, and Hanns Eisler. In these years he developed his theory of "epic theatre" and an austere form of irregular verse. He also became a Marxist.

In 1933 he went into exile: in Scandinavia (1933–41), mainly in Denmark; then in the United States (1941–47), where he did some film work in Hollywood. In Germany his books were burned and his citizenship was withdrawn. He was cut off from the German theatre; but between 1937 and 1941 he wrote most of his great plays, his major theoretical essays and dialogues, and many of the poems collected as *Svendborger Gedichte* (1939). The plays of these years are now famous in his own and other productions: among them are *Mutter Courage und ihre Kinder* (1941; *Mother Courage and Her Children*), a chronicle play of the Thirty Years' War; *Leben des Galilei* (1943; *The Life of Galileo;* 2nd version, trans. Brecht and Charles Laughton, 1947); *Der gute Mensch von Sezuan* (1943; as *The Good Woman of Setzuan*, 1948), a parable play set in prewar China; *Der Aufhaltsame Aufstieg des Arturo Ui* (*The Resistible Rise of Arturo Ui*, publ. 1957), a parable play of Hitler's rise to power set in prewar Chicago; *Herr Puntila und sein Knecht Matti* (1948; *Herr Puntila and His Man Matti*), a *Volksstück* (popular play) about a Finnish farmer who oscillates between churlish sobriety and drunken good humour; and *The Caucasian Chalk Circle* (first produced in English, 1948; *Der kaukasische Kreidekreis*, publ. 1949), the story of a struggle for possession of a child between its highborn mother, who deserts it, and the servant girl who looks after it.

Brecht left the U.S. in 1947 after having had to give evidence before the House Unamerican Activities Committee. He spent a year in Zürich, working mainly on *Antigone-Modell 1948* (adapted from Hölderlin's translation of Sophocles; produced 1948) and on his most important theoretical work, the *Kleines Organon für das Theater* (1949). In 1949 he went to Berlin to help stage *Mutter Courage* (with his wife, Helene Weigel, in the title part) at Reinhardt's old Deutsches Theater in the Soviet sector. This led to formation of the Brechts' own company, the Berliner Ensemble, and to permanent return to Berlin. Henceforward the Ensemble and the staging of his own plays had first claim on Brecht's time. Often suspect in eastern Europe because of his unorthodox aesthetic theories, and denigrated or boycotted in the West for his Communist opinions, he yet had a great triumph at the Paris Théâtre des Nations in 1955, and in the same year in Moscow received a Stalin Peace Prize. He died in East Berlin on Aug. 14, 1956.

Brecht was, first, a great poet, with a command of many styles and moods. As a playwright he was an intensive worker, a restless piecer-together of ideas not always his own (*The Threepenny Opera* is based on John Gay's *Beggar's Opera*, and *Edward II* on Marlowe), a sardonic humorist, and a man of rare musical and visual awareness; but he was often bad at creating living characters or at giving his plays tension and shape. As a producer he liked lightness, clarity, and a firmly knotted narrative sequence; a perfectionist, he forced the German theatre, against its nature, to underplay. As a theoretician he made principles out of his preferences—and even out of his faults. In his lifetime, nobody realized the full range of his work, for he was always ready to change, shelve, or forget what he had done: to amend or destroy or begin something new. He was never content.

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BRECKINRIDGE, JOHN CABELL (1821–1875), U.S. lawyer, soldier and political leader, was born near Lexington, Ky., on Jan. 21, 1821. He graduated from Centre college, Danville, Ky., in the class of 1839, continued his education at the College of New Jersey (now Princeton university), and studied law at Transylvania university, Lexington, Ky. After practising law in Frankfort, Ky., Burlington, Ia., and Lexington, Ky., Breckinridge served in the Mexican War with the rank of major in a volunteer regiment. He began his political career in 1849 as a member of the Kentucky legislature and in 1851 was elected to the U.S. House of Representatives. In 1856 Breckinridge was elected vice-president of the United States on the ticket with James Buchanan and served as presiding officer of the U.S. Senate in the difficult years preceding the American Civil War. When internal dissensions brought about a split within the Democratic party in 1860, Breckinridge was nominated for the presidency by the southern proslavery Democrats who refused to accept Stephen A. Douglas as their nominee. Though defeated in the election, Breckinridge received 72 electoral votes from nine southern and two border states. He succeeded John J. Crittenden as U.S. senator from Kentucky in March 1861; later in the year he resigned, and in December was formally expelled from that body.

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BRECKINRIDGE

Meanwhile he was commissioned as brigadier general in the Confederate army. Following the battle of Shiloh, in which he commanded the reserve, Breckinridge was promoted to the rank of major general and thereafter took part in many campaigns. He defeated Gen. Franz Sigel at Newmarket, Va., served with Lee's army in the Wilderness and was second in command to Gen. Jubal Early in the Shenandoah campaign. In the final months of the war Breckinridge served as Confederate secretary of war, and at the close of hostilities he fled to England. After a self-imposed exile of three years, Breckinridge returned to the U.S. and resumed his law practice in Lexington, Ky., where he died on May 17, 1875.

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BRECKNOCKSHIRE (BRECONSHIRE; Welsh, SIR FRYCHEINIOG), an inland county in south Wales, the third largest administrative and fourth largest geographical county in Wales, bounded on the northwest by Cardiganshire, on the north and northeast by Radnorshire, on the east by Herefordshire, on the southeast by Monmouthshire, on the south by Glamorgan and on the west by Carmarthenshire. Area 733.3 sq.mi. (1,899 sq.km.).

Physical Geography.—The greater part of the county is composed of Old Red Sandstone of the Devonian period. On the southern boundary this is overlain successively by Carboniferous limestone, Millstone Grit and, in the southwest and southeast, by the lower coal measures of the south Wales basin. In the north the Old Red Sandstone has been eroded to expose older Silurian and Ordovician rocks which appear in bands running approximately northeastward, the widest being the shales, sandstones and conglomerates of the Llandeilo and Llandovery beds, while to the southeast of these are narrow outcrops of the Wenlock and Ludlow sandstones and mudstones. Intrusions of igneous rocks produce sulfur and saline springs at Builth Wells, Llangamarch Wells and Llanwrtyd Wells, the last-named having the highest sulfur content of any mineral springs in Great Britain.

The oldest rocks in the northwest of the county form a barren upland rising to more than 2,000 ft. and are part of the central Wales massif. This is separated from Mynydd Eppynt by the valley of the Irfon, a tributary of the Wye which latter forms the boundary with Radnorshire for about 30 mi. Mynydd Eppynt, stretching northeastward across the county and rising to 1,560 ft., is the most northerly outcrop of the Old Red Sandstone. Another tributary of the Wye, the Llynfi, flowing northward through Llangorse lake, separates Mynydd Eppynt from the deeply channeled, high plateau of the Black mountains in the east. Except for one isolated cap of Carboniferous limestone, Pen Cerrig-calch, near Crickhowell, these hills are composed of rocks of the Old Red Sandstone series, the highest point, Waun Fach, rising to 2,260 ft. Near Abergavenny, the Sugar Loaf (1,955 ft.) is a conspicuous landmark on the county boundary. Running from west to east across the south of the county are the upland masses of Fforest Fawr and the Brecon Beacons, with their main crests frequently rising to summits over 2,000 ft., which are regarded as remnants of the much-dissected high plateau of Wales. At the highest point of the Brecon Beacons (Pen-y-Fan, 2,906 ft.) are residual summits regarded as ancient monadnocks rising well above the high plateau surface and which form the highest hills in south Wales. These hills are separated from Mynydd Eppynt and the Black mountains by the valley of the Usk (Wysg) which rises on the western borders of the county at Carmarthen Van (Fan Foel, 2,632 ft.) and flows eastward and southeastward across the county.

The dip slope of each of these upland masses is south or southeast giving fairly steep and well-defined escarpments on the northern sides of Mynydd Eppynt, the Brecon Beacons and the Black mountains. The more gentle southerly slopes are channeled by roughly parallel streams. The Tawe, Neath (Nedd) and Taff (Taf) all flow southward from the Brecon Beacons range, and the Towy (Tywi), also flowing southward, forms the county boundary on the northwest. All the rivers eventually flow southward into the Bristol channel thereby cutting across the geological structure of the Paleozoic rocks of the south Wales coal basin. This discordant drainage pattern is regarded as having been superimposed from a now vanished cover of Mesozoic rocks. There is evidence that the region was heavily glaciated. The northern flanks of the higher hills have the steep cwm (dingle) formations associated with ice erosion, while much boulder clay or till is found in the lower valley lands. Striated pebbles and boulders occur at a great height on the Black mountains, where several ice streams converging on their northern escarpment forced the ice up over the ridge southward into the valley of the Honddu. The county is one of the best water-producing areas in Wales, and Birmingham, Swansea, Cardiff, Newport and other towns are supplied from its reservoirs.

History.—Barrows, implements and standing stones give evidence of occupation of the county in the Stone Age and Bronze Age. Traces of prehistoric lake dwellings were found at Llangorse lake (Llyn Safaddan) in 1869. There are many hill camp sites of the Early Iron Age. The conquest of the district by the Romans from the Silures was effected about A.D. 75–80, and the most important remains of this occupation, at Y Gaer near Brecon, were excavated by Sir R. E. Mortimer Wheeler in 1925–26. Five Roman roads radiated from this camp.

On the departure of the Romans about A.D. 400 the land, excepting the lordship of Buellt (Builth), came under the domination of Brychan Brycheiniog, a native prince, after whom the county is named. Many of the older churches were founded by or dedicated to his descendants during the age of the Celtic saints and monastic missionaries. St. Illtud, who greatly influenced the foundation of early scholarship in south Wales, is supposed to have been buried about 480 near one of the churches in the county dedicated to him. Subsequently Bernard de Newmarch conquered the area for the Normans. He built a castle at Talgarth, Brychan's ancient capital on the Llynfi. After advancing westward and fighting a battle at Y Gaer about 1091, in which Bleddyn ap Maenarch, the king of Brycheiniog, was slain, he founded the castle and town of Brecon (Aberhonddu). A number of other castles were erected, some of them on the sites of older defense points established against Mercian attacks. Brycheiniog afterward became a marcher lordship and suffered in the strife which followed. In 1282, Llewelyn, the last native prince of Wales, fell in a skirmish with the English near Builth. Later, Owain Glyndwr (*see* GLENDOWER, OWEN) carried out raids in the area. Warfare was almost continuous until the dissolution of the marcher lordships in 1536 by the Act of Union, when the present county was formed.

In the 17th and 18th centuries the market towns became centres of thriving wool and leather industries, and iron was smelted at various points before the large iron-working communities, on the southern borders of the county, sprang up with the development of the south Wales coal field during the Industrial Revolution. John Penry (1563–93), whose birthplace is preserved at Llangamarch, typified the spirit of Puritanism in this region. Howell Harris (1714–73), a leader of the Methodist revival, was another native of the county.

The most important medieval remains at Brecon are the castle and the cathedral (*see* below), both of Norman foundation, and Christ college, a public school which was founded by charter from Henry VIII in the 13th-century Dominican friary on the site of the present school. Tretower court near Crickhowell, parts of which date back to *c.* 1400, is one of the finest examples extant of a lightly fortified dwelling of the period. It was especially associated with the Vaughan family which included Sir Roger Vaughan, the Yorkist, and the metaphysical poet, Henry Vaughan (1622–95), who was a native of the county. Some of the Norman castles remain. Of the many old churches in the county, Llanfilo and Partrishow are of particular interest. The county museum contains collections representative of all periods of Brecknockshire's history.

Population and Administration.—In 1961 the census showed a population of 55,185, including an appreciable number in the various military establishments in the county. The county figure rose from 54,213 in 1901 to 61,069 in 1921 but fell to 52,540 (est.) in 1939. The fluctuation in the total conceals a tendency to a steady decline throughout the 20th century in most of the rural areas. The only municipal borough is Brecon (*q.v.*), the county town. There are four urban districts: Brynmawr, Builth Wells, Hay (*qq.v.*) and Llanwrtyd Wells.

The county forms part of the south Wales circuit, and the assizes are held at Brecon. It has one court of quarter sessions and is divided into ten petty sessional divisions. The county is not divided for parliamentary purposes and until 1918 returned one member to parliament; after that time its representation was joined with that of the county of Radnor. There are 89 civil parishes. Ecclesiastically the county is part of the diocese of Swansea and Brecon, which was formed in 1923 out of the ancient dioceses of St. David's and Llandaff. The fine old Benedictine priory of St. John at Brecon became the cathedral of the new diocese.

Industries and Communications.—Agriculture is the county's chief occupation. Nearly 50% of its area is rough grazing and, the average rainfall varying from about 30 in. per annum at Hay to nearly 100 in. on the Brecon Beacons, the emphasis is on beef cattle and sheep rearing, though arable farming is undertaken on the lower valley lands, especially the fertile alluvial soils of the Usk and Llynfi valley regions. The Brecknockshire Agricultural society is one of the oldest in Great Britain, dating from 1755. Extensive afforestation has also been undertaken. The mining of anthracite coal is an important industry in the Ystradgynlais district in the southwest of the county, and the quarrying of limestone and silica rock is undertaken near the southern boundary. A small part of the southern region of the county was included in the south Wales and Monmouthshire development area defined after World War II, and a few new industries, including one employing disabled persons at Ystradgynlais, were introduced. Its scenic beauty makes Brecknockshire a tourist county; more than half its area was designated in 1955 as part of the Brecon Beacons National park.

Single-track railways radiate from Brecon in the centre of the county to Builth Wells and Moat Lane, Hereford, Newport, Merthyr Tydfil and Neath. The Craven Arms-Swansea line runs through the north of the county. The pattern of main roads is similar, trunk or class I roads running from Brecon to Builth Wells and north Wales, Hereford, Newport, Cardiff, Swansea and Carmarthen. The Swansea-Manchester trunk road runs through the Irfon valley and the Neath-Abergavenny trunk road passes along the southern edge of the county. The Brecon-Newport canal, opened in 1800 but, like the Ystradgynlais-Swansea canal, disused for many years, is being repaired for pleasure boats on the length between Brecon and Pontypool.

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BRECON (BRECKNOCK; Welsh, ABERHONDDU), a cathedral town, municipal borough and county town of Brecknockshire, Wales, is 42 mi. N.N.W. of Cardiff. Pop. (1961) 5,797. It lies where the Honddu from the north and the Tarell from the south enter the Usk, near the centre of the county. Its site commands routes from Builth Wells in the north, Llandovery in the west, Merthyr Tydfil in the south, Crickhowell in the southeast and Hay in the northeast. About 3 mi. W. of the town is the Roman fort known as Y Gaer, garrisoned during the 2nd century by a squadron of Spanish cavalry. Brecon maintained the importance of its nodal site selected by the Romans. Bernard de Newmarch conquered the district known as Brycheiniog (named for Brychan, son of a 5th-century Welsh chieftain) and probably built the original Norman castle in 1092. Bernard de Newmarch subsequently founded, near the castle, the Benedictine priory of St. John. Nothing remains of the original church except portions of the nave, but it was entirely rebuilt in the first half of the 13th century and the 14th century with Early English and Decorated additions. In 1923 it was made the cathedral of the newly constituted diocese of Swansea and Brecon.

The town, picturesquely situated, is remarkable for its medieval plan and for its Georgian buildings. Around the original castle and priory a small medieval town grew up. It received a series of charters from the de Bohuns, into which family the castle and lordship passed, the earliest recorded charter being granted by Humphrey, 3rd earl of Hereford. A Dominican friary (now Christ college) was established southwest of the town and was refounded by Henry VIII in 1542 as a collegiate church and school. The position of the town offered special facilities during Tudor economic developments for the establishment of trade guilds as well as a guildhall. There were formerly five guilds, the main industries being cloth and leather manufacture. Brecon destroyed its castle to preserve its neutrality during the Civil War, and in 1645 Charles I, while staying at Brecon priory, wrote the famous letter to his son in which he tells him to "prepare for the worst." Thomas Coke, founder of the American Methodist Episcopalian Church, the actress Mrs. Sarah Siddons and her brother Charles Kemble were all born in the town. There are two ancient pleasure fairs, and stock fairs are held monthly.

BREDA, the name of two Italian industrialists, cousins, who did much to develop Italy's railway and heavy engineering industries during the 19th and early 20th centuries.

VINCENZO STEFANO BREDA (1825–1903) was born at Limena (Padua) on April 30, 1825, and became a railway engineer. In 1854 he founded a society for the development of railways in central Italy, in 1872 the Società Veneta for public engineering projects, and is best remembered for his foundation of the Terni steelworks (*see* TERNI). He also took an interest in agriculture and promoted horse racing. He died at Padua on Jan. 4, 1903.

ERNESTO BREDA (1852–1918), born at Campo San Martino (Padua), worked first under Vincenzo Stefano Breda, his cousin, at the Terni plant. In 1886 he founded the heavy engineering firm known from 1900 onward as the Società Italiana Ernesto Breda, with works at Sesto San Giovanni near Milan. By the outbreak of World War I this firm was producing numerous locomotives for the Italian state railways, besides agricultural machinery. Ernesto Breda rapidly put the works on a wartime production footing, created a steel plant and exploited hydroelectric power. At this period also the firm began to produce airplanes and aircraft engines, as well as electric locomotives. At the same time Breda planned postwar reconversion and a scientific metallurgical research institute. He died in Milan on Nov. 6, 1918. (S. Lo.)

BREDA, town, province of North Brabant, Neth., at the confluence of the Merk (Mark) and Aa rivers. Pop. (1960) 107,843. Breda was in the 12th century a direct fief of the duchy of Brabant, its earliest known lord being Godfrey I (1152–1170), in whose family it continued, until 1327, when Gerard of Rassoghem sold his rights to Brabant. It passed ultimately to William I of Orange (1533–84). Breda obtained municipal rights in 1252. It was fortified 1531–36 by Count Henry of Nassau, who restored the old castle built by John of Polanen in 1350. It remained until the 19th century an important fortress on the Mark. Captured by the Spaniards in 1581, it fell again into the hands of Maurice of Nassau in 1590. Its surrender to the Spaniards (1625) is the subject of the famous picture by Velázquez in the Museo del Prado in Madrid. In 1637 Breda was recaptured by Frederick Henry of Orange, and in 1648 was finally ceded to the Netherlands by the treaty of Westphalia. It was the residence during exile of Charles II of England. In 1696 William of Orange, King of England, completed the castle (now the Royal Military academy). During the French Revolution it was taken by (Charles François) Dumouriez in 1793, evacuated soon after and retaken by Charles Pichegru in 1795. In 1813 the citizens of Breda again made themselves masters of the town. In 1575 a conference was held there between the ambassadors of Spain and the United Provinces; in 1667 a peace was signed by England, the Netherlands, France and Denmark. The town has a fine quay, town hall and park. The principal Protestant church (Grote Kerk) is a Gothic building (15th century), with a fine tower, and a choir (of 1410). The population of Breda was evacuated in May 1940 and the town was liberated from the Germans in Oct. 1944.

The seat of a Roman Catholic bishop, the town's manufactures include the making of machinery, artificial silk, matches and chocolate.

BREDERO, GERBRAND ADRIAENSZOON (1585–1618), Dutch poet and playwright, the rugged epitome of an age of change and conflict. Born in Amsterdam, March 16, 1585, he was of humble origins and little learning, yet he had artistic leanings and poetic genius; and his erotic temperament warred with his stern Protestant convictions. The irreconcilable conflict between his birthright—the medieval, full-blooded life of the back streets of Amsterdam—and the sophistication of the Renaissance intelligentsia is most evident in his earliest poetry, contained in *Groot Liedt-Boeck* (1622). Here, the humorous poems reveal a power of observation rivaling that of the painters Jan Steen and Adriaen van Ostade (*qq.v.*), while the sensuality of the amorous songs and sonnets strikes a wild contrast to the sincerity and often the remorse of the devotional poetry.

His dramatized versions of Spanish romances show his true talent only in the comic intermezzos and indeed his farces, the best of which is *Klucht van de Koe* (1612), with their trenchant caricature and brisk Terentian dialogue, provide the best and the last of this medieval genre. But his comedy *De Spaanschen Brabander* (1617) makes Bredero unique in Dutch letters. This play, inspired by the Spanish picaresque novel *Lazarillo de Tormes,* is truly great, like the medieval poem *Vanden Vos Reinaerde,* because of its humanity and wit. While championing the quick-witted underdog at the expense of the pompous hidalgo, it also provides a salutary corrective to the romantic notion that the Golden Age was a period of universal prosperity and culture. Bredero died, Aug. 23, 1618, in Amsterdam.

See his *Werken*, ed. by J. A. N. Knuttel, 3 vol. (1918–29); *G. A. Bredero Toneelwerk*, ed. by A. A. van Rhijnbach (1942). (P. K. K.)

BREDERODE, HENDRIK, Lord of (1531–1568), the popular resistance leader during the first phase of the revolt of the Netherlands, was born in Brussels on Dec. 20, 1531, of a family whose genealogy reaches back to 1205 and who from 1418 had also held the lordship of Vianen, south of Utrecht. A soldier, hard-drinking, reckless and jovial, Hendrik seems to have been moved above all by hatred of popery and (true to his family traditions) by resentment against the encroaching monarchical power. Succeeding to the family titles in 1556, he joined the league of great nobles who succeeded in 1564 in getting rid of Cardinal Granvelle, his relative by marriage (*see* Netherlands, The: *Philip II*). Sharing the more radical sentiments of the gentry, he became in Dec. 1565 one of the leading men of the newly founded confederacy of the lesser nobility, which had a markedly Protestant tinge. On April 5, 1566, it was he who, at the head of approximately 300 gentlemen, presented to the regent Margaret of Parma, at Brussels, the petition known as the "Compromise of the Nobility" asking for a new religious policy. He continued to press for freedom of conscience. During the reaction following the excesses of the iconoclasts in 1566, he refused to take the oath of unconditional loyalty demanded by the regent. Resorting to force, he made military preparations at Vianen, raised troops at Antwerp and elsewhere and took a prominent part in an abortive Calvinist rising. Having vainly tried to win over Amsterdam, he fled to Emden on April 27, 1567. He died at Harenburg castle near Recklinghausen on Feb. 15, 1568. (A. G. J.)

BREEZE. A current of air less than a wind, which in turn is less than a gale. (*See* Beaufort Scale.) The term is qualified in many different ways; *e.g.*, glacial breeze—a cold breeze blowing down the course of a glacier; lake breeze—light wind blowing on to the coast of a lake in sunny weather during the middle of the day; mountain breeze—a mass of air flowing down into the valley during the night; valley breeze—a day breeze blowing up the valleys. The unqualified term is usually applied to the light wind blowing landwards by day, sea breeze, and the counter wind blowing offshore at night, land breeze.

BRÉGUET, LOUIS CHARLES (1880–1955), French aviation pioneer and founder of Air France, was born Jan. 2, 1880, in Paris, a descendant of the famous watchmaker, Abraham Louis Bréguet. Educated at the Lycées Condorcet and Carnot and at the École Supérieure d'Electricité, he joined the family engineering firm, Maison Bréguet, becoming head engineer of its electric service. He published reports on aerodynamics, and in 1917 built and flew a "gyroplane," the forerunner of the helicopter. He built his first airplane in 1909, set a speed record for 10 km. in 1911, and in that year founded the Société des Ateliers d'Aviation Louis Bréguet. In 1912 he built his first hydroplane. He built military planes in World Wars I and II, and in 1919 founded the Compagnie des Messageries Aériennes, which ultimately became Air France. He died at St. Germain-en-Laye, Paris, May 4, 1955.

BREHON LAWS, more properly called *Feinechus*, were the ancient laws of Ireland. Brehon (*Breitheamh*) is the Irish word for judge. Regular courts and judges existed in Ireland from prehistoric times.

The extant remains of these laws are manuscript transcripts from earlier copies made on vellum from the 8th to the 13th century, now preserved with other Gaelic manuscripts in Trinity college and the Royal Irish academy, Dublin, the British museum Oxford university, some private collections and several libraries on the continent of Europe. The largest and most important of these documents is the *Senchas Már*, or "Great Old Law Book." No copy of it now existing is complete. What remains of it occupies the first, second and a portion of the third of the volumes produced by the Brehon Law commission appointed in 1852.

In the *Annals of the Four Masters* it is said: "The age of Christ 438, the tenth year of King Laeghaire (Lairy), the *Senchas Már* and *Feinechus* of Ireland were purified and written." This entry has some historical corroboration.

The text and earlier commentaries are in the *Bearla Feini*—the most archaic form of the Gaelic language. Many words, phrases and idioms are now obsolete and so difficult to translate that the official translations are to some extent confessedly conjectural. Frequently only the opening words of the original text remain. Wherever the text is whole, it is curt, elliptical and yet rhythmical. The rigorously authentic character of these laws, relating to, and dealing with, the actual realities of life, and with institutions and a state of society nowhere else revealed to the same extent, the extreme antiquity both of the provisions and of the language, and the meagreness of continental material illustrative of the same things endow them with exceptional archaic, archaeological and philological interest. No man was allowed to act as judge until he had studied the full law course, which occupied 20 years, and had passed a rigorous public examination. The course of study for judge and law agent, respectively, is carefully laid down. The Brehon was an arbitrator, umpire and expounder of the law rather than a judge in the modern acceptation. It appears, without being expressly stated, that the facts of a case were investigated and ascertained by laymen before submission to a Brehon for legal decision. The complainant could select any Brehon he pleased, if there were more than one in his district. Every king or chief of sufficient territory retained an official Brehon, who was provided with free land for his maintenance and acted as registrar or assessor in the king's court. In ordinary cases the Brehon's fee was said to have been one-twelfth of the amount at stake.

Assemblies, national, provincial and local, were a marked characteristic of ancient Irish life. They all, without exception, discharged legal, legislative or administrative functions. Most of the assemblies were annual, some triennial, some lasted only a day or two, others a week and occasionally longer. All originated in pagan funeral or commemorative rites and continued to be held, even in Christian times, in very ancient cemeteries. They were called by different names—*Feis, Aenach, Dál*, etc. At one assembly held at Uisneach about a century before Christ a uniform law of distraint for the whole of Ireland was adopted. Each provincial kingdom and each *tuath* had assemblies of its own. Very careful provision is made for the preparation of the sites of great assemblies, and the preservation of peace and order at them is sanctioned by the severest penalties of the law.

The Clan System.—*Tuath, Cinel* and *Clann* were synonyms meaning a small tribe or nation descended from a common ancestor. The theory of common origin was not rigidly adhered to, a king and clan being able, subject to certain limitations, to adopt new members or families, or amalgamate with another clan. Kinship with the clan was an essential qualification for holding any office or property. The rules of kinship largely determined status with its correlative rights and obligations, supplied the place of contract and of laws affecting the ownership, disposition and devolution of property, constituting the clan an organic, self-contained entity, a political, social and mutual insurance copartnership. The solidarity of the clan was its most important and all-pervading characteristic. According to the traditional view the entire territory occupied by a clan was the common and absolute property of that clan, a portion being set apart for the maintenance of the king. Warriors, statesmen, Brehons, Ollamhs, physicians, poets and even eminent workers in the more important arts were also rewarded with free lands. Rank, with the accompanying privileges, jurisdiction and responsibility, was based upon a qualification of kinship and of property, held by a family for a specified number of generations, together with certain concurrent conditions; and it could be lost by loss of property, crime, cowardice or other disgraceful conduct. A portion of land called the *Cumhal Senorba* was devoted to the support of widows, orphans and old childless people. According to the later and now very generally accepted view of John (Eoin) MacNeill there was no communal holding of land by the clan. Clan itself meant little more than a princely family, like, say, the Hohenzollerns in Germany. There was no land, blood or personal name common to the people subject to such a family. Anything in the nature of common holding or redistribution of land was confined to the joint families next to be described.

Fine (*finĕ*), originally meaning family, came in course of time to be applied to a group of kindred families or a joint family group of four generations. Even those who adhere to the traditional view of the clan will admit that in course of time a large and increasing proportion of the good land became limited private property. The area of arable land available for the common use of the clansmen was gradually diminished by these encroachments. The land belonging to the joint family (*finĕ*) was at intervals liable to redistribution when the joint family broke up. In this distribution men might or might not receive again their former portions. In the latter case compensation was made for unexhausted improvements. This land could not be sold, nor even let except for a season in case of domestic necessity. The holders had no landlord and no rent to pay for this land and could not be deprived of it except for a crime. They were subject only to public tributes and the ordinary obligations of free men. The unfenced and unappropriated common lands—waste, bog, forest and mountain—all clansmen were free to use promiscuously at will.

Tenure of Land.—There was hardly any selling and little letting of land in ancient times. Nobles and other persons holding large areas let to clansmen not the land but rather the grazing of a number of cattle specified by agreement. They also let cattle to a clansman who had none or not enough, and this was the most prevalent practice. There were two distinct methods of letting and hiring—*saer* ("free") and *daer* ("unfree"), the conditions being fundamentally different. The conditions of *saer*-tenure were largely settled by the law, were comparatively easy, did not require any security to be given, left the clansman free within the limits of justice to end the connection, left him competent in case of dispute to give evidence against that of the noble and did not impose any liability on the joint family of the clansman. By continued use of the same land for some years and discharge of the public obligations in respect of it in addition to the *ciss* or payment as tenant, a clansman became a subowner or permanent tenant and could not be evicted. There is no provision in these laws for evicting anyone. For the hire of cattle a usual payment was one beast in seven per annum for seven years, after which the cattle that remained became the property of the hirer. *Daer*-tenure, whether of cattle or of the right to graze cattle upon land, was subject to a *ciss-ninsciss* ("wearisome tribute"), for the payment of which security had to be given. A man not in the enjoyment of full civil rights, if able to find security, could become an unfree clansman. A free clansman by becoming an unfree clansman lowered his own status and that of his joint family, became incompetent to give evidence against that of a noble, and could not end the connection until the end of the term except by a large payment. The members of his joint family were liable, in the degree of their relationship, to make good out of their own property any default in the payments. Hence this tenure could not be legally entered into by a free clansman without the permission of his joint family. Unfree clansmen were also exposed to casual burdens, like that of lodging and feeding soldiers when in their district. All payments were made in kind. When the particular kind was not specified by the law or by agreement, the payments were made according to convenience in horses, cattle, sheep, pigs, wool, butter, bacon, corn, vegetables, yarn, dye plants, leather, cloth, articles of use or ornament, etc.

People who did not belong to the clan and were not citizens were in a base condition and incompetent to appear in court in suit or defense except through a freeman. The *Bothach* ("cottier") and the *Sen-cléithe* ("old dependent") were people who, though living for successive generations attached to the families of nobles, did not belong to the clan and had no rights of citizenship. *Fuidhirs*, or manual labourers without property, were the lowest section of the population. Some were born in this condition, some clansmen were depressed into it by crime, consequences of war or other misfortune; and strangers of a low class coming into the territory found their level in it. The *fuidhirs* also were divided into free and unfree, the former being free by industry and thrift to acquire some property, after which five of them could club together to acquire rights corresponding to those of one freeman. The unfree *fuidhirs* were tramps, fugitives, captives, etc.

Fosterage, the custom of sending children to be reared and educated in the families of fellow clansmen, was prevalent among the wealthy classes. A child in fosterage was reared and educated suitably for the position it was destined to fill in life. There was fosterage for affection, for payment and for a literary education. Fosterage began when the child was a year old and ended when the marriageable age was reached, unless previously terminated by death or crime. Every fostered person was under an obligation to provide, if necessary, for the old age of foster parents. The affection arising from this relationship was usually greater, and was regarded as more sacred, than that of blood relationship.

Law of Contract.—The solidarity of clan and joint family in their respective spheres, the provisions of the system, the simple rural life and the prevalence of barter and payments in kind left comparatively little occasion for contracts between individuals. Consequently the rules relating to contract are not very numerous. They are, however, sufficiently solemn. No contract affecting land was valid unless made with the consent of the joint family. Contracts relating to other kinds of property are more numerous. When important or involving a considerable amount, they had to be made in the presence of a noble or magistrate. The parties to a contract should be free citizens, of full age, sound mind, free to contract and under no legal disability. "The world would be in a state of confusion if express contracts were not binding." From the repeated correlative dicta that "nothing is due without deserving," and that a thing done "for God's sake," *i.e.*, gratis, imposed little obligation, it is clear that the importance of valuable consideration was fully recognized. So also was the importance of time. "To be asleep avails no one"; "Sloth takes away a man's welfare." Contracts made by the following persons were invalid: (1) a servant without his master's authority; (2) a monk without authority from his abbot or manager of temporalities; (3) a son subject to his father without the father's authority; (4) an infant, lunatic or "one who had not the full vigilance of reason"; (5) a wife in relation to her husband's property without his authority. She was free to hold and deal with property of her own and bind it by contract. If a son living with his father entered into a contract with his father's knowledge, the father was held to have ratified the contract unless he promptly repudiated it. "One is held to adopt what he does not repudiate after knowledge, having the power." Contract of sale or barter with warranty could be dissolved for fraud, provided action was taken within a limited time after the fraud had become known. Treaties and occasional very important contracts were made "blood covenants" and inviolable by drawing a drop of blood from the little finger of each of the contracting parties, blending this with water, and both drinking the mixture out of the same cup. The forms of legal evidence were pledges, documents, witnesses and oaths. In cases of special importance the pledges were human beings, "hostage sureties." These were treated as in their own homes according to the rank to which they belonged and were discharged on the performance of the contract. If the contract was broken they became prisoners and might be fettered or made to work as slaves until the obligation was satisfied. Authentic documents were considered good evidence. A witness was in all cases important and, in some, essential to the validity of a contract. His status affected the force of the contract as well as the value of his evidence; and the laws appear to imply that by becoming a witness a man incurred liabilities as a surety. The pre-Christian oath might be by one or more of the elements, powers or phenomena of nature, as the sun, moon, water, night, day, sea, land. The Christian oath might be on a copy of the Gospels, a saint's crozier, relic or other holy thing.

Criminal Laws.—These laws recognized crime, but in the same calm and deliberate way in which they recognized contract and other things seriously affecting the people. Although we find in the poems of Dubhthach, written in the 5th century and prefixed to the *Senchas Már*, the sentences "Let every one die who kills a human being," and "Every living person that inflicts death shall suffer death," capital punishment did not prevail in Ireland before or after. The laws uniformly discountenanced revenge, retaliation, the punishment of one crime by another, and permitted capital punishment only in the last resort and in ultimate default of every other form of redress. They contain elaborate provision for dealing with crime, but the standpoint from which it is regarded and treated is essentially different from ours. The state, for all its elaborate structure, did not assume jurisdiction in relation to any crimes except political ones, such as treason or the disturbance of a large assembly. For these it inflicted the severest penalties known to the law—banishment, confiscation of property, death or putting out of eyes. A crime against the person, character or property of an individual or family was regarded as a thing for which reparation should be made, but the individual or family had to seek the reparation by a personal action. This differed from a civil action only in the terms employed and the elements used in calculating the amount of the reparation. The function of a judge in a criminal as in a civil action was to see that the facts, with modifying circumstances, were fully and truly submitted to him, and then by applying the law to these facts to ascertain and declare the amount of compensation that would make a legal adjustment. For this amount the guilty person, and in his default his kindred, became legally debtor, and the injured person or family became entitled to recover the amount like a civil debt by distraint. There were no police, sheriffs or public prisons. The decisions of the law were executed by the persons concerned, supported by a highly organized and disciplined public opinion springing from honour and interest and inherent in the solidarity of the clan. MacNeill, however, contends that the state took a far more active part in enforcing Brehon decisions than that herein described, the king in general acting as judge, subject to professional advice. There is good reason to believe that the system was as effectual in the prevention and punishment of crime and in the redress of wrongs as any other human contrivance has ever been.

In calculating the amount of compensation the most characteristic and important element was *Enechlann* ("honour-price," "honour-value"), a value attached to every free person, varying in amount from one cow to 30 cows according to rank. It was the assessed value of *status* or *caput*. It was frequently of consequence in relation to contracts and other clan affairs; but it emerges most clearly in connection with crime. By the commission of crime, breach of contract or other disgraceful or injurious conduct, Enechlann was diminished or destroyed, a *capitis diminutio* occurred, apart from any other punishment. Though existing apart from fine, Enechlann was the first element in almost every fine. *Dire* was the commonest word for fine, whether great or small. *Eric* ("reparation," "redemption") was the fine for "separating body from soul"; but the term was used in lighter cases also. In capital cases the word sometimes meant Enechlann, sometimes *coirp-dire* ("body-fine"), but most correctly the sum of these two. It may be taken that, subject to modifying circumstances, a person guilty of homicide had to pay (1) *coirp-dire* for the destruction of life, irrespective of rank; (2) the honour-value of the victim; (3) his own honour-value if the deed was unintentional; and (4) double his own honour-value if committed with malice aforethought. The sum of these was in all cases heavy; heaviest when the parties were wealthy. The amount was recoverable as a debt from the criminal to the extent of his property, and, in his default, from the members of his joint family in sums determined by the degree of relationship; and it was distributable among the members of the joint family of a murdered person in the same proportions, like a distribution among the next of kin. The joint family of a murderer could free themselves from liability by giving up the murderer and his goods, or, if he escaped, by giving up any goods he had left, depriving him of clanship and lodging a pledge against his future misdeeds. In these circumstances the law held the criminal's life forfeit, and he might be slain or taken as a prisoner or slave. He could escape only by becoming an unfree labourer in some distant territory. When the effect of a crime did not go beyond an individual, if that individual's joint family did not make good their claim while the criminal lived, it lapsed on his death. "The crime dies with the criminal." If an unknown stranger or person without property caught red-handed in the commission of a crime refused to submit to arrest, it was lawful to maim or slay him according to the magnitude of the attempted crime. "A person who came to inflict a wound on the body may be safely killed when unknown and without a name, and when there is no power to arrest him at the time of committing the trespass." For crimes against property the usual penalty, as in breach of contract, was generic restitution, the quantity, subject to modifying circumstances, being twice the amount taken or destroyed.

Law of Distress.—Distress or seizure of property being the universal mode of obtaining satisfaction, whether for crime, breach of contract, nonpayment of debt or any other cause, the law of distress came into operation as the solvent of almost every dispute. Hence it is the most extensive and important branch, if not more than a branch, of these ancient laws. There was no sale, because sale for money was little known. The property in the thing seized, to the amount of the debt and expenses, became legally transferred from the debtor to the creditor, not all at once but in stages fixed by law. A creditor was not at liberty to seize household goods, farming utensils or any goods the loss of which would prevent the debtor recovering from embarrassment, so long as there was other property which could be seized. A seizure could be made only between sunrise and sunset. "If a man who is sued evades justice, knowing the debt to be due of him, double the debt is payable by him and a fine of five *seds*." When a large debt was clearly due and there was no property to seize, the debtor himself could be seized and compelled to work as a prisoner or slave until the debt was paid.

When a defendant was of superior rank to that of the plaintiff, distress had to be preceded by *troscad* ("fasting"). This is a legal process unknown elsewhere except in parts of India. The plaintiff, having made his demand and having waited a certain time without result, went and sat without food before the door of the defendant. To refuse to submit to fasting was considered indelibly disgraceful and was one of the things which legally degraded a man by reducing or destroying his honour-value. The law said, "he who does not give a pledge to fasting is an evader of all; he who disregards all things shall not be paid by God or man." If a plaintiff having duly fasted did not receive within a certain time the satisfaction of his claim, he was entitled to distrain as in the case of an ordinary defendant, and to seize double the amount that would have satisfied him in the first instance. If a person fasting in accordance with law died during or in consequence of the fast, the person fasted upon was held guilty of murder. Fasting could be stopped by paying the debt, giving a pledge or submitting to the decision of a Brehon. A creditor fasting after a reasonable offer of settlement had been made to him forfeited his claim. "He who fasts notwithstanding the offer of what should be accorded to him, forfeits his legal right."

BIBLIOGRAPHY.—Pending the work of a second Brehon Law commission, the laws are best studied in the six imperfect volumes (*Ancient Laws of Ireland*, 1865–1901) produced by the first commission (ignoring their long and worthless introductions), together with Whitley Stokes's *Criticism* (1903) of Atkinson's *Glossary* (1901). The following are important references (kindly supplied by Stokes) for detailed research:—R. Dareste, *Études d'histoire de droit*, pp. 356–381 (1889); Arbois de Jubainville and Paul Collinet, *Études sur le droit celtique*, 2 vol., (1895); Patrick W. Joyce, *Social History of Ancient Ireland*, vol. i., pp. 168–214 (1903); *Zeitschrift für celtische Philologie*, vol. 4, p. 221 (*see* also vol. 14, p. 1 and vol. 15); the Copenhagen fragments of the laws (1903); important letters in *The Academy*, nos. 699, 700, 701, 702, 703, 704, 706, 707 (substantially covered by Stokes's *Criticism*); *Revue Celtique*, vol. xxv, p. 344; *Eriu*, vol. i, pp. 209–315 (collation by Kuno Meyer of the law tract Crith Gablach). Maine's *Early History of Institutions* (1875) and *Early Law and Custom*, pp. 162, 180 (1883); William E. Hearn's *Aryan Household* (1879) and Maclennan's *Studies*

in Ancient History, pp. 453–507 (1876), contain interesting general references, but the writers were not themselves original students of the laws. L. Ginnell's *Brehon Laws* (1894) may also be consulted. *See* also A. Ua Clerigh, *History of Ireland to the Coming of Henry II*, ch. 14 and 15 (1908); J. MacNeill, *Phases of Irish History*, ch. 10 and 12 (1919); S. Bryant, *Liberty, Order and Law Under Native Irish Rule* (1923); R. Thurneysen, *Cōic Conara Fugill* (*Die fünf Wege zum Urteil*) (1926). (M. J. R.; A. E. C.)

BREISACH, a town of Germany, stands on a basalt rock 250 ft. above the Rhine, 16 km. (10 mi.) W. of Freiburg. Pop. (1959 est.) 4,778. Breisach has a fine minster, partly Romanesque, partly Gothic, dating from the 10th to the 15th centuries. The interior is remarkable for the wood carving of the high altar, and for tombs and pictures. Although most of the town was destroyed in World War II, it has been rebuilt in the original style. On the opposite bank of the Rhine, connected by a road bridge, lies the little town of Neubreisach, built as a fortress by Louis XIV. Railways run to Freiburg and Riegel. Breisach trades in textiles and electrical goods and also in wines and other agricultural produce. Breisach (ancient Brisiacum) was a stronghold of the Sequani (*q.v.*). It was captured in the time of Julius Caesar by Ariovistus and became known as the Mons Brisiacus. Fortified by the emperor Valentinian in 369 to defend the Rhine against the Germans, it remained throughout the middle ages as one of the chief bulwarks of Germany and was called the "cushion and key (*Kissen und Schlüssel*) of the German empire." It gave its name to the district Breisgau. In 939 it was taken by the German King Otto I. In 1254 and 1262 the bishops of Basel obtained full control over it, but in 1275 it was made an imperial city by King Rudolf I, and the Habsburgs possessed it from the 14th century. In the Thirty Years' War Breisach successfully resisted the Swedes, but it was forced to capitulate to the Protestants after a memorable siege in 1638. The French held it from 1648, and it was several times besieged by them after its restoration to Austria in 1697. By the peace of Pressburg (1805) it was finally incorporated into Baden, and the fortifications were razed. Two medieval gates, however, remain. After the merger of Baden *Land* in 1952, Breisach became a town of Baden-Württemberg, Federal Republic of Germany.

BREISGAU, the most southwesterly district of Germany, and originally an Alamannic province, lies in the upper Rhine plain between Kenzingen and Lörrach and is bounded by the Black Forest. In the early middle ages the Zähringen counts ruled Breisgau, founding the town of Freiburg in 1120. The Zähringen counts died out in 1218 and the countship was partitioned between the line of Zähringen margraves and the counts of Freiburg. From the 14th century the Habsburgs began to extend their influence east of the Rhine and by the end of this century Breisgau, except for the so-called margrave lands and the lordship of Hachberg, formed with the lordships of Hauenstein and Triberg a constituent part of the Austrian lands. In 1457 Albert VI of Austria founded the university at Freiburg. Breisgau suffered heavily during the Peasants' War and the Thirty Years' War, Freiburg undergoing many sieges and falling for a while into Swedish hands. In 1665 the Austrian *Vorlande* reverted to the senior Habsburg line, but in Feb. 1679, when the emperor Leopold I accepted the treaty of Nijmegen, Freiburg passed under French rule, only being returned to Austria, together with Breisach, by the treaty of Rijswijk in 1697. By the peace of Lunéville in 1801 Breisgau was given to the duke of Modena to compensate for the surrender of his duchy to Napoleon, and at the peace of Pressburg in 1805 the countship was divided between Baden and Württemberg. The latter ceded its portion to Baden in 1806. (M. Kr.)

BREITENFELD, BATTLES OF, two engagements in the Thirty Years' War (*q.v.*), fought near the village of Breitenfeld (now a suburb of Leipzig) in Saxony.

The First Battle.—On Sept. 17 (new style; Sept. 7, old style), 1631, the army of the Catholic league under Tilly was decisively defeated by Gustavus Adolphus of Sweden. Tilly's invasion of Saxony at the end of August, intended to force the elector to abandon his neutrality, had led instead to a Swedish-Saxon alliance. Confronted by the Swedish army of 16,000 foot, 10,000 horse and 50 guns as well as by the Saxon army, under Hans von Arnim, of 14,000 foot (mostly untrained militia), 6,000 horse and 20 guns, Tilly, who had only about 21,000 foot (13,000 veterans of the league and 8,000 imperial troops), 15,000 horse (8,000 veterans, 7,000 imperial) and 27 guns, wanted at first to effect a junction with strong detachments of imperial troops in Thuringia and Hesse, but was persuaded by his cavalry commander, Gottfried von Pappenheim, to accept battle. He arrayed his army, in accordance with the classical Spanish tactics, in 13 unwieldy squares composed equally of musketeers and of pikemen, with the imperial cavalry on the right and the league horse under Pappenheim on the left. Gustavus Adolphus, on the other hand, interspersed his flexible infantry units (with two musketeers to one pikeman) with cavalry shock squadrons. The Saxon army on the Swedish left was quickly overrun by the Bavarians and pursued by Johann Isolani's cavalry, and Tilly then tried to outflank the Swedes. Meanwhile, however, the Swedish right had, by its well-drilled combination of infantry and artillery fire, completely routed Pappenheim's cuirassiers. Thus, while Gustaf Horn on the Swedish left built up a new front, Gustavus Adolphus, supported by Lennart Torstensson's artillery, could wheel his right and centre against Tilly's exposed left, capturing the guns and mowing down the now defenseless squares. Tilly, seriously wounded, escaped with a few thousand men, having lost more than 12,000 men on the field. The Swedish losses amounted to about 1,500, the Saxon to 2,000. The victory opened central and southern Germany to the Swedes. The age of the Spanish infantry was over; the military future lay with the shock attack of heavy cavalry preceded by the disciplined fire-power of guns.

The Second Battle.—On Nov. 2 (N.S., Oct. 23, O.S.), 1642, a Swedish-French army under Torstensson and the comte de Guébriant (J. B. de Budes) defeated an imperial army under Ottavio Piccolomini. Four days later, Leipzig surrendered to the Swedes. (S. H. S.)

BREITINGER, JOHANN JAKOB (1701–1776), Swiss writer, like his friend J. J. Bodmer (*q.v.*), one of the most influential 18th-century literary critics in Germany, was born in Zürich, March 15, 1701. He studied theology and became professor at the Collegium Carolinum. He lectured on Hebrew, Greek, Latin, logic and rhetoric, showed his excellence as a philologist in many editions, and advocated education on humanist lines (Zürich school reform, 1765–75).

Inspired by the *Spectator* papers of Joseph Addison and Richard Steele, Breitinger founded the weekly *Discourse* (1721–23) for which he wrote essays on morals and aesthetics. The most important of his many publications, however, was the *Critische Dichtkunst* (1740), in which he attacked the narrowly rationalist *Dichtkunst* of the Leipzig "literary pope" J. C. Gottsched (*q.v.*) (1730), which was chained to Latin and French patterns. Breitinger stressed the place of the imagination and the wonderful in poetry; fired the German public with enthusiasm for Homer; and spread the ideas of John Locke, Lord Shaftesbury and Alexander Pope. He was visited by Goethe and others, and his pupils included J. K. Lavater and J. H. Pestalozzi. He died in Zürich, Dec. 14, 1776.

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BREMEN, a city and the largest port, after Hamburg, of Germany, the capital of the *Land* of Bremen and one of the old free Hanseatic towns. It extends 27 mi. along the Weser, covering 125 sq.mi., and is 46 mi. from the North sea. Pop. (1959 est.), 552,025. The old town (*Altstadt*) occupies a sandy slope on the right bank of the river. In the 17th century the new town (*Neustadt*) on the left bank was added to it. Suburban expansion was rapid after the late 19th century and there were large-scale incorporations of rural communities in 1902, 1921, 1939 (when some former Prussian boroughs to the north and southeast were also added) and 1945. Other satellite towns have risen in the east and south: Neue Vahr, Huchting and others. In Bremen city the Weser is spanned by five bridges (the Grosse Weser bridge mentioned as early as 1250, was reconstructed a little farther upstream). At the beginning of the 19th century the town's ramparts were made into promenades.

The old town was severely damaged in World War II, but the Gothic town hall (Rathaus) was spared. Dating from the early 15th century, it has a three-gabled Renaissance façade (early 17th century). Before it stands the statue of Roland (1404), the emblem of ancient legal privileges and imperial freedom. These rights are also embodied in the Gothic sculptures on the Rathaus front, which depict the emperor and the seven electors. Within, the hall is particularly noteworthy for its murals (including "The Judgment of Solomon," painted in 1532 by Bartholomaeus Bruyn) and for its Golden Chamber (Güldenkammer) with rich baroque wood carvings and its 16th- to 18th-century ship models. In 1909–13 a new wing (Neues Rathaus) was built on the site of the former Stadthaus, which in turn stood on the foundations of the archbishop's palace. The Schütting on the opposite side of the market square was the guildhall of the merchant aldermen and dates from the 16th century. It houses the chamber of commerce. Though damaged in World War II, it was restored in its original form. On the site where a wooden church once marked the institution of the bishopric by Charlemagne rises St. Peter's cathedral, an 11th-century structure crowned by two tall spires facing west. At the end of the 19th century restoration was completed and a third spire added. Of the four parish churches, dating mainly from the 13th century, the Church of Our Lady was repaired after World War II, except for its spire; St. Martin's and St. Stephen's were also restored. St. Ansgarius', with its celebrated 310-ft. "helmet" spire, was completely demolished. The old Minorite church of St. John's is used by the Catholic community. Among the notable public buildings the Gewerbehaus (originally the guildhall of the cloth traders, later of the retail traders' guild) and the Essighaus (an example of an old Bremen merchant's house) were restored, while in the early 1960s the Stadtwaage was restored, as were the old houses to the west of the market place and the oldest quarter of the town (the Schnoor and adjoining streets). An important development was the one-family house unit peculiar to Bremen. There are several parks, of which the most beautiful, the Bürgerpark, was founded and is maintained by private gifts.

Industry.—Bremen's economy has always depended greatly on trade and shipping, particularly after the close of the 18th century. A world market for tobacco and the foremost cotton centre on the European continent, Bremen led for a time in the rice trade and in crude oil transactions; then it developed its trade in wool and coffee. Transit and forwarding business also developed. The Norddeutsche Lloyd is the most prominent shipping company, followed by the Hansa, with a network of regular services to India and the middle east. During 1883–94 the Weser was transformed into a waterway capable of carrying ocean-going shipping. Bremen has 9.6 mi. of quays and Bremerhaven 9.1. The main imports are cotton, wool, tobacco, coffee, timber (notably Scandinavian sawn wood), cellulose, grain, citrus fruits, wine, cork, iron and manganese ores, gasoline, oilseed, crude oil and anthracite coal.

Most of the products of Bremen's own industry are exported. Industrial undertakings were originally closely affiliated with commerce and navigation; the main industries were shipbuilding and associated industries and the processing of colonial goods—tobacco, rice, coffee, cocoa, wool, jute and, to some extent, grain. After 1900 large-scale machine production and related industries, automobile manufacturing, electrical industries and smelting of imported ores grew up. Heavy industry (iron and steel production) gained a foothold with the acquisition of the Norddeutsche Hütte by the Klöckner group, and big steel-works were erected.

History.—In 787 St. Willehad, whom Charlemagne had established as missionary bishop of the lower Weser, chose Bremen as his see. When the destruction of Hamburg by the Norsemen in 845 led to the succession of St. Ansgarius, the archiepiscopal title and the office of a north European mission were transferred from Hamburg to Bremen. In 965 the right to establish a market "in the place called Bremun" was conferred on Archbishop Adaldag. Under Archbishop Adalbert (*q.v.*) (*c.* 1043–72), who planned a north European patriarchate, Bremen was a centre for north Europe and experienced its first, though short, period of prosperity. After the close of the 12th century the gradual consolidation of legislation led to the adoption of an independent policy under the leadership of the town council whose main concern was the securing of trade routes by sea and land, priority being given to the defense of the *Dominium Visurgis*, or free access to the sea. The council strove to achieve its purpose by founding on the banks of the lower Weser a coastal state over which it exercised absolute control, while, as early as 1400 efforts were made to attain the freedom of the empire. This was not finally secured until 1646. Bremen entered the Hanseatic league (*q.v.*) in 1358, but often steered its own course. Upon the dissolution of the league (the last meeting took place in 1669) Bremen, with Hamburg and Lübeck, was entrusted with guarding the privileges of the German merchant class.

Bremen was inclined toward the Reformation as early as 1522, but about 1600 it turned away from orthodox Lutheranism and toward Calvinism, establishing a close relationship with its sympathizers in faith, particularly Holland. This had political, economic and cultural consequences. After the Thirty Years' War, Bremen had to defend its status as a free city in two wars against the Swedes, who occupied the ancient diocese of Bremen, and subsequently against the claims of the electors of Hanover, the legal successors to the Swedes in the diocese. However, the new era heralded by the proclamation of the United States of America and by the French Revolution brought with it a notable resurgence which gained momentum when the damage caused by the French occupation (Bremen formed part of the Napoleonic empire in 1810–13) had been overcome. Efficient statesmen, notably Bürgermeister Johann Smidt, secured its independence; Smidt also established its importance as a seaport by the foundation (1827) of Bremerhaven (*q.v.*). Until 1866 Bremen was one of the member states of the German confederation, then of the North German confederation and after 1871 of the reconstituted German empire, in which Bremen and Hamburg held unique positions as a result of their leadership in international trade and world shipping and their port facilities. After the abolition of the monarchy, in 1918, the federal state was transformed into a *land* and new democratic institutions were adopted, while an earlier constitution of 1854 providing for a senate and parliament (*Bürgerschaft*) was repealed. A system of "deputations" permitted citizens to participate in the administration. Later constitutional amendments did not touch these basic functions, and they were incorporated in the constitution of 1920–47. After 1945, Bremen and Bremerhaven together comprised the *land* of Bremen, German Federal Republic.

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(F. J. D. P.)

BREMEN (officially FREIE HANSESTADT BREMEN), the smallest of the ten *Länder* of the German Federal Republic. The population, mostly Protestant, was 706,336 (1961); area, 404 sq.km. (156 sq.mi.). In 1945 the last of the localities in the former rural areas were incorporated in Bremen municipality, and the *land* now consists of two cities, Bremen and Bremerhaven (*qq.v.*). Bremen is the oldest German republic and is governed by a senate elected by the *Bürgerschaft* ("parliament"), with one representative from Bremerhaven for every four from Bremen city.

BREMER, FREDRIKA (1801–1865), Swedish novelist and champion of women's rights, was born at Åbo, Fin., on Aug. 17, 1801. When she was three her father, a wealthy merchant, settled on his own estate at Årsta, near Stockholm, and there she was carefully educated. Her reading included Schiller, as well as the contemporary English novelists, by whom she was deeply impressed. Later she studied Jeremy Bentham, John Stuart Mill and Plato, but above all she read the Bible; her greatest ambition was to prepare for a Christian millennium. Her *Teckningar utur hvardagslifvet*, begun in 1828, introduced the domestic English novel into Swedish literature and was followed by *Familjen H.*

(1831), a great success. Her best novels are *Grannarne* (1837), *Hemmet* (1839) and *En dagbok* (1843). Her works were admirably translated by the poet and writer Mary Howitt (11 vol., 1844–45) and became well known in the United States, where she was warmly welcomed (1849–51). She gave an account of her experiences there in *Hemmen i den nya verlden*, three volumes (1853–54), one of the most interesting of Swedish travel books. Her novels *Hertha* (1856) and *Fader och dotter* (1858) deal with the social effects of assertion of women's rights. From 1856 to 1861 she traveled widely. Her journals, *Lifvet i gamla verlden*, were published during 1860–62. She died at Årsta on Dec. 31, 1865.

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BREMERHAVEN, a port of Germany, situated on the east of the Weser estuary on both banks of the Geeste river at its confluence with the Weser, 61 km. (38 mi.) N. of Bremen. Pop. (1969 est.) 149,290. Bremerhaven became a single municipality by the amalgamation of three separate towns: (1) Bremerhaven, founded as a port on the north bank of the Geeste in 1827 by Bremen's burgomaster Johann Smidt on a strip of territory ceded by Hanover; (2) Geestemünde, founded in competition on the south bank of the Geeste in 1845; and (3) Lehe, a borough dating from medieval times which attained town status in 1920 and was united with Geestemünde four years later to become the town of Wesermünde. In 1939 Bremerhaven was incorporated in Wesermünde and put under Prussian rule. This unified city was restored to the *Land* of Bremen, Federal Republic of Germany, in 1947 and thereafter known as Bremerhaven.

After 1830, when the "Old Harbour" was opened, the docks were expanded by repeated cessions of Prussian territory. They include the Columbus quay and Columbus station which deal with transatlantic passenger traffic. After improvements to the Weser channel freight traffic was increasingly diverted to Bremen. On the Geestemünde (south) bank is the fishery port, the home of much of the German trawler fleet. Shipbuilding flourishes. During World War II Bremerhaven suffered heavy damage, particularly on Sept. 18, 1944, when the central town area was demolished, although the docks were substantially unimpaired. There are museums and 17th-century peasant houses (open-air museum).

See G. Bessell *et al., Heimatchronik der Stadt Bremerhaven* (1955). (F. J. D. P.)

BREMERTON, a city of Kitsap County, Wash., U.S., 15 mi. WSW across Puget Sound from Seattle. It is located on an arm of Kitsap peninsula and is surrounded on three sides by water.

Bremerton was named after William Bremer, German-born real-estate promoter, who platted the town in 1891. Bremer sold land to the federal government at a low price in his successful effort to secure the navy yard for the new town. The Puget Sound naval shipyard became the chief economic feature of the city and the second largest industry in the Pacific northwest. Employing about 9,500 in the early 1970s and covering more than 300 ac. of land, it is a vast concentration of piers, dry docks, shops, cranes, railroads (more than 35 mi. of track), and buildings. It is the site of Olympic College, a two-year college established in 1946.

Bremerton was incorporated as a city in 1901. Pop. (1970) 35,307. For comparative population figures *see* table in WASHINGTON: *Population.* (R. E. BU.)

BRENDAN, SAINT (BRANDON or BRANDAN, correctly BRÉNAIND) (*c.* 484–*c.* 578), Irish saint and hero of legendary voyages in the Atlantic, was born at Tralee in Kerry. He founded his chief monastery, Clúain Ferta Brénaind (anglicized Clonfert), in County Galway some 20 years before his death, and is known as Brendan of Clonfert to distinguish him from several namesakes, the chief being his contemporary St. Brendan of Birr. It seems reasonably certain that St. Brendan himself made a voyage to the Scottish isles, and perhaps to the Clyde valley and Wales—nothing unusual for a Celtic abbot in the 6th century. At a later period, possibly as early as the 8th century, he was made the hero of a Christian tale of sea adventure similar to the *Imrama* (*see* IRISH LITERATURE). The legend, a narrative masterpiece, known as the *Navigatio Brendani* ("Voyage of St. Brendan"), was put down in Latin prose early in the 9th century. Nearly every detail, though set forth in the vague way of an epic narration and hardly ever localized, is clearly based on authentic seamen's reports. Either as ascetics in search of an island abode or more prosaically as explorers, the Irish had thus first-hand accounts to give, not only of islands lying north and northwest, but also of the continent of America, before the Scandinavians settled on Iceland. St. Brendan's ultimate goal was the "Promised Land of the Saints"; after a prolonged search he reaches it, but is sent back to Ireland and tells his tale. Over 100 manuscripts of the *Navigatio Brendani* are extant, besides translations and adaptations in prose or verse, with many variations, into Norman French, French, Italian, Provençal, English, Dutch, Flemish, German, Irish, Welsh, Breton and Scottish Gaelic. St. Brendan's Island, somewhere in the Atlantic ocean, long sought by sailors, was believed to have been sighted, probably an effect of mirage. His feast day is May 16.

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BRENNAN, CHRISTOPHER JOHN (1870–1932), Australian poet and scholar whose awareness of French and German literary movements influenced his own work and brought Australian literature into closer touch with European culture, was born at Sydney, on Nov. 1, 1870. He was educated at Riverview college, Sydney university and Berlin university. He returned to Sydney in 1894 and in 1895 became assistant librarian at the public library. In 1908 he became a lecturer in French and German at Sydney university and in 1920 an associate professor, but resigned in 1925 when his wife divorced him. He died on Oct. 7, 1932.

Brennan has been described as the "arthritic giant" of Australian literature. A huge, heavy, amiable man, with a talent for conversation and a taste for good food, he impressed those who knew him by his personality. His poetry, despite some obscurity, shows maturity of outlook and technical skill.

BIBLIOGRAPHY.—Brennan's chief works were *XXI Poems 1893–1897: Towards the Source* (1897); *Poems* (1914); *A Chant of Doom and Other Verses* (1918). *See* also A. R. Chisholm, *Christopher Brennan: The Man and His Poetry* (1946). (C. M. H. C.)

BRENNER PASS (Ital. PASSO DEL BRENNERO; Ger. BRENNER SATTEL), one of the lowest and most important passes through the main chain of the Alps. It divides the Rhaetian and Noric alps, and the highest point of the pass (4,501 ft.) is a continental divide between the Adriatic and Black seas. The Brenner pass has been one of the main entrances to Italy from the north and since Roman times the principal road between the eastern Alps, Germany and the Po valley. There was a Roman road across the pass, and since the 14th century it has been one of Europe's great trade routes. A carriage road was built across the pass in 1772 and the railroad was completed in 1867, linking Innsbruck in Austria with Verona in Italy. The road and railway climb rather steeply from Innsbruck to the Brenner pass and then descend into the valley of the Isarco past Bressanone to Bolzano, where the Isarco joins the Adige river. From Bolzano past Trento to its terminal at Verona, the railway and road follow the Adige valley, a distance of 175 mi. by rail from Innsbruck to Verona. The village and customs station of Brennero, scene of the meetings between Hitler and Mussolini (1940–43), is near the head of the pass in Italy. (G. KH.)

BRENNUS, the name of two leaders of the Gauls in the 4th and 3rd centuries B.C. The first invaded Italy in 390 or 387 B.C. His name, which first appears in the works of Livy, is not mentioned by Polybius or Diodorus Siculus. It is difficult to disentangle the facts of his capture of Rome from the legends. It is clear that Brennus crossed the Apennines, advanced on Rome down the Via Salaria, and defeated the Roman army at the Allia river, about 12 mi. from Rome. He then appears to have delayed a day or two on the field, giving time to fortify the Capitol; he sacked Rome, besieged the Capitol for seven months, accepted the offer of the defenders to ransom themselves, and then departed safely with his booty. Details are less credible: the massacre of the patricians in their chairs; the night attack on the Capitol; the sacred geese and the exploits of Marcus Manlius; the false weights at the paying of the ransom; and the hurling by Brennus of his sword into the scales, with the famous words *vae victis* ("woe to the vanquished"). The ending given by Livy, wherein Marcus Furius Camillus arrived at the moment of payment and wiped out Brennus and his forces, cannot be accepted.

In 279 another Brennus at the head of a band of Gauls invaded Greece. Earlier in the year Gallic invaders had defeated and killed Ptolemy Ceraunus in Macedonia. Brennus then advanced through Macedonia toward Greece proper, and was first held up at Thermopylae with great loss. Later, as had happened to Leonidas, the mountain pass was betrayed, but the Greek army was taken off by the Athenian fleet. Brennus, with the advance guard that had gone over the upper pass, pushed on for Delphi with its vast treasure. He was wounded, and in the subsequent general retreat northward few Gauls escaped. Brennus committed suicide.

BRENT, MARGARET (*c.* 1600–*c.* 1671), American colonial landowner and administrator, was born at Gloucester, Eng., the daughter of Richard Brent, Lord of Stoke and Admington. Little is known about the first 35 years of Margaret Brent's life or her later private life, except that she never married.

In 1638, Margaret and her sister Mary, accompanied by two brothers and a number of indentured men and women, landed at the town of St. Mary's, Md. Through land deeded to her by members of her family and through business transactions, Margaret Brent in 1657 had become one of the largest landowners in the colony.

In 1642 she began her public career. The death of the governor of Maryland, Leonard Calvert, in 1647 opened the period of her most active service to the colony. He appointed her his sole executrix and she appeared again and again to defend the rights of the deceased governor. Her position was complicated by claims against the estate by Virginia soldiers, who had fought for Calvert in the dispute with William Claiborne over the possession of Kent Island. Their wages, long overdue, had been promised by the governor out of his own estate and that of the lord proprietor. She sold enough of the proprietor's cattle to pay the soldiers, quelled a mutiny, and was credited with having saved the province from civil war. Convinced that she needed a voice in the assembly to discharge her obligations, she went to that body on Jan. 21, 1648, to request one vote for herself and another as Calvert's administrator and Baltimore's attorney. The votes were denied her, whereupon she protested against all proceedings of the assembly. Lord Baltimore, who remained in England, condemned her actions, however. She moved to her estate in Westmoreland county, Va., and died between May 1669 and May 1671.

BRENT, one of the 32 London boroughs constituting Greater London, Eng., lies in its northwestern area. This outer London borough was established on April 1, 1965, under the London Government Act 1963 (*see* LONDON) by the amalgamation of the former boroughs of Wembley and Willesden, both in the former Middlesex County. Area 17.1 sq.mi. (44 sq.km.). Pop. (1965 est.) 294,850. Brent returns four members to Parliament. The borough is named for the small River Brent, a tributary of the Thames that formed the boundary between Wembley and Willesden. These districts developed and extended toward each other independently.

The Wembley area was developed mostly between the two World Wars, mainly as a residential suburb but with limited industrialization under strict town planning control, the nucleus originating in buildings erected for the British Empire Exhibition (1924–25). The Empire Stadium, accommodating 100,000 spectators, is a well-known sports arena and the scene, especially, of national and international association football (soccer) matches, including cup finals. It was the venue of the 1948 Olympic Games. An adjoining indoor arena also offers a wide range of recreational activities, including a swimming pool and an ice rink. The 175-ac. Brent Reservoir, known as the Welsh Harp (constructed in 1835–39 to feed the Grand Junction Canal), is used by sailing clubs and is the setting for an annual regatta. The riparian area is a resting ground for many species of wild fowl. The 992 ac. (401 ha.) of open spaces include Barn Hill (250 ac.), and the Northwick, Roundwood, Gladstone, and Queen's parks.

The principal industrial area in Willesden is at Park Royal, first developed during World War I with munition works and now much diversified; other factory concentrations are at North Cricklewood, Church End, North Wembley, Alperton, and Kingsbury. Large-scale output includes automobile accessories, clocks and watches, water heaters, stoves, food and beverages, industrial gases, electrical equipment, and photographic materials. Mechanical engineering plants and railway maintenance shops, together with many lesser concerns, make up one of the largest industrial complexes in Greater London. The coal tar dyeing industry was started at Greenford Green by Sir William H. Perkin (1838–1907).

St. Mary's parish church has Norman features; in the 15th century it was a place of pilgrimage for cures at the Shrine of Our Lady of Willesden; parish registers date from 1569. Other historic buildings are Oxgate Farm House (16th–17th century), The Grange (*c.* 1700) in Neasden, and Dollis Hill House in Gladstone Park, where William Gladstone was frequently a guest of Lord Aberdeen. At Kingsbury, a rural retreat of Oliver Goldsmith, St. Andrew's Church contains much Saxon work and Roman materials. Wemba Lea (Wemba's Clearing, probably the place-name origin of Wembley) is mentioned in a charter of King Beornwulf in 825 conferring lands on Wulfred, archbishop of Canterbury. In 940 ten manors at Neasden-cum-Willesden were granted to the canons of St. Paul's. (J. G. G.)

BRENTANO, CLEMENS (1778–1842), German poet and novelist, a leader of the second movement in German romanticism, was born at Ehrenbreitstein on Sept. 9, 1778. His sister was Bettina von Arnim, the correspondent of Goethe; his mother, Maximiliane Brentano, Goethe's friend of 1772–74. He studied at Halle and Jena, where he made the acquaintance of the Schlegels, Hardenberg (Novalis) and J. L. Tieck, and afterward lived at Heidelberg, Vienna and Berlin, in close touch with writers of the patriotic revival of 1813. Emotionally unstable, he reflected in his troubled life the atmosphere popularly associated with the romantic poets. In 1817 he became a fervent Roman Catholic and spent the years 1819–24 at the monastery of Dülmen, taking down the revelations of a stigmatized nun Anna Katharina Emmerich. He died at Aschaffenburg on July 28, 1842.

Brentano belonged to the Heidelberg group of romantic writers, and his works are marked by fantastic imagery and by abrupt, bizarre modes of expression. His cultivation of the poetry of the Rheinland and of the medieval and student atmosphere are important in the history of German romanticism. A born poet, he created some of the best-known German lyrics. The publication of *Des Knaben Wunderhorn* (1805–08), which he edited with Achim von Arnim, showed the new character of the romantic movement. Instead of the vague profundity typical of the first romantics, there is here the simplicity of the *Volkslied,* a form of lyric which Brentano could imitate and reconstruct most skilfully. Some of his prose works show a satirical vein. Among his first publications were *Satiren und poetische Spiele* (1800) and a fantastic romance *Godwi* (1801–02); of his dramas the best are *Ponce de Léon* (1804) and *Die Gründung Prags* (1815). On the whole his finest work is the collection of *Romanzen vom Rosenkranz* (1852); his short stories, and especially the charming *Geschichte vom braven Kasperl und dem schönen Annerl* (1817; Eng. trans., *The Story of the Just Casper and Fair Annie,* 1927), imbue the folk stories on which they are based with a delicate romanticism.

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BRENTANO, FRANZ (1838–1917), German philosopher, one of the most influential teachers of his period, was born at Marienburg, near Boppard on the Rhine, on Jan. 16, 1838. His uncle was the poet Clemens Brentano, his father a well-known Catholic writer. Ordained as a Catholic priest in 1864, he was appointed *Privatdocent* in philosophy at Würzburg in 1866 and professor there in 1872. Religious doubts, exacerbated by the dogma of papal infallibility (1870), led to his resigning this post and seceding from the church in 1873. In 1874 he became professor of philosophy at Vienna. He resigned this post in 1880, thereafter teaching in Vienna till 1895. From 1896 to 1915 he lived in retirement in Florence. He died in Zurich on March 17, 1917.

Unlike most German philosophers of his day, Brentano's guiding principle was "back to Aristotle" rather than "back to Kant." His earliest publications were Aristotelian studies, and his last important book, *Aristoteles und seine Weltanschauung* (1911), was an attempt to reassess the essential features of Aristotle's thought in the light of modern knowledge.

In metaphysics Brentano's own views inclined toward realism rather than toward idealism; but he insisted throughout on the existence of a personal and immaterial soul. Psychology he defined as the science of the soul; but the special object of its study was, he held, not psychical states but psychical processes or acts. His most original contribution was a revival and modernization of the scholastic theory of "intentional inexistence," or, as he sometimes called it, "immanent objectivity." His restatement of the doctrine is set forth most clearly in his most important book, *Psychologie vom empirischen Standpunkte* (1874), in a paragraph (ii, 1, 5) that became the credo of his followers and formed the starting point of their later work. Psychical phenomena, he declares, are distinguished from all other types of phenomena by a property "which the schoolmen called the intentional or mental inexistence of an object, and which we should rather describe as *the direction of the mind to an object*, by which we need not understand a reality." The task of the psychologist is therefore to investigate the various ways in which a mind can refer to an object. Three, Brentano maintains, are fundamental: (1) perception (the placing of the object or idea before the mind), a process which is logically prior to the rest; (2) judgment or belief; and (3) approval and disapproval, which he preferred to call love and hate. The doctrine of love and hate he subsequently treated as the key to an analytic theory of value.

Brentano's influence on the later development of philosophic thought has been exerted largely through the work of his two most famous pupils, Edmund Husserl and Alexius Meinong (*qq.v.*). Critics have contended that the reference of the mind to an object is not so fundamental as Brentano supposed; in experiences of sheer pain or pleasure there is little extrinsic reference. Nevertheless, the property is one which no nonmental thing could possess; and the priority given by Brentano to the psychic act as distinct from the psychic state has gained wide acceptance.

See *F. Brentano: Gesammelte philosophische Schriften,* ed. by O. Kraus and A. Kastil, 10 vol. (1922–30). (Cy. B.)

BRENTANO, LUJO (Ludwig Joseph) (1844–1931), German economist, was born at Aschaffenburg on Dec. 18, 1844. He received some of his academic education in Dublin and was professor of political theory in Breslau (1872) and later in Strasbourg, Vienna, Leipzig and Munich. He retired in 1914.

In 1868 Brentano made a thorough study of trade unionism in England, which resulted in his principal work, *Die Arbeitergilden der Gegenwart* (1871–72). The book was attacked by some economists but was important not only as an authority on modern associations of workmen but also for the impetus it gave to the study of guilds of the middle ages. His other works, of a more theoretical nature, relate chiefly to political economy. He advocated free trade, and in industrial questions combated the wages fund theory. Brentano was a leading opponent of German militarism.

BRENTWOOD, an urban district, Essex, Eng., is 18 mi. N.E. of London by rail. Pop. (1961) 49,242, area 28.5 sq.mi.; altitude 400 ft. Surrounded by pleasant undulating country, now including Boyles Court, Thorndon and Weald parks, Brentwood (*i.e.*, "burned wood," its site being originally that of a forest fire) was on the route followed by pilgrims from East Anglia to Canterbury. It was an assize town when judges first went on circuit and the Elizabethan assize house remains. The grammar school was founded by Sir Anthony Browne in 1558. Warley barracks were erected in 1805. Brentwood is the seat of a Roman Catholic bishop and the site of a county mental hospital.

The district is predominantly residential. Industrial products include photographic films, agricultural machinery, steel equipment and prefabricated concrete.

BRENZ, JOHANN (1499–1570), German reformer, a leader of the Reformation in Württemberg, was born at Weil, Württemberg, on June 24, 1499, and studied at Heidelberg under John Oecolampadius. Ordained priest in 1520, he ceased to celebrate mass in 1523. Brenz was a strong advocate of Lutheran doctrine, and author of *Syngramma Suevicum* (Oct. 21, 1525), which set forth Luther's doctrine of the Eucharist. Protected by his patron Duke Ulrich of Württemberg, he was appointed (Jan. 1553) provost of the collegiate church of Stuttgart. He opposed applying the death penalty to Anabaptists or other heretics in the *De Haereticis, an sint persequendi* (1554). An incomplete edition of his works appeared in 1576–90, and T. Pressel edited *Anecdota Brentiana* in 1868. Brenz died on Sept. 11, 1570.

See J. Hartmann and C. Jäger, *Johann Brenz,* 2 vol. (1840–42).

BREQUIGNY, LOUIS GEORGES OUDARD FEUDRIX DE (1714–1794), French scholar who investigated the annals of French history in England. He was probably born at Gainneville near Le Havre on Feb. 24, 1714. After the Seven Years' War he was sent to search in the archives of England for documents bearing upon the history of France, particularly upon that of the French provinces which once belonged to England. From this mission Bréquigny brought back copies of 70,000 documents, which form 109 vol. in the Bibliothèque Nationale. A selection was published by Jean Jacques Champollion-Figeac in *Documents inédits relatifs à l'histoire de France,* 2 vol. (1839–47). Bréquigny was a member of the Académie des Inscriptions and in 1777 was elected to the Académie Française. The Revolution interrupted him in his collection of *Mémoires concernant l'histoire, les sciences, les lettres, et les arts des Chinois,* begun in 1776, when 14 volumes had appeared. He died in Paris, July 2, 1794.

See the article on Bréquigny by E. Dumont in *Assises de Caumont* (1896), including a bibliography; L. P. de Bachaumont, *Mémoires secrets* (1777–89).

BRERETON, LEWIS HYDE (1890–1967), U.S. air force officer who commanded the 9th air force in European operations during World War II, was born on June 21, 1890, at Pittsburgh, Pa. He was graduated from the U.S. naval academy in 1911, but became an army pilot and served as combat commander during World War I. He was promoted to the grade of major general in 1941. Commander of the U.S. far east air force which was almost destroyed in the Philippines in 1941, Brereton thereafter commanded the 10th air force in India (1942); the 9th air force based in the middle east (1942–43) and England and France (1943–44); and the 1st allied airborne army (1944–45). Beginning with a small nucleus in Oct. 1943, he built the 9th air force into the world's most powerful tactical air unit which, with the Royal Air Force, defeated the *Luftwaffe* in western France and supported U.S. armies in France and Belgium in 1944. He published his war memoirs under the title of *The Brereton Diaries* (1946). He died on July 20, 1967, in Washington, D.C. (A. Gg.)

BRESCIA, capital of the province of Brescia, Lombardia, northern Italy, lies at the foot of the Alps, 91 km. (56 mi.) E. of Milan. Pop. (1961) 179,845 (commune). The plan is rectangular, with streets at right angles, a Roman peculiarity, though the Roman town occupied only the eastern portion of the later one. The Piazza del Foro marks the site of the forum, and the museum on its north side is in a Corinthian temple with three cellae, probably the Capitolium of the city, erected by Vespasian in A.D. 73. It contains numerous tombstones, objects in bronze (one of which is the famous "Statue of Victory" found in 1826) and glass, as well as ceramics, mosaics and coins. Near it are the remains of the ancient theatre. The castle, at the northeast angle, commands a fine view. The old cathedral (11th–12th century) is a round domed building over a 6th-century church, and the Broletto, adjoining the new cathedral (1604) on the north, is a massive building of the 12th and 13th centuries (the original town hall, now the prefecture and the seat of the provincial administration), with a lofty tower. The convent of S. Salvatore, founded by Desiderius, king of Lombardy, has three churches, two of which have been occupied since 1882 by the fine medieval museum, in which can be seen the "Dittici consolari" (5th century), the "Lipsanoteca" (4th century), the "Croce di Desiderio" (8th century), sculpture, objects in bronze, glass and majolica, enamels and medallions. The church of S. Francesco has a Gothic façade and cloisters. The Palazzo del Comune, begun in 1492 and completed by Ludovico Beretta in 1554–74, is a magnificent structure, with fine ornamentation. The church of Sta. Maria dei Miracoli (1488–1523) has rich details, especially of the reliefs on the façade. Many other churches, and the picture gallery (Galleria Tosio-Martinengo), contain works of the painters of the Brescian school, Vincenzo Foppa, Girolamo Savoldo, Alessandro Bonvicino (Moretto), Girolamo Romanino and Moretto's pupil, Giambattista Moroni. The city has no less than 72 public fountains. Brescia is on the main line from Milan to Verona; other lines run to Trento, Cremona and Parma. It makes ironware, particularly firearms, also machinery, woolens, linens and silks, matches and candles. It is the chief centre of the stocking factories of Italy. Mazzano, 13 km. (8 mi.) E. of Brescia, has stone quarries.

The Celtic Brixia of the Cenomani submitted to Rome in 225 B.C. Augustus founded a civil colony there in 27 B.C. In 452 it was plundered by Attila, but was the seat of a duchy in the Lombard period; from 1167 it was an active member of the Lombard league. In 1258 it fell to Ezzelino da Romano, and belonged to the Scaligers (della Scala) until 1421, when it came under the Visconti of Milan, and in 1426 under Venice. Early in the 16th century it was one of the wealthiest cities of Lombardy, but never recovered from its sack by the French under Gaston de Foix in 1512. It belonged to Venice until 1797, then to Austria; it revolted in 1848, and in 1849 was the only Lombard town to rally to Charles Albert, but it was taken by the Austrians and lost again in 1859. In World War II it was damaged by bombardments and liberated by the Allies on April 25, 1945.

Brescia province (area 4,749 sq.km.; pop. 877,241) is situated between lakes Garda and Iseo. The mountainous northern region gives way to a fertile irrigated plain (agricultural and cattle raising) in the south. The province is drained by the Oglio, Mella and Chiese rivers. (G. Pa.)

BRESLAU: *see* Wroclaw.

BRESSE, a natural region of eastern France, embracing parts of the *départements* of Ain and Saône-et-Loire, and extending for 60 mi. from the Dombes region in the south to the Doubs river in the north and for 20 mi. from the Jura in the east to the Saône river in the west, toward which it gradually slopes. A fairly prosperous agricultural area, it has long been renowned for its poultry.

In the northern part the lords of the Vienne, Antigny, Sainte-Croix and Coligny families were powerful landowners for many years, beside the dukes of Burgundy, who from the 14th century were continually increasing their possessions in Bresse until the death of Charles the Bold (1477), after which most of northern Bresse was annexed, together with Burgundy, to the crown of France. The southern part was at first also under the rule of various lords, the most powerful being the lords of Bâgé. They were, however, superseded in 1272 by the house of Savoy, which in the 15th century organized the province of Bresse, with Bourg as its capital. This province was ceded to France in 1601 by the treaty of Lyons. Soon afterward the whole of Bresse was incorporated into the royal *gouvernement* of Burgundy. (M. Pac.)

BREST, a naval station and port in the *département* of Finistère, Brittany, western France, lies on the northern shore of the magnificent landlocked Rade de Brest and on the slopes of two hills divided by the Penfeld river. It is 255 km. (158 mi.) W.N.W. of Rennes. Pop. (1968) 154,023. Eighty per cent of the town was destroyed during the siege of 1944 in World War II, but by 1960 rebuilding was almost complete and the tourist trade increased. The chief streets are the rue de Siam, rue Jean Jaurès and rue de Lyon; the first two meet in the Place de la Liberté, the centre of the new town. Along the shore south of the town is the Cours Dajot promenade. At the western end stands the castle with its keep and seven towers commanding the entrance to the Penfeld. Its first walls were built at the end of the 3rd century.

The roadstead consists of a deep indentation formed by coastal subsidence, about 23 km. (14 mi.) long and of the same average width, barred by the peninsula of Quélern, leaving the Goulet passage 2–3 km. (1–2 mi.) wide. The outline of the bay is broken by numerous submerged tributary valleys. The naval port, much of it excavated out of the rock, extends along both banks of the Penfeld. Large areas have been reclaimed from the sea, and the principal dry docks and workshops are now situated along the roadstead on both sides of the mouth of the river. The commercial port, separated from the town by the Cours Dajot, comprises a tidal port with docks and an outer harbour.

Brest is the terminus of the main railway line from Paris through Chartres, Le Mans and Rennes. Another line runs southeastward through Nantes to Bordeaux. There is a daily air link with Rennes and Paris. Many industries from the Paris district are moving to Brest. The principal industries are brewing, ship repairing, the manufacture of chemicals and superphosphate, and the cleaning of oil tankers. Wine, coal, timber, gasoline, iron and steel, fertilizers and paper pulp are imported, while fruit (strawberries from Plougastel), seed potatoes, and cattle are exported.

Brest was ceded about 1240 by Count Hervé V of Léon to John I, duke of Brittany. From 1342 to 1397 it was in English hands, and the saying was current that "he is not duke of Brittany who is not lord of Brest." By the marriage of Charles VIII, king of France, with Duchess Anne of Brittany in 1491 Brest passed to the French crown with the rest of Brittany. Richelieu decided in 1631 to create the port of Brest, and it became a station for the French navy. Colbert improved the port; Vauban's fortifications followed in 1680–94. The fortifications and the naval importance of Brest continued to develop. During World War I it was the port of disembarkation for the U.S. army fighting in France. After 1918 it became increasingly important as a port of call for transatlantic liners and a leading naval centre. In World War II Brest was occupied by the Germans in June 1940. The town was besieged by U.S. forces from Aug. 15 to Sept. 18, 1944, when it was captured; by 1960 the destroyed docks had been rebuilt with the most modern equipment. (A. J. Mi.)

BREST (Brest-Litovsk), an *oblast* of the Belorussian Soviet Socialist Republic, U.S.S.R., was formed in 1939, following the Soviet occupation of east Poland, from part of the territory held by Poland from 1921 to 1939. Its area of 12,471 sq.mi. (32,300 sq.km.) lies almost wholly in the basin of the Pripet (Pripyat) and its tributaries, notably the Yaselda. Most of the *oblast* is very level and covered by the great swamps and forests, known as Polesye (*q.v.*). Extensive spring floods occur. Only in the north, around Pruzhany and Baranovichi, where the land rises to the morainic hills of the White Russian ridge, is it drier, and there most of the forest has been cleared. After 1873 drainage was accomplished in various areas. Agriculture is chiefly flax, hemp, potato, and sugar beet growing, with cattle raising and dairying on the abundant pastures. Forestry is important. The main industries are the processing of agricultural products and timber. Peat is widely used for power. The population (1970 prelim.) was 1,295,000, of whom 451,000 (35%) were urban. The largest towns are Brest, Baranovichi, Pinsk (*qq.v.*), and Kobrin.

The main Moscow–Warsaw railway and highway traverse the *oblast,* together with the Brest–Gomel and Vilnius (Vilna)–Rovno railways. The Dnieper-Bug Canal, linking the Pripet to the Bug, takes small craft, chiefly with iron ore westward and coal eastward. (R. A. F.)

BREST (formerly Brest-Litovsk), a town and the administrative centre of Brest Oblast of the Belorussian Soviet Socialist Republic, U.S.S.R., stands on the right bank of the Western Bug at the Mukhavets outfall. Pop. (1970 prelim.) 122,000.

First mentioned in 1017 as Berest'ye, its key position gave Brest great trading importance, and a very stormy history. In the 12th century it passed from Kiev to the princes of Volyn, in 1340 to the Grand Duchy of Lithuania, and later to Poland. The

Synod of Brzesc in 1596, establishing the Uniate Church, took place here (*see* POLAND: *History*). The third partition of Poland in 1795 gave Brest to Russia. On March 3, 1918, the Treaty of Brest was signed between the new Soviet government and Germany. Seized in 1919, Brest was again officially part of Poland from 1921 to 1939. The fortress, built in 1936, was the scene of a long and gallant defense against the Germans in 1941.

Modern Brest is chiefly important as the main western rail entry point to the U.S.S.R., with special equipment to deal with the change of gauge. It is a river port on the Bug and Dnieper-Bug Canal. There are food-processing, carpet, and light-engineering industries. (R. A. F.)

BREST-LITOVSK, TREATIES OF. The short-lived peace treaties signed at Brest-Litovsk during World War I by the Central powers with the Ukrainian republic (Feb. 9, 1918) and with Soviet Russia (March 3) disclosed what sort of peace victorious Germany had in mind for eastern Europe.

On Nov. 8, 1917, the day after it had assumed power in Petrograd, the Soviet Russian government published a declaration proposing an immediate opening of negotiations for a "just and democratic peace, without annexations or indemnities." On Nov. 26, Russian truce-bearers crossed the front and started discussion with the representatives of the German high command in the east, who agreed to come to terms. On Nov. 30 the Soviet government sent notes to the Entente powers suggesting peace negotiations, but they did not reply.

On Dec. 3, at Brest-Litovsk, preliminary negotiations started between the Soviet government and the Central powers. On Dec. 5 a truce was arranged for a week, and on Dec. 15 an armistice was signed to last until Jan. 14, 1918, with automatic prolongation unless seven-day notice of rupture was given by either party.

Peace negotiations began on Dec. 22. The Soviet delegation was headed by Adolf A. Ioffe, the German by Richard von Kühlmann (*q.v.*), the Austro-Hungarian by Ottokar Graf Czernin; Bulgaria and Turkey were also represented. Ioffe at once laid down as a *sine qua non* the principle of "peace without annexations and indemnities, and the recognition of the right of self-determination for all nations." Kühlmann and Czernin accepted this with the proviso, supplied by Gen. Max Hoffmann, chief of staff of the German armies in the east and second German delegate, that Poland, Lithuania and Courland had already exercised their right of self-determination when they opted "either for an independent existence or a protected status within the German empire." On Dec. 28 the conference was suspended on the pretext that the Soviet government wanted to secure the inclusion of Entente powers in the negotiations. Actually the Russians were delaying in the hope of arousing the workers not only of Germany and Austria-Hungary, but also of the Entente countries.

When the conference reopened on Jan. 9, 1918, Lev D. Trotski (*q.v.*) was the head of the Soviet delegation. A new situation was created by the arrival at Brest-Litovsk, on Jan. 7, of a delegation claiming to represent the independent Ukrainian republic and insisting on concluding a separate peace treaty with the Central powers. Ignoring its presence, Trotski insisted on the withdrawal of German and Austro-Hungarian troops from the territories of the former Russian empire and demanded that the non-Russian peoples should determine their future through plebiscites. Hoffmann refused to evacuate the occupied territories, and on Jan. 18 the negotiations were again adjourned.

Trotski left for Petrograd and at a meeting of the Soviet government recommended a policy which he summarized as follows: "We shall stop the war but should not sign the peace treaty." Lenin had his doubts. Speaking on Jan. 22 as the central committee of the Communist party, he said: "We cannot afford Trotski's formula. If the Germans advance we will have to conclude peace in any case, but the terms will be worse if we do not sign now."

Trotski, however, who returned to Brest-Litovsk on Jan. 30, was in no mood of compromise. Thus deadlock was complete and in these circumstances the Central powers decided to sign, on Feb. 9, the peace treaty with the Ukraine against the will of Russia. A considerable area of Russian Poland—the so-called Chelm district—was ceded to the Ukraine, and Austria-Hungary undertook to erect the Ukrainian parts of Galicia and Bukovina into an autonomous crownland—all of which was a deadly offense to the Poles. In return the Ukrainian delegation, headed by Vsevolod Holubovych, the prime minister, undertook to supply the central powers with 1,000,000 tons of breadstuffs annually.

Trotski announced that the treaty with the Ukraine was an unfriendly act. On Feb. 10, he left Brest-Litovsk after announcing that Russia would cease hostilities but not conclude a peace. On Feb. 16 Hoffmann denounced the armistice, and on Feb. 18 the German and Austro-Hungarian armies advanced to occupy the rest of Latvia, Estonia, almost all of Belorussia and the Ukraine.

In Petrograd stormy meetings of the central committee of the party as well as of the All-Russian Central Executive committee took place. Lenin declared that Trotski's experiment had failed, that there seemed no hope of immediate revolution in Germany and that therefore peace must be signed at once. Trotski now sided with Lenin, and on Feb. 19, by seven votes to six, the central committee decided to sign the peace treaty. Germany, however, replied by an ultimatum embodying fresh demands: all the occupied lands were no longer to be subject to Russian sovereignty. On Feb. 24, after a dramatic debate, the All-Russian committee, by 116 votes against 85, with 26 abstentions, accepted the ultimatum.

On Feb. 26 the Russian delegation, G. Ya. Sokolnikov, A. A. Ioffe, L. M. Karakhan, G. V. Chicherin and G. I. Petrovski, once more appeared at Brest-Litovsk. The peace treaty was signed on March 3. Russia renounced control over Estonia, Latvia, Lithuania, Russian Poland and a major part of Belorussia and also ceded to Turkey the districts of Kars, Ardahan and Batum. The independence of Finland and of the Ukraine was recognized. In all, Russia lost about 386,000 sq.mi., with about 46,000,000 inhabitants. On March 15 the All-Russian committee ratified the peace treaty.

Both peace treaties, the Russian and the Ukrainian, were annulled by the armistice of Nov. 11, 1918, which marked the final defeat of Germany. Two days later the Soviet government declared the Brest-Litovsk treaty null and void.

See also references under "Brest-Litovsk, Treaties of" in the Index.

See U.S. Department of State, *Proceedings of the Brest-Litovsk Peace Conference, Nov. 21, 1917–March 3, 1918* (1918); J. W. Wheeler-Bennett, *Brest-Litovsk, The Forgotten Peace* (1938). (K. SM.)

BRETHREN, CHURCH OF THE, the parent and largest of several bodies of Brethren (variously known also as GERMAN BAPTIST BRETHREN, DUNKARDS, DUNKERS, TUNKERS, TAUFERS or DONKELAARS) who took their theology largely from the Lutheran Pietists of the 17th century (*see* PIETISM). They are now found in the United States, West Germany and Denmark. (1) The parent body, the Church of the Brethren (headquarters Elgin, Ill.), numbers about 1,000 churches with a membership of about 200,000. (2) The Brethren Church (Progressive Dunkers), which separated from the main body in 1882 because of differences over church polity (headquarters Ashland, O.), claims about 25,000 members. (3) The Old German Baptist Brethren (Old Order Dunkers), separated from the main body in 1881 in protest against liberalizing tendencies (headquarters North Manchester, Ind.), number around 4,000. (4) The Church of God (New Dunkers), which separated in 1848, numbers fewer than 700 members. (5) The Grace Brethren Church (1939; headquarters Winona Lake, Ind.) has about 25,000 members.

Origins.—By 1708 a large number of Pietists and evangelicals had found refuge at Schwarzenau, in Wittgenstein. A group of eight persons, who with Alexander Mack as their leader had been meeting there for Bible study and prayer, determined to covenant with God to forsake the world and to follow Christ in all the commandments and ordinances of the New Testament. This led them to accept baptism by trine immersion (a figure of death, burial and resurrection). Mack was baptized by one of the eight, chosen by lot, after which he baptized the other seven. Devotions and confirmation followed the baptism. An intense missionary enthusiasm was manifested by the group, and their fervour was so contagious that other persons rapidly united with them in Wittgenstein, Marienborn and other parts of the Palatinate. Because of the persecution that followed in some of these communities (as a result chiefly of their social views, one of which was pacifism), many of the believers finally went to Krefeld in Prussia, where they found safety.

Move to America.—The Brethren began their emigration to America in 1719, joining the 15,000 Palatine Germans who settled in Pennsylvania between 1683 and 1730. Peter Becker and Brethren from the Marienborn district were among the first, and after three years' residence in Pennsylvania, Becker became pastor of the first organized Brethren church, in Germantown (1723). In 1729 Mack and his three sons arrived. The first withdrawals from the church took place as a result of Conrad Beissel's establishment, beginning in 1732, of the Ephrata colony, a semimonastic communal group of celibate men and women who observed the seventh day as the Sabbath. The group was never large; at Beissel's death in 1768 the community numbered 135 members. The town of Ephrata (12 mi. N.E. of Lancaster) remains, and the cloister there is maintained by the state as a historical shrine.

The Church of God group separated from the parent body in 1848; it is strongly conservative in belief and strictly congregational in government. The Old Order Dunkards, who withdrew in 1881, stand for the literal interpretation of the Scriptures in regard to the Lord's Supper, and practice close communion; they have no Sunday schools, educational work or missions.

The worst split occurred in 1882 when a group withdrew to form the Brethren Church. This now centres in Ashland, O., where Ashland college, a seminary, a publishing company and mission board offices are located. The *Brethren Evangelist* is the church weekly. Its mission fields are in Nigeria and Argentina. The Grace Brethren Church withdrew from the Brethren Church in 1939 over points of church polity and theological emphasis. Its centre is at Winona Lake, Ind., where Grace college and seminary are located. The church carries on mission work in the region formerly known as French Equatorial Africa and in Argentina.

The parent Church of the Brethren operates nine colleges and Bethany seminary, Chicago, Ill., and carries on mission work in Europe, Asia and Africa.

Polity.—The Brethren's rejection of every form of mingling of church and state, in opposition to the ideas prevalent during the period of their emergence in Germany, caused them to emphasize individual freedom of belief and a congregational form of church government, with each member of the congregation having a vote in church affairs. Since 1742, however, the Standing Committee of the Annual Meeting has taken an increasingly active part in the over-all supervision of the individual congregations. The Standing Committee, the "upper house" of the Annual Meeting, is made up of delegates elected from the member churches. Local congregations are headed by moderators (lay or clerical, men or women), and ministers are chosen by congregational vote.

Doctrine and Worship.—The Brethren recognize only believer's baptism, by trine immersion (*see* BAPTISM, CHRISTIAN). They model their communion service after what they believe to have been the experiences of Jesus and his disciples at the Last Supper. Thus they perform the rite of footwashing, and follow it by partaking of the love feast, after which the communion of the bread and the cup (as symbols of the broken body and shed blood of Christ) is taken (*see* AGAPE).

The Brethren use the kiss of charity; they anoint the sick with oil in the name of the Lord for healing; and they refuse to take oaths. They endeavour to settle matters of difference with each other without appeal to law or the courts. They hold to the position of nonresistance. They believe in total abstinence from alcohol and tobacco and in the avoidance of places of amusement.

BIBLIOGRAPHY.—M. G. Brumbaugh, *A History of the German Baptist Brethren in Europe and America* (1899); Daniel F. Durnbaugh, *European Origins of the Brethren* (1958); Frank S. Mead, *Handbook of Denominations in the United States*, pp. 46–53 (1956). (E. Bo.)

BRETHREN IN CHRIST (RIVER BRETHREN), a religious body of the United States and Canada, incorporated in 1904 and numbering about 6,500 members. Its headquarters is at Lancaster, Pa.

The Brethren in Christ, who derive from the general background of European Pietists, Anabaptists and Waldensians, came to America about 1750 and settled in Pennsylvania along the Susquehanna river; hence the name River Brethren, by which they were known for many years.

The church was not officially organized under the name Brethren in Christ until 1863, when the drafting of young men into the Union army made necessary its formal organization as a body of conscientious objectors.

The church stands for equality of all communicants, though the ultimate authority in policy and doctrine is vested in a General Conference held annually. There are six regional conferences, five in the United States and one in Canada, by which petitions and business reach the General Conference.

The revised constitution of the church (1959) sets forth its theological position: its object is "to promote worship of Almighty God and to disseminate His gospel." The confession of faith states that God is eternal, omnipotent and triune, the Creator, sustainer, provider of redemption through faith in Christ. The work of the Holy Spirit is stressed, and the Bible is the inspired Word of God and final authority for faith and practice. The confession teaches believer's baptism by trine immersion (*see* BAPTISM, CHRISTIAN), washing of the saints' feet, partaking of the Lord's Supper, the holy kiss, nonconformity to the world, nonresistance in war, the imminence of the second coming of Christ, and general resurrection of the dead. The Brethren frown on worldly amusements.

The denomination supports three colleges, home missions and foreign missions in Rhodesia, India, Japan and Cuba.

In 1843 a small group of members, feeling that the River Brethren were becoming lax, seceded and formed the Old Order or Yorker Brethren; they number only a few hundred members in Pennsylvania. In doctrine they are identical to the other River Brethren, but they refuse to build or meet in churches. Another branch, the United Zion Church, was formed in 1855 when Bishop Matthias Brinser was expelled from the River Brethren for holding services in a meetinghouse; the body was incorporated in 1954. It has fewer than 1,000 members, nearly all in three Pennsylvania counties.

See Frank S. Mead, *Handbook of Denominations in the United States*, pp. 52–53 (1956). (E. Bo.)

BRETHREN OF THE COMMON LIFE, living a form of Christian communal life, were established by Gerhard Groote (1340–84) at Deventer in the Netherlands. Groote, originally a worldly cleric, was converted by the Carthusians, with whom he lived for several years, and was influenced by the mystic Jan van Ruysbroeck; he subsequently became a well-known preacher of penance. From among his friends and disciples, among whom was Florentius Radewyns (d. 1400), he formed about 1380 a community devoted to education and the care of the poor; similar groups of women were established practising weaving and spinning. After Groote's death, and at his express wish, many of the brotherhood became Austin canons (1387) at Zwolle; henceforth the movement had two forms, the one of regulars, the other in the world. The institute spread throughout the Low Countries, the Rhineland and north Germany. It displayed, and by means of its teaching fostered, all the most characteristic features of north European piety in the century before the Reformation: the concept of a Christian life, social and self-supporting, based on that of the first disciples (Acts iv, 32–35); a simple regime in common, an absence of ceremonial, complicated ordinances, penances and severe fasting, and little of the rich liturgical life of medieval monasticism. The Brethren were among the principal exponents of the *devotio moderna,* which received its fullest and most permanent expression in the *Imitation of Christ,* usually ascribed to their friend and sometime associate Thomas à Kempis. Among the chief aims of the Brethren were the education of a Christian *élite,* and the furtherance of the reading of devout literature by the production of finely written manuscripts and later by the printing press. They kept large schools, in which the scholarship though not the spirit of the Italian Renaissance found a home; Erasmus as a boy was deeply influenced by them, both in this and in many features of his religious outlook. Gerhard Groote also founded at Deventer in 1379 the first house of Sisters of the Common Life, devoted to education, the copying of books and weaving. The whole movement, eminently characteristic of its epoch and region, which was a principal theatre of activity of the early reformers, was seriously affected by the religious upheaval, and passed out of existence early in the 17th century. *See* also WINDESHEIM, CONGREGATION OF.

See M. Heimbucher, *Orden und Kongregationen*, vol. 1, pp. 552–560 (1933–34); A. Hyma, *The Brethren of the Common Life* (1950). (M. D. K.)

BRÉTIGNY, TREATY OF, an unratified treaty between Edward III of England and John II of France, signed on May 8, 1360, at Brétigny, near Chartres. It ended the first phase of the Hundred Years' War (*q.v.*), after the French defeats at Sluis (1340), Crécy (1346) and Poitiers (1356), where John was captured. The valid treaty of Calais, ratified on Oct. 24, 1360, which replaced that of Brétigny, differed from it in that the English agreed to defer the signing of a clause whereby Edward renounced the French throne and John any suzerainty over territories that he ceded. Such an agreement was to be concluded after the agreed exchanges of territories between the contracting parties.

Otherwise the treaties were virtually identical. John agreed to pay a ransom of 3,000,000 gold crowns and to surrender, in west-central and southwestern France, all Aquitaine (including Guienne, Gascony, Bigorre, Béarn, Poitou, Aunis, Saintonge, Limousin, Périgord, Angoumois, Gaure, Rouergue and Quercy) and, in the north, the counties of Ponthieu (including Montreuil) and of Guînes, together with Calais, Sangatte and Ham. All adjacent islands to these territories and all other islands then in Edward's possession (hence the Channel islands) became English. In his turn Edward relinquished Normandy and Touraine and renounced suzerainty of Brittany and Flanders. (J. D. L.)

BRETON, NICHOLAS (1555?–1625?), indefatigable English writer of religious and pastoral poems, satires, dialogues, essays, etc. His father, a wealthy London merchant, died when his children were minors, and his mother subsequently married George Gascoigne, who squandered his stepson's patrimony and influenced his early poetry. There is no official record of Breton's residence at the university, although a contemporary described him as "once of Oriel College." His life was spent mainly in London; he was presumably still alive when the burial of Matilda, daughter of "Nicholas Breton, gent.," was recorded on July 27, 1625. He dedicated his works to many patrons, including James I; his chief early patron was the Countess of Pembroke, whose favour he temporarily lost in the 1590s.

In 1598 Breton was accounted one of the best lyrical poets but he outwrote himself and outlived his reputation. His satires are rather mild and general; more successful are the descriptions of simple country pleasures, whether in the pastoral poetry of *The Passionate Shepherd* or in the prose descriptions of the months and the hours in his *Fantastics* (1604?) which in some respects anticipates the fashion for character books. Breton himself wrote two character books later (*The Good and the Bad* and *Characters Upon Essays*—the latter containing essays as well). His prose works also include stories, dialogues and letter writers: his *A Post With a Packet of Mad Letters* was many times reprinted in the 17th century. His carefully balanced quadripartite sentences become rather monotonous, as also do the fervent stanzas of the long devotional poems he wrote under titles such as "A Solemn Passion of the Soul's Love."

BIBLIOGRAPHY.—Most of Breton's works were collected by A. B. Grosart in 1879: some of the volumes which he could not obtain (all Breton's works are bibliographical rarities) will be found, with a biography and canon, in *Poems by Nicholas Breton Not Hitherto Reprinted*, ed. by J. Robertson (1952). (J. RN.)

BRETÓN DE LOS HERREROS, MANUEL (1796–1873), Spanish poet and dramatist who was one of the most important and prolific writers in Spain during the 19th-century. Born at Quel, Logroño, on Dec. 19, 1796, he was educated at Madrid where his family had settled in 1806. Six years later he enlisted, fought against the French in Valencia and Catalonia and served in the army until 1822. His first play, *A la vejez viruelas*, was produced in 1824 with some success, and thereafter he managed to combine writing with his duties in a number of minor posts in government service. In 1837 he was elected to the Spanish Academy and ten years later became director of the Biblioteca Nacional. He died in Madrid on Nov. 8, 1873. His total of 177 plays, most of which portray the everyday life of middle-class society and lack the profundity of earlier Spanish dramatists, exhibit a great wealth of verse-forms and an astonishing degree of metrical dexterity. Among his best works are *Marcela* (1831), *Muérete y verás* (1837) and *El pelo de la dehesa* (1840).

BRETON LANGUAGES: *see* INDO-EUROPEAN; CELTIC LANGUAGES.

BRETON LITERATURE, like the language, divides into three periods—old, middle and modern. Old Breton written remains (8th to 11th centuries) consist entirely of names and glosses in documents, the chief collections of which were all published by Joseph Loth in *Vocabulaire vieux-breton* (1884). Breton names occur in Latin books and charters written between the 9th and 11th centuries. Lists appear in Loth's *Chrestomathie bretonne* (1890).

No Breton literature has survived from the beginning of the Middle Breton period (11th to 17th centuries), though it certainly existed, since Breton harpists were well known; but they were content to sing their compositions and we can learn nothing about their poetry except from the many works their songs inspired in the better-known languages. Until the 15th century only names are found, in such documents as charters, apart from a few scraps of verse discovered in a 14th-century manuscript in Paris (*Revue celtique*, vol. xxxiv, pp. 241–248 [1913]), which constitute the earliest known connected text in Breton. Written Breton literature did not really begin until the late 15th century, when there appeared the *Catholicon* of Jean Lagadeuc—a Breton-Latin-French dictionary dated 1464 and printed in 1499 (probably the first printed Breton book)—and Quiquer de Roscoff's French-Breton dictionary and conversations, printed in 1616 and often reprinted, an edition appearing in 1915. A collection entitled *Cantiques bretons* (1642) names several Breton airs. All the remaining works of the period are religious and most are in verse. *Buez santez Nonn* ("Life of St. Nonn," late 15th-century, reprinted, 1835) paraphrases and dramatizes the Latin life, attempting to localize some events in Brittany. *Burzud bras Jezuz* ("The Great Mystery of Jesus," 1530, reprinted 1865) follows Arnoul Gresban and Jean Michel's French play. *Buhez santes Barba* ("Life of St. Barbara," 1557, reprinted 1885) also derives from a French play. These three mystery plays were probably the most significant products of the middle period. Three long poems belonging to the 1530s, reprinted in *Poèmes bretons du moyen âge* (1879), "Tremenvan an itron gwerches Maria" ("The Passing of the Virgin Mary"), "Pemzec levenez Maria" ("The Fifteen Joys of Mary") and "Buhez mabden" ("The Life of Man") were all probably based on French versions. *Mellezour an Maru* ("The Mirror of Death"), a long, somewhat lugubrious poem composed in 1519 and printed in 1575, is based ultimately on a Latin work of which versions exist in French. A book of hours in verse reprinted as *Middle Breton Hours*, ed. by W. Stokes (1876), a prose extract from the Léon missal and a prose catechism also belong to the 16th century as does the prose *Buhez and itron sanctes Cathell* ("Life of St. Catherine," 1576), a translation of the Golden Legend version. *An Mirouer an Confession* ("The Mirror of Confession," 1621) is translated from French and so is *Doctrin an Christenien* ("Christian's Doctrine," 1622). A collection of carols, *An Nouelou ancient ha devot*, appeared in 1650, and a book of metrical meditations in 1651. Middle Breton literature obviously lacks originality and does not reflect Breton life of the period. The indigenous culture of Brittany seems to have been entirely neglected by the educated classes, who introduced an enormous number of French words into the preponderantly religious works published.

17th- and 18th-Century Mystery Plays.—Linguistically, Modern Breton is said to begin in 1659, when Julien Maunoir substituted a more phonetic orthography for the traditional system in his grammar *Le Sacré Collège de Jésus*. However, this is of little literary significance since works of the Middle Breton type continued to appear up to the 19th century. Much religious prose and verse was published, but the bulk of Breton literature in this period consisted of mystery and miracle plays treating subjects taken from the Old and New Testaments, saints' lives and stories of chivalry, generally derived from French or Latin sources. Even Breton saints are treated in the invariable traditional style and though there is occasional local colouring, the plays evince little originality. Old Testament plays include *Creation ar bed* ("Creation of the World"), *Bue Jacob* ("Life of Jacob"), *Trajedi Moyzes* ("The Mystery of Moses"), and *Bue Devy* ("Life of David"); New Testament plays *Bue santes Anna* ("Life of St. Anne"), *Sant Ian Baptist, An Passion* and *Buez Antekrist* ("Life of Antichrist"), which treats of the Last Judgment. There are, naturally, several Breton plays about saints—*Buez an abad Goenole* ("Life of Abbot Gwennolé"), *Bue an otro Sant Garan* ("Life of St. Garan"), a play about St. Patrick, etc. Dramas on chivalric themes are *Vie des quatre fils Aymon* and *Bue Huon a Vourdel* ("Huon of Bordeaux"). Other plays included *Buhez Louis Eunius* ("Life of Louis Eunius"), *Bue Robard an Diaoul* ("Robert the Devil") and three farces *Ar Farvel goapaër* ("The Mocking Fool"), *Ian Mêlarge* ("Shrove Tuesday") and *Bue en tad Mallarge a Tristemina e vroec hac e vugale* ("The Life of Mallargé, Tristemine His Wife and His Children"). These plays were always acted by peasants and incurred the displeasure of the clergy, with the result that at the time when the old religious drama was struggling to survive, the revival of Breton literature began. In the 18th century, many Breton dictionaries were published but little of literary significance was produced. However, one name survives: Claude-Marie Le Laë (1745–91) who wrote satirical poems—*Ar C'hy* ("The Dog") and the sermon of *Mikel Morin.*

The Revival of Breton Literature.—The "Celtomanes"—*e.g.*, Le Brigant and La Tour d'Auvergne—became enthusiasts for the Breton language; Le Gonidec (1775–1838) codified modern Breton, wrote a Celto-Breton grammar (1807) and dictionary (1821) and edited a Breton translation of the New Testament (1827). Interest in Breton revived at the time when the central government was trying to impose French on the area and destroy the regional language: however, the Bretons endeavoured to create a national literature, particularly after the publication of the celebrated *Barzas Breiz* (1839; after 3rd ed., 1845, *Barzaz Breiz*—"Breton Bardic Poems"), a collection made in the villages by Théodore Hersart de La Villemarqué (1815–95) who edited, translated and commented on each song, declaring that internal evidence showed they were composed in the remote past and had survived unchanged as part of Breton folklore.

The collection acquired considerable renown: George Sand called it "finer and more perfect poetry than any masterpiece the human mind has yet conceived" and such historians as Augustin Thierry thought the poems precious documents. However, Breton-speaking scholars were surprised at its strange vocabulary, which included Welsh words and incorrect expressions. Critics who doubted its authenticity soon began to speak of "the Breton Macpherson." Attacks on the book reached their height about 1870, when La Villemarqué, who had published several learned works in the interim, had been elected a member of the *Institut.* R. F. Le Men, in his reprinting of *Catholicon* (1867), and François-Marie Luzel, in a paper delivered in 1872, showed that *Barzaz Breiz* was not an anthology of Breton folk poetry. They divided its contents into three classes: (1) old poems rearranged by the editor or others, chiefly love songs and ballads, (2) modern poems made to look medieval and (3) spurious poems on such personages as Merlin and Nomenoë. But neither this nor even the publication of a 600-page thesis by Francis Gourvil in 1960 abated the controversy. The fact remains that *Barzaz Breiz* was very important: the historical poems (which exalt the Breton's traditional struggle against oppression) had an especially strong influence. Although they were often read only in French translation, the poems made Bretons proud of their own language and continue to be admired (the 1959 edition almost sold out in a year). *Barzaz Breiz* led to the reawakening of Breton writers and stimulated Luzel himself to collect authentic folksongs and publish *Gwerziou Breiz-Izel* ("Ballads of Lower Brittany," two volumes, 1868, 1874) and in collaboration with Anatole Le Braz, *Soniou Breiz-Izel* ("Folksongs of Lower Brittany," two volumes, 1890–91).

19th- and 20th-Century Prose.—Luzel also collected folk tales and legends, publishing many in Breton as well as in French translation, including *Contes bretons* (1870), *Veillées bretonnes* (1879) and *Les Légendes chrétiennes de la Basse-Bretagne* (1881). His collaborator, Le Braz, investigated Breton stories concerning *an Ankou* ("Death"), which he published as *La Légende de la Mort* (1893; Eng. trans. *Dealings With the Dead,* 1898). Many books of stories appeared in Breton between the 1860s and the 1960s in which it is hard to distinguish between traditional and literary elements, as in Gabriel Milin's *Marvailhou Grac'h koz* ("Old Wives' Tales," 1867), Lan Inisan's *Emgann Kergidu* ("The Battle of Kergidu," 1877) and many others. When Breton writers do not depend on folk legends for material, they like to fictionalize their own life stories; *e.g.*, Fañch Al Lay, who transposes his own youth into the 18th century in *Bilzig* (1925). Many books of war memoirs and mixtures of autobiography and imaginative writing were published in Breton in the early and mid-20th century. Other prose works include the novels of Berthou-Kerverziou, Fañch Eliès-Abeozen, J. M. Kerwerc'hez, Roparz Hémon and the painter Xavier de Langlais. The few published works of Jakez Riou (1899–1937) show what a loss Breton literature sustained when he died in his prime: the short stories in *Geotenn ar Werc'hez* ("The Virgin's Herb," 1934) are remarkably concise and unexpectedly combine sensitivity with profound skepticism. His friend Youenn Drezen wrote the best Modern Breton novel, *Itron Varia Garmez* ("Our Lady of the Carmelites," 1942). The many improving religious works published are not at all original; yet many Bretons who have read only one book in their own language have read *Buez ar Zent* ("Lives of the Saints").

19th- and 20th-Century Drama.—Most playwrights were concerned to teach moral and religious lessons—*e.g.*, Toussaint Le Garrec (1866–1939) and Abbé J. Le Bayon (1876–1935), who revived the tradition of the mystery plays, inspired by the Oberammergau passion play (*q.v.*), and at his theatre at Sainte Anne d'Auray produced four great mysteries—*Nicolazig, Boeh er Goed* ("The Voice of the Blood"), *Ar hent en Hadour* ("In the Steps of the Sower") and *Ar en hent de Vethleem* ("On the Way to Bethlehem"). Since 1900 more than 100 plays have been written in Breton by writers of great talent such as Le Braz, Eliès, Hémon, de Langlais, Riou and Drezen. The work of Tanguy Malmanche (1875–1953) dominates the first half of the 20th century: it was compared with that of Paul Claudel and J. M. Synge. Several of his plays were performed in French translation. His work was carried on by Pierre Hélias, a talented younger writer who has written 300 radio plays and had many stage plays produced. His writing was both popular and extremely polished.

19th- and 20th-Century Poetry.—Most novelists and playwrights wrote poetry as well as prose. For 200 years Bretons expressed their feelings in poems published as pamphlets—either as *soniou* (love songs, satires, carols, marriage lays) or *gwerziou* (ballads or broadsides describing recent events in Brittany and elsewhere). Their authors were people of every social class, very few of whom read *Barzaz Breiz,* and the poems were hawked around from fair to fair. A catalogue of the 2,000 of these pamphlets that remain was made by Joseph Ollivier (1942). Prosper Proux (1812–73) had his *soniou* printed in book form, as *Bombard Kerne* ("The Hautboy of Cornouailles," 1866), and dozens of poets published collections after the appearance of *Barzaz Breiz;* well known are those by Jaffrennou-Taldir, Loeiz Herrieu, Roperh Er Mason, Joseph Cuillandre, Paotr Tréouré; but the outstanding figure was undoubtedly Jean-Pierre Calloc'h, killed in action in 1917, whose poems were published with a French translation in 1921 as *Ar en Deulin* ("Kneeling").

Reviews and Movements.—Literary reviews abounded in the early 20th century and published much valuable work. The most influential leader of any of the literary schools publishing a magazine was Roparz Hémon, whose *Gwalarn* ("North-West") was founded in 1925. He published work of enormous diversity, including many fine poems and stories and other pieces—*e.g.*, translations from W. B. Yeats, Synge and Aeschylus—intended chiefly to further the literary development of the Breton language and increase its range and power. René le Roux, author of the "archaeological romance" *Sketla Segobrani* (1923–25), and the lexicographer François Vallée were similarly preoccupied with the struggle to resist the encroachment of French words and to make Breton self-sufficient. The new standardized spelling system introduced in 1941 was adopted only by some writers, so that in the mid-20th century there were two literatures differing in spelling, vocabulary and outlook: one, as represented by the review *Al Liamm* ("The Link"), aimed at only a small number of initiates (its best writers were Ronan Huon and the poet Maodez Glanndour); the other school, which published the review *Brud* ("Fame"), was led by Pierre Hélias: it did not wish to be cut off from ordinary Breton readers, whom it tried to attract little by little toward literary works of an increasingly high standard. A law passed in 1951, which gave Breton a place in the state schools as well as in the *baccalaureat* syllabus, might well make this task easier, for if instruction is given in Breton, writers might increase in numbers and quality. Until 1951, however, though all Bretons could read books written in their own language, the only people who could write in it were educated French-speakers who had come to Breton late in life (hence the ease with which certain writers forget the realities of the language) and a very small proportion of the 900,000 native Breton-speakers who had been taught to use their own language in a few church schools and seminaries (this, rather than the Bretons' traditional piety, probably accounts for the abundance of Breton literature inspired by religion).

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BRETONNEAU, PIERRE (1778–1862), French physician, one of the greatest epidemiologists of his time, was born on April 3, 1778, at St. Georges-sur-Cher. His fame rests on the first performance (1825) of the operation of tracheotomy for croup; on the clinical distinction of diphtheria, so-named by him in his *Des inflammations spéciales du tissu muqueux et en particulier de la diphthérite* (1826); and on his work on typhoid, which, he foresaw, would be differentiated from typhus. In 1814 he passed the examination for doctor of medicine in Paris and in 1815 became *médecin in chef* of the hospital at Tours. There he studied epidemic typhoid. His contribution to the knowledge of this disease is second in historical importance only to that of his work on diphtheria. The doctrine of specificity was his third most important contribution to medicine. By this doctrine he foreshadowed the germ theory of disease. Bretonneau died on Feb. 18, 1862.

See P. Triaire, *Bretonneau et ses correspondants* (1892); *Proceedings* of the Royal Society of Medicine, vol. 18, page 1 (1924).

BRETSCHNEIDER, KARL GOTTLIEB (1776–1848), German theologian, was born at Gersdorf, Saxony, on Feb. 11, 1776. He lectured on philosophy and theology at Wittenberg (1804–06); was pastor of Schneeberg, Saxony (1806–08); superintendent at Annaberg, Saxony (1808–16); and then moved to Gotha, where he was general superintendent until his death on Jan. 22, 1848. The best part of his life's work was done at Gotha. In 1820 appeared his most notable work, a treatise on the Gospel of St. John, which discussed with moderation the arguments against Johannine authorship. His greatest contribution to exegesis was his *Lexicon Manuale Graeco-Latinum in libros Novi Testamenti* (1824), valuable for its use of the Greek of the Septuagint, of the Old and New Testament Apocrypha, of Josephus and of the apostolic fathers, in illustration of the language of the New Testament. In 1826 he published *Apologie der neuern Theologie des evangelischen Deutschlands.* An English translation of his *Manual of the Religion and History of the Christian Church* appeared in 1857. Recognizing a supernatural element in the Bible, Bretschneider nevertheless allowed a full critical exercise of reason in the interpretation of its dogmas.

BRETT, GEORGE HOWARD (1886–), U.S. air commander in World War II, was born in Cleveland, O., Feb. 7, 1886. He served with the U.S. air service in France in 1917–18 and after extensive experience, especially in the matériel field, became chief of the U.S. army air corps in 1940. When World War II began, Brett was on an official tour of India and China, from which he was diverted to Australia to take command of U.S. troops there. After Gen. Douglas MacArthur's arrival in Australia in March 1942, Brett became chief of the Allied air forces in the Southwest Pacific, directing the defense of Australia and New Guinea until he was succeeded by Maj. Gen. George C. Kenney in Aug. 1942. Operating with air forces described as "pitiable" in strength, Brett had not been able to stop the Japanese advance along the island chain toward Australia. From Nov. 1942 he headed the Caribbean defense command in the war against German submarines in that area. He retired in 1945, with rank of major general. (A. GG.)

BREUER, JOSEF (1842–1925), Austrian physician and physiologist and the principal forerunner of psychoanalysis, was born in Vienna on Jan. 15, 1842.

In 1868 he studied the respiratory cycle and discovered the Hering-Breuer reflex, which is the foundation for the understanding of the nervous control of respiration. In 1873 he discovered the sensory function of the semicircular canals and their relation to positional sense. He practised medicine and was physician to many members of the Viennese medical faculty.

In 1880 he used hypnosis in treating a hysterical patient, "Anna O." (Bertha Pappenheim). Breuer found that she improved when she remembered unpleasant past experiences. He concluded that neurotic symptoms result from unconscious processes and disappear when the unconscious processes become conscious. Breuer treated no other patients by psychotherapy, but he described his methods and results to Freud and referred several patients to him. Breuer and Freud published *Studien über Hysterie* in 1895 but Freud soon after broke off his relations with Breuer. Freud rightly stated that Breuer's contributions were an integral part of the foundations of psychoanalysis. Breuer was elected to the Viennese Academy of Science in 1894. He died in Vienna on June 20, 1925.

See PSYCHOANALYSIS. (P. F. C.)

BREUER, MARCEL LAJOS (1902–), Hungarian-U.S. architect and designer, a leading exponent of the international style of modern architecture and a primary influence on 20th-century building, was born in Pécs, Hung., on May 21, 1902. At the age of 18 he went to Vienna with the intention of studying painting and sculpture. His disinclination to embark on the standard academic course led him to enter the workshop of a furniture designer in the Austrian capital. He soon (1920) left Vienna to study at Weimar, at the Bauhaus (*q.v.*), the pioneer school founded by Walter Gropius where the principles of modern design were being applied to the industrial as well as the fine arts. Breuer became Master of Carpentry and in 1925 invented the tubular steel chair, which, with its continuously bent structural frame inspired by the handlebars of a bicycle, was to become a leitmotif of modern design. Also at the Bauhaus and under the influence of Gropius, Breuer developed a strong interest in unit construction, a principle of design in which standardized units are multiplied to form a technologically simple yet functionally complex whole. In 1928 he left the Bauhaus in search of greater architectural opportunities and began private practice in Berlin. His first two complete buildings date from this period: the Harnischmacher House, Wiesbaden (1932), and the Dolderthal Apartments, Zürich (1934–36), built for the Swiss architectural historian Sigfried Giedion. In 1935 he moved to London where, along with Gropius, he was one of the prime factors in transmitting the modern movement to England, working in partnership with F. R. S. Yorke. During his two-year stay Breuer designed an important line of laminated plywood furniture for Isokon.

In 1937 he was invited by Gropius to teach architecture at Harvard. Gropius and Breuer practised architecture together in Cambridge, Mass., during 1938–41, a period in which they experimented with the American form of the wood-frame house

MARC & EVELYNE BERNHEIM—RAPHO GUILLUMETTE

WHITNEY MUSEUM OF AMERICAN ART, NEW YORK CITY, BY MARCEL BREUER, COMPLETED IN 1966

and evolved a type of building which, in its synthesis of Bauhaus internationalism with the regional characteristics of New England architecture, was to help determine the direction of U.S. domestic architecture in the 20th century. Among these were Breuer's own house at Lincoln, Mass. (1939), and the Chamberlain Cottage, Weyland, Mass. (1940). From 1941 to 1946 Breuer practised independently in Cambridge, Mass. He then moved to New York and in the early 1950s a series of large and important commissions came his way. These included the UNESCO headquarters, Paris (with Bernard H. Zehrfuss and Pier Luigi Nervi, 1953–58); St. John's Abbey, Collegeville, Minn. (1953–61); and the Bijenkorf department store, Rotterdam (1955–57). In 1966 the Whitney Museum of American Art in New York was completed to his design. Breuer, who once described modern architecture as the "civilizing of technology," was the author of *Sun and Shadow, the Philosophy of an Architect* (1955).

See P. Blake, *Marcel Breuer, Architect and Designer* (1949); Cranston Jones (ed.), *Marcel Breuer, Buildings and Projects 1921–1961* (1962). (S. Mi.)

BREUGHEL: *see* Brueghel, Pieter.

BREUIL, HENRI EDOUARD PROSPER (1877–1961), French archaeologist, an authority on prehistoric archaeology especially associated with the evaluation of the cave paintings of Europe and Africa, was born in Mortain, Manche, on Feb. 28, 1877. His science professor at the Seminary of Issy les Moulineaux encouraged him to take up a scientific career. After first studying the Bronze Age of the Paris basin, he became one of the pioneers in the field of Paleolithic art. Among his many books, illustrated by his copies of paintings and engravings, are those on *La Caverne de Font-de-Gaume* (1910), *Les Combarelles* (1924) and *Les Trois Frères* (1958) in France, *La Caverne d'Altamira* (1906) and *Les cavernes de la règion cantabrique* (1911) and other regions in Spain. *Quatre cents siècles d'art pariétal* (1952) reveals the great scope of his activities in this field. During and after World War II he spent about six years in South and South-West Africa and Rhodesia, copying many of the painted rock shelters. His archaeological publications include *Les Subdivisions du Paléolithique supérieur et leur signification* (1912), which added the Aurignacian period to the existing classification; *Les Industries à éclats du paléolithique ancien. 1. Le Clactonien* (1932). On his 80th birthday his bibliography listed more than 600 items. He was professor at the Institut de Paléontologie Humaine (Paris) from 1910 and at the Collège de France from 1929 to 1947. He became a member of the Institut de France in 1938. Breuil died in L'Isle-Adam, Seine-et-Oise, on Aug. 14, 1961. (H. Ke.)

BREVE: *see* Musical Notation.

BREVET: *see* Officers, Military.

BREVIARY OF ALARIC (*Breviarium Alaricianum*), also called Lex Romana, Corpus Theodosii or, most usually, Lex Romana Visigothorum, a collection of Roman law, compiled by order of Alaric II, king of the Visigoths, and promulgated at Toulouse in A.D. 506 for the use of his Roman subjects. The task was entrusted to a committee of lawyers, but the final work was submitted for approval to an assembly of Roman bishops and elected provincials. The breviary contains about one-ninth of the constitutions of the Theodosian code (*see* Roman Law: *Sources of Law*) and one-third of the post-Theodosian *Novels;* a few extracts from the Gregorian and Hermogenian codes; an epitome of Gaius' *Institutes* (*see* Gaius); about 600 of the *Sententiae Pauli;* one *responsum* of Papinian. An *Interpretatio* accompanies all the breviary except the epitome of Gaius.

In 654 the Visigothic king Recceswinth promulgated a uniform law for Goths and Romans and repealed the breviary, except for a few decrees (called *Antiqua*). The breviary, however, continued to be used for legal study in several countries (particularly in France, where it had considerable persuasive authority); indeed it was almost the only source of Roman law in western Europe down to the 11th century. Abridgments were made between the 6th and the 9th centuries. An imperfect abstract of it formed the basis of the *Lex Romana Curiensis,* probably written in Graubünden in the 8th century. A 9th-century recast made for the use of Lombardy was preserved in a manuscript called *Codex Utinensis.*

There is considerable dispute concerning the *Interpretatio.* For example, F. Wieacker held that it was not original work by the Visigothic lawyers but was based on 5th-century commentaries. W. W. Buckland found features that distinguish the *Interpretatio* for the *Sententiae Pauli* from the *Interpretatio* for the extracts from the Theodosian code. E. F. Bruck stressed the haste with which the breviary was compiled (to appease Alaric's Roman subjects) as a reason for the absence of an *Interpretatio* for the epitome of Gaius, while admitting that the *Interpretatio* for the *Sententiae Pauli* probably existed before the compilation.

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BREWING. Brewing is the preparation of beer from carbohydrate material, chiefly malted barley, by means of the action of yeast and usually with the addition of hops. For a description of beer, including types of beer, *see* Beer.

HISTORY

The Middle East and Europe.—Since many fermentative yeasts occur naturally on vegetable matter and in soil, alcohol no doubt originated accidentally but man must soon have learned to carry over some of the active agent from one brew to the next. The nature of the earliest fermented beverages is uncertain; they may have been derived from barley, dates, grapes or honey. Brewing seems to have originated in Babylon where, as in Egypt, barley grew wild, and there is some evidence that beer made from malted grain was being brewed in Mesopotamia by 6000 B.C. By the fourth or fifth millenium B.C. brewing was well established and evidence exists of the various types of beer extant in Babylon about 1800 B.C. Brewing in Egypt began at a later date than in

Babylon but probably developed independently. It was said to have been a gift of the god Osiris, or his wife Isis, about 2000 B.C. although it seems that several different types of beer were brewed in Egypt a thousand years before then, and there is a reference to its use as a mortuary offering in the 5th dynasty, about 2800 B.C. In later times beer drinking is well documented and illustrated, and beer appears to have been the national beverage. It played an important part in religious worship, and some of the festival offerings were dispensed among the populace. During his reign Rameses III (about 1225 B.C.) is claimed to have distributed the equivalent of more than 500,000 gal. Beer was also used extensively in medicine.

Since the raw materials are grain and yeast, brewing was usually carried out by bakers. The barley was soaked until it germinated and then was roughly ground. Yeast was added to this malted material and molded into cakes, which were partially baked. These were then crumbled, put in a jar of water and left to ferment. This method is similar to that still used in Egypt in the making of "bouza." The end product has the consistency of soup and is sometimes strained through a cloth.

The origin of the use of hops is unknown. Some authorities think herbs and other flavourings were widely used in these ancient brews but the evidence, particularly with regard to hops, is slender. The modern "bouza" has no flavouring added although the Abyssinians add the bitter leaves of a shrub called "ghesh." One suggestion is that the Hebrews learned the use of hops during the Babylonian captivity in the 8th and 9th centuries B.C.

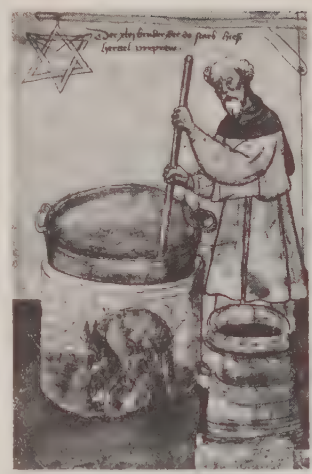
The Greeks learned brewing from the Egyptians and also grew hops, although they do not appear to have used them particularly in brewing. The Romans learned about beer from the Greeks, and it became known also in Gaul and Spain, but references to the use of hops do not reappear till the 8th century.

The northern European races probably discovered the technique of brewing long before the Christian era, the earliest Teutonic and Celtic beverages being made from a mixture of corn and honey and hence approximating mead. Beer has always been drunk most extensively in lands where soil and climate are inhospitable to the vine.

There is no direct evidence of beer brewing in Britain prior to the Roman occupation but by Anglo-Saxon times, probably as the result of invasion, beer or ale was well established. In the early middle ages brewing was carried on in most large households and was largely the duty of the women folk, hence the terms "maltster" and "brewster," which are the feminine forms of "malter" and "brewer." The growth of the monasteries resulted in the development of larger brewing units; the monks became excellent brewers.

EGYPTIAN BREWER STRAINING MASH FROM FERMENTED BARLEY BREAD INTO A BEER VAT; IN FRONT OF THE VAT ARE SEALED JARS OF BEER. TOMB MODEL FROM ASYUT, EGYPT, MIDDLE KINGDOM, *c.* 2000 B.C.

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM



BY COURTESY OF THE STAATSBIBLIOTHEK NURNBERG

MEDIEVAL BREWER, ILLUSTRATION FROM "THE HOUSEKEEPING BOOK OF THE 12 MENDEL BROTHERS," 14TH CENTURY

There was a great variety of brews, and the strength of the best beers was considerable. Weaker brews were drunk in great quantity since the water in many areas was unwholesome. The use of hops was introduced from northern Europe in the 16th century; thereafter the hopped beverage became commonly known as "beer" whereas "ale" indicated the unhopped drink. Nowadays in Britain the term "ale" has no special significance but it is used in America to distinguish top-fermented or British beers (see *The Brewing Process* below), from the more widespread lager beers.

North America.—Various alcoholic beverages were made by the Indians long before the advent of Europeans but the history of American brewing really begins in 1584 when the British brewed beer from corn (maize) during their first attempt to colonize Virginia. Later, in 1612, Dutch colonists are said to have set up a brew house on the most southerly point of Manhattan Island. In Massachusetts the price of beer was carefully controlled and in 1657 regulations were also laid down about the ingredients of the different varieties. Fines were imposed on maltsters whose product contained too many impurities. Although the quantity and quality of the home-grown barley soon became inadequate, the import of European grain, malt and flour was prohibited in order to encourage home production. In 1660 this law, in regard to malt, was repealed because it encouraged the people to drink poor spirits instead of beer. This legislation is an early example of attempts to discourage heavy spirit drinking by encouraging the consumption of beer. Similarly, when Jean Talon, *intendant of* New France, was faced with a high degree of alcoholism among the colonists he established, in Quebec city, the first Canadian brewery.

In 1683 William Penn erected the first brewery in Pennsylvania and in the following century many other famous men were concerned with brewing. Samuel Adams, "Father of the Revolution," was a brewer, as was his father before him. Thomas Chittenden, first governor of Vermont, was a brewer and innkeeper, and others who fostered the industry included Thomas Jefferson, Patrick Henry, Israel Putnam, Benjamin Rush and James Madison. George Washington himself had a small brewery at Mount Vernon.

Until the mid-19th century only "British" types of beer were brewed in North America but about 1840 German brewers introduced the newer methods of making lager beer, thus laying the foundations of the vast modern American industry, which produces 87,000,000 U.S. barrels a year. Between 1870 and 1960 the quantity brewed in the U.S. increased tenfold but since the industry became concentrated in the hands of a few large firms the number of breweries, and hence the variety of beers available, decreased considerably.

Measurement.—The units of measurement used in America differ from those used in Britain. 1 U.S. gal. = 0.8327 British gal.; 1 standard U.S. barrel contains 31.5 U.S. gal.; 1 U.S. beer barrel contains 31 U.S. gal.; 1 British barrel contains 36 British gal. Unless otherwise designated, measurements referring exclusively to British beers will be given in British units and all other measurements will be given in American units.

BREWING MATERIALS

The principal materials employed are malted barley, hops, water and yeast. In certain countries, *e.g.,* Germany, the use of other materials is forbidden by law (except for export beers), but in most places other materials are employed to give colour and flavour and are known as "adjuncts."

Malt.—Barley malt is far and away the most important raw material. Not all barleys are suitable for malting but there is a great variety among those that are. In North America six-rowed barleys are by far the most widely used but in Europe the two-rowed varieties are grown for brewing (*see* BARLEY: *Uses*).

After harvesting, barley passes through a dormant phase; the length of this phase depends not only on the variety of barley but also on climatic conditions at harvest. For this reason, malting used to start several months after harvesting, but dormancy can now be overcome in various ways so that malting takes place all the year round. During malting, profound changes occur in the barleycorn (barley grain), the most important being the development of certain enzymes. The two most important groups are the amylolytic enzymes, which can convert starch to carbohydrates of lower molecular weight, and the proteolytic types, which can break down the protein constituents of the barley to simpler nitrogenous compounds. These processes are actually initiated during the malting, together with a partial breakdown of the cell walls, and the extent to which they are allowed to proceed is known as the degree of modification of the resulting malt.

Malting is carried out at some breweries and also as a separate industry. The skill of the maltster lies in achieving the desired modification from variable raw materials. Before malting, the barley is steeped in water to soften the grains and initiate germination. Steeping also removes undesirable materials, such as tannin complexes (mostly from the husks), which are thought to inhibit the subsequent fermentation. Steeping takes place at 55°–60° F. and lasts up to 48 hr. in the case of the barley used in British beers and up to 70 hr. for the harder and more nitrogenous barley used in lager beers. Steeped barley is known as "green malt."

There are three principal methods of malting: (1) In floor malting, which is the oldest method, the green malt is spread thinly over a heated floor, sprinkled with water and turned over from time to time in order to air it. In these favourable conditions germination takes place, the rate of growth of the acrospire (germinating shoot) increasing as the rootlets begin to wither about the eighth day. (2) In box malting (also called the Saladin process after its inventor) the steeped barley is put into a long rectangular box, to a depth of about two feet, and moist air is blown into the grain through vents in the sides of the box. Vertical helical screws move slowly back and forth through the barley, turning it twice or thrice a day. (3) Drum malting is another form of pneumatic malting, in which the steeped barley is put into large cylindrical drums that are rotated horizontally while water-saturated air is driven through the grain.

After germination the malt is dried in a kiln until the moisture content is between 1.5% and 2%. The shriveled rootlets drop off and are collected and sold as animal feed. The temperature at which each operation takes place, and the time taken, varies with the type of beer being made. Generally British malt is allowed to germinate for 11 days and is dried by direct heat for 3 to 4 days at temperatures up to 225° F. Lager malt is allowed to germinate for only 7 or 8 days and is consequently less highly modified. It is dried with hot air at about 130° F. Malt in Britain is measured in quarters that weigh 336 lb. as opposed to quarters of barley, which weigh 448 lb.

Since the composition of the malt is of paramount importance each batch is analyzed for moisture content, extract (a measure of the soluble matter extracted from the malt), tint, diastatic activity and cold water extract (the proportion of water-soluble materials), total nitrogen and permanently soluble nitrogen. (*See* also MALT.)

Adjuncts.—These are carbohydrate materials that provide additional fermentable material. They are used to reduce costs, to give flavour and to correct the balance in the composition of the extract; for example, with a malt made from a high-nitrogen barley. They are added during mashing, when the excess amylolytic enzymes in the malt break them down to fermentable sugars (see *The Brewing Process* below). In Europe they usually account for 10%–25% of the total weight while in the U.S. they may reach 40%.

The principal adjuncts are corn (maize), rice, unmalted barley and tapioca. Corn is the commonest, while rice is used particularly for the palest beers. Brewing sugars and sirups are also used and, since they need no further conversion, are added during boiling (*see* below). These sugars may be in the form of glucose, made by the acid hydrolysis of starch; invert sugar (equal parts of glucose and fructose), made by the dilute acid inversion of sucrose; or sucrose itself. The yeast that is added at a later stage secretes an enzyme, invertase, that inverts the sucrose to glucose and fructose so it can be fermented. Glucose made from starch contains unfermentable dextrins that act as mellowing agents in the finished beer.

Hops.—Hops are not an essential constituent of beer and have not always been employed in brewing (see *History*). Nowadays their use is almost universal, but the types and quantities employed vary widely and greatly influence the character of the resulting beers. The hop plant (*see* HOP) is dioecious; *i.e.*, the male and female flowers are borne on separate plants. The flowers of the female plants are grouped in cones and contain a resinous material, lupulin. It is these cones that are used in brewing. If fertilized with pollen from a male hop flower, they develop seeds with an unpleasantly bitter taste, and for this reason the male plant is banned in most European countries. The female plant is propagated exclusively by cuttings. The finest hops are those from the Saaz district of Czechoslovakia, such Bavarian types as Hallertau and the Styrian hops from Yugoslavia. Britain produces rich aromatic hops for her "top fermentation" beers (see *Yeast* and also *The Brewing Process* below); other small producers are France, Poland, Russia and Belgium. Outside Europe, the U.S. is the only large hop grower, hops being grown chiefly in Oregon, California, Idaho and New York state. They tend to have a strong flavour that restricts their use for British and European beers, although when used with brewing waters containing calcium sulfate the undesirable part of the flavour is suppressed.

Hops are added to the wort, or mashed malt solution, during boiling (see *The Brewing Process* below). They have several functions. Their resins and oils impart the desired bitter flavour and aroma, and the derived constituents act as a preservative. Also, the tannin they contain assists the "break," or precipitation of protein material, which might later cause haze in the beer. The quantity of hops added during brewing varies with the type of beer being brewed and with the species of hops. The amount may be less than $\frac{1}{3}$ of a pound per barrel of light lager and over $2\frac{1}{2}$ pounds per barrel of strong British beer.

Water.—The chemical composition of brewing water has a profound effect on the character of the beer being brewed. In the past the suitability of the certain waters has decided the locality of the breweries, for instance those at Burton upon Trent, Dortmund, Dublin, Pilsen and Munich. Nowadays the composition can be adjusted.

The hydrogen ion concentration of the water is of extreme importance. If the water is alkaline, large amounts of unwanted matter will be dissolved from the husks of the malt and, since an acid solution is needed for the maximum activity of amylolytic and proteolytic enzymes, enzymic activity will be somewhat diminished. The commonest cause of alkalinity is the presence of magnesium and calcium bicarbonates in solution. These bicarbonates produce what is known as temporary hardness and can be removed by boiling since the bicarbonates decompose and precipitate as the insoluble carbonates. Permanent hardness, which gives a faintly acid solution, is caused by the presence of calcium and magnesium in the form of sulfates and chlorides and is usually an advantage to the brewer.

Broadly speaking, waters containing calcium sulfate (gypsum) are the best for pale ale brewing, as at Burton and Dortmund. Dark lagers are brewed at Munich with a type of water very similar to that of Dublin. A very small amount of gypsum is necessary for the best bitter beers, such as those brewed in London. However, the question of brewing waters can be oversimplified, and many other factors have to be considered, such as the other materials present and the methods of brewing involved.

The waters must also be free of bacterial contamination, iron and of any malodorous content. Since the quantity of water used for washing bottles and casks is 8–20 times the amount used in brewing, the supply must also be a plentiful one. Nowadays most brewers use their local town supply, which should ensure its good quality.

In Britain, brewing water is generally referred to in the trade as "liquor," a term likely to be misunderstood elsewhere.

Yeast.—Yeast (*q.v.*) is used to convert the fermentable sugars in the wort, which consists mainly of the sugar maltose, into ethyl alcohol and carbon dioxide. The original Gay-Lussac formula for this reaction:

$$\underset{\text{sugar}}{C_6H_{12}O_6} \longrightarrow \underset{\text{ethyl alcohol}}{2C_2H_5OH} + \underset{\text{carbon dioxide}}{2CO_2}$$

is actually only 95% correct and is the oversimplification of a complex series of intermediate steps, as indicated by the Embden-Meyerhof-Parnas scheme (*see* FERMENTATION: *The Modern Position*). Yeasts are microscopic vegetable organisms belonging to the fungi family. There are many thousands of species and strains but those used in brewing all belong to the species *Saccharomyces cerevisiae.* Although there are a great many types within this single species, from the brewer's point of view they can all be placed in one of two categories, "bottom" and "top," depending on whether the cells sink or rise during fermentation. In the brewing process it is the manner of fermentation that is responsible for the basic difference between British beers, which are "top fermented," and lager beers, which are "bottom fermented." Bottom fermentation takes place at lower temperatures.

THE BREWING PROCESS

The three main stages of the brewing process are: mashing, boiling and fermentation.

Prior to mashing the malt is crushed between rollers so that the resulting flour is well separated from the husk, though not too finely ground. The husk should remain as unfragmented as possible because it is used later as a filter bed.

Mashing.—The procedure after the grist (flour and husk) leaves the mill depends on whether British or lager beer is being produced.

Infusion Mashing.—This is the top-fermentation, or British, system. The grist is passed through a Steel's masher, a machine with a revolving worm screw, which mixes the grist with incoming water to make a porridgelike mixture. This then enters the mash tun, a circular vessel having a domed cover fitted with sliding doors or hinged segments that can be raised individually. The diameter is about twice the height from base to the edge of the dome, and the vessel has a false bottom to permit drainage. The "striking heat" of the water as it meets the grist is about 150° F. and the principal reaction is the breakdown of the insoluble starch in the endosperm of the malted barley. It is converted into soluble maltose and other sugars and dextrins by the amylolytic enzymes, α- and β-amylase, which are present in the malt (see *Malt* above). The mash is kept moving by rakes and the "wort," as the solution of converted carbohydrate is called, filters out of the bottom of the mash tun, leaving the malt husks behind. The mash is left to stand for about two hours and then the husks are sparged (sprinkled) with hot water to complete the extraction of the sugars and dextrins. The proportion of maltose and dextrins obtained in the mash can be controlled by varying the acidity and temperature. α-amylase converts the starch into dextrins and is most active between 150° and 168° F.; β-amylase breaks down starch and dextrins into maltose, but above 140° F. its power is diminished. A higher temperature therefore yields a more dextrinous and less fermentable wort and will tend to give a less alcoholic though more fully flavoured beer. In infusion mashing the breakdown of the nitrogenous material is restricted since proteolytic enzymes react best at temperatures from 122°–130° F., which are well below those for amylolytic enzymes.

Decoction Mashing.—This process is used for all but British beers and has many variations. Because the malts to be mashed are usually less modified than British malts, they have to be more finely mashed. The most common variation is the three-mash system in which, after a preliminary mashing at 100° F., the temperature of the mash is raised in three stages: first to the optimum temperature for the activity of the proteolytic enzymes (122°–130° F.), second to 150° F. and lastly to 168° F. The first of these stages lasts two hours and is known as the "protein rest." The temperature rises at each stage are achieved by withdrawing about one-third of the mash, boiling it and returning it to the rest of the mixture. Though the enzymes in the portion that is boiled are destroyed, the body of the mash retains a sufficient quantity to convert the whole. In a two-mash process the preliminary mash is omitted, the temperature being taken straight up to 122–130° F. There are many variations to this and other mashing systems; for instance, the Pilsen system, a decoction using only two vessels. In a one-mash system about 5% of the total is taken off, the bulk is raised by stages to boiling and then cooled and mixed with the withdrawn 5%, which still has its enzymes intact and can convert the whole mash. The quick-mashing system, which is used in America, employs two mashes at temperatures of about 145° and 172° F.

When rice and corn are to be added they are mashed separately with a little malt to provide the necessary enzymes. They are then added to the main mash in quantities calculated to give the requisite rises in temperature.

Decoction mashing is suitable for malts that are not highly modified and have a high nitrogen content, because the "protein rest" permits the breaking down of the nitrogenous material into soluble nitrogen compounds, and the various subsequent boilings encourage protein coagulation and precipitation.

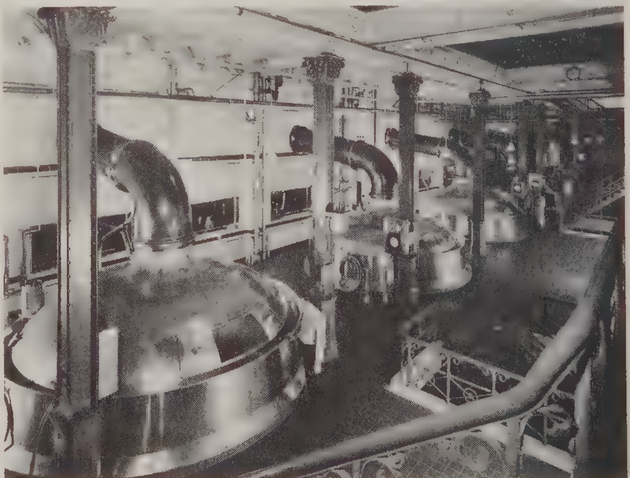
Boiling.—After mashing, and sometimes after filtering, the wort is boiled in a copper tank or kettle. This prevents any further enzyme action and coagulates a great deal of the protein material, which is known as the "hot break" or "trub." The boiling also sterilizes the wort, makes it more concentrated and provides an opportunity for the hops to be added.

The length of boil depends upon the type of beer to be brewed but it is usually about two hours. Some of the hops may be added when the boiling is half completed and more towards the end. If sugar adjuncts are used, they too can be added during the latter half of the boil.

Kettles once were fired directly, but nowadays heating coils, steam jackets or a percolating system in the kettle are more usual, particularly in America. Pressure boiling is sometimes used; it tends to affect the colour and flavour of the beer.

After boiling, the wort is filtered quickly to remove the hops and also as much of the hot break as possible. The filter bed is formed of spent hops between 18 and 24 in. deep and after filtering is sprinkled with water to remove any residual wort.

From the hop strainer the hot wort passes either through a high-speed centrifuge to achieve greater clarity or directly to the cooler. In the cooler protein-resin-tannin complexes are precipi-



BY COURTESY OF THE JOS. SCHLITZ BREWING COMPANY

MODERN BREWERY IN MILWAUKEE, WIS.; THE WORT IS BOILED IN THE 500-BARREL COPPER BREW KETTLES FOR ABOUT TWO HOURS tated, a reaction known as the "cold break." During this phase the wort is susceptible to infection by bacteria and wild yeasts, and great care must be taken to ensure sterility.

The simplest form of cooler is a large shallow vessel (cool ship) where the wort stands at a depth of about 6 in. until it is cool. A second type is the original "refrigerator," a vertical cooler in which the wort flows over flattened pipes containing cold brine. The third form of cooler, and one which is extensively used, is the closed plate cooler in which the wort passes between plates on the other sides of which cooling water flows. The advantage of this closed system is that there is less risk of infection.

Fermentation.—Fermentation begins when the yeast is "pitched" into the wort.

Bottom Fermentation.—This type of brewing was developed in Germany in the 15th century in order to produce a stable beer that could be stored satisfactorily.

The temperature of the wort at pitching is 43°–50° F. and the yeast is added in the form of a slurry, about 1 lb. of pressed yeast being allowed for each barrel of wort. A certain amount of aeration may be employed at the earliest stage to encourage yeast growth. The sooner the yeast begins to grow, the less danger there is from bacterial infection. Within a few hours a fine fluffy white head appears and the fermenting wort is often pumped or transferred to another, preferably closed, vessel, leaving behind much of the unwanted protein, hops and resins. Activity increases and the stage known as the "kräusen," or "cauliflower," stage is reached after two days. After a further 24 hr. the most active stage, the "high kräusen," is reached and continues for three days, during which the temperature must not be allowed to rise above 50° F. or the activity of the yeast is impaired. The head then starts to collapse and the temperature is allowed to fall gradually to about 39° F. After about eight days' fermentation in all, most of the fermentable material will have been converted to alcohol and the "green" beer is then removed to the storage cellar (for the "Ruh," or resting stage) at just over 32° F.

During the lagering period which follows, a slow secondary fermentation takes place. Carbon dioxide is evolved, suspended protein matter and yeast settle out and a polyphenolic protein complex, which tends to cloud chilled beer, is also partly precipitated. During this stage the beer improves in flavour so long as oxygen is excluded. Lagering may be continued for three months but much shorter periods are common, particularly in America. Nowadays, in order to save lagering time, the beer is often filtered and carbonated soon after fermentation.

Pure strains of yeast have been used in bottom fermentations since this practice was introduced in 1883 by E. C. Hansen, first director of the Carlsberg laboratory in Copenhagen. Later pure strains with different characteristics were mixed together; *e.g.*, a yeast that starts fermenting quickly is used in conjunction with one that is a good attenuator, (converter of sugar to alcohol) but a slow starter. Now the pure-culture yeasts are worked up by stages from a laboratory stock culture or taken from a previous uninfected brew.

The strength of the beer is sometimes referred to in terms of the specific gravity of the wort from which it was made. The original gravity (O.G.) of the wort is high when its content of fermentable sugars is high. The higher the O.G., the higher the alcohol content after fermentation and specific gravity of the resultant beer.

Top Fermentation.—About 98% of British beer is still brewed by this method. The wort is at 60° F. when fermentation begins and is allowed to rise about 10° F. during five- to seven-day fermentation period. A light froth appears in the first few hours, giving place to small "cauliflowers" and then to "rocky heads" that contain a considerable amount of protein and resinous matter that is skimmed off. On the second day a high rocky head develops, fermentation is vigorous and heat generation is at its greatest. On the third day the head gradually collapses and the blanket of yeast is skimmed off, except for the bottom inch, and used for a subsequent brew. The head then forms pleats or folds as the beer is cooled for a second skimming.

Two other famous systems of top fermentation need special mention: the Burton union and the Yorkshire stone square. In the first, fermentation takes place in large casks, or unions, and the beer and yeast work up through swan necks into a trough and are fed back into the unions. For this a nonflocculating yeast must be used. The resulting beer is of good character and stability but the system is susceptible to infection and much labour is expended on cleaning. In the Yorkshire stone square, a system still used in the north of England, a highly flocculant type of yeast is used in conjunction with characteristically small fermentation vessels. The mixture is kept moving from one vessel to the other and a full-flavoured beer is obtained although, with so much unfermented material present, stability is not high.

In top fermentation brewing pure-culture yeasts are not generally employed; several strains are usually present. The use of pure yeast cultures is, however, increasing and should continuous fermentation (see *Research and Consumption* below) come, it may be essential.

Flocculence.—Some brewing yeasts form clumps or flocs during fermentation whereas others do not. Both top and bottom yeasts exhibit this phenomenon, which has nothing to do with whether they rise or sink during fermentation. A yeast that flocculates is removed from the sphere of action, leaving a great deal of sugar unfermented. On the other hand, an entirely nonflocculating or powdery yeast may convert too much of the sugar into alcohol and leave large amounts of yeast still in suspension at the end of fermentation. The degree of conversion is known as the "attenuation" of the brew. Numerous theories of the cause of flocculence exist and none, by itself, is completely satisfactory. The most important factors appear to be genetics, electrical charge and the nature of the cell wall.

Kegging, Bottling and Canning.—When fermentation is complete the beer is run off into tanks for racking (casking). Some beers are "conditioned" in tank and cask for several days before leaving the cellars, and special beers may be retained for many months, thereby acquiring excellent character, though this practice is less common than it used to be. When mild beers are casked, or racked (placed in kegs or barrels), they are sometimes primed with sugar to give condition and flavour, while bitter beers are often dry hopped; *i.e.*, a few ounces of hops are added to each barrel. A colloid such as isinglass is also added to precipitate particles of protein material and yeast cells and to give a bright beer.

Except for dark and conditioned beers, beer for bottling and canning is filtered through pulp, sheet or diatomaceous earth and carbonation is carried out at the same time. The "polished" beer goes to bright beer tanks, where it is fed to filling machines. Most bottled and canned beers are pasteurized nowadays in their containers but a recent system of "hot bottling" is arousing interest. Pasteurization destroys wild yeasts and bacteria whose action might make the beer turbid or unpalatable, and is usually effected by holding at a temperature of 140° F. for about 20 min.

The can is becoming increasingly popular as a container, particularly since the development of linings that do not alter the taste of the beer. In a flat-topped can the air content is very low and the beer keeps well. In America far more beer is consumed from bottle and can than from keg: in Britain the trend is in the same direction though in 1960 the consumption of bottled and canned beer was roughly equal to that from the keg.

By-Products.—The chief by-products are carbon dioxide, yeast and the spent grains from the mash tun.

After the first few hours of fermentation the carbon dioxide evolved reaches a high degree of purity and can be recovered for use in carbonation.

Far more yeast is produced during fermentation than is needed for subsequent brews and it has a high nutritive value, containing 50% protein and 2% fat by dry weight, a good content of the B vitamins and minerals such as calcium and iron. It is very bitter on account of the hop resins so that for some purposes a debittering process is necessary. It is in good demand for livestock feeding stuff, yeast extract manufacture and for various pharmaceutical purposes.

Like the rootlets from the malt (see *Malt* above), brewer's spent grains are used for animal feeding since they contain about 20%

protein and 8% fat by dry weight. The spent hops are dried and sold as hop manure.

RESEARCH AND CONSUMPTION

Scientific research in brewing has been going on for over a century but has intensified since World War II. This applies to North America, western Europe and particularly to the Brewing Industry Research Foundation in Britain. The larger brewing organizations also have research staffs. Work on raw materials is mainly carried out by agricultural institutes in close collaboration with the industry. In Britain, hop research is concerned with breeding palatable types of hops that are resistant to disease and with the chemistry of hop resins and oils. The elucidation of hop chemistry has led to the evaluation of hops based on the isohumulone content as an index of beer bitterness. Barley research is directed to the production of barleys that malt well and can stand up to the vagaries of climate. Improved malting methods are being investigated and systems of continuous brewing are being developed that will have a substantial effect on capital outlay as regards plant, space and labour. Already the fermentation stage is being operated commercially and the ultimate aim is to streamline the whole process into one continuous operation. Other topics always under investigation are head retention, haze prevention and yeast behaviour, while such bodies as the European Brewery convention and the American Society of Brewing Chemists are working together to reach agreement on analytical methods.

Annual world consumption of beer is estimated to be about 8,500,000,000 U.S. gallons. In the United States beer is estimated to account for approximately 49% of the total alcohol consumed; in the United Kingdom this figure is 84.3% and in Canada 64.5%. On a per capita basis the greatest consumers of beer are Belgium (34 U.S. gallons annually), Luxembourg (33), Australia and West Germany (27), United Kingdom (22), Denmark and Austria (19), Switzerland and Canada (16) and the United States (15).

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BREWSTER, SIR DAVID (1781–1868), Scottish physicist, is notable for his experimental work in optics and polarized light. He was born at Jedburgh on Dec. 11, 1781, and died on Feb. 10, 1868, at Allerby, Melrose. At the age of 12 he was sent to the University of Edinburgh to study for the ministry. He finished his theological course but his interest in science prevented him from pursuing this profession.

In 1799 he was induced by a fellow student to begin the study of the diffraction of light. He made his name by a series of investigations on this subject, the results of which he contributed from time to time to *Philosophical Transactions* and other scientific journals.

Brewster's most important studies concerned polarization, metallic reflection and light absorption. He formulated the rule governing polarization by reflection which states that light reflected from a glass surface is completely polarized when the reflected and refracted rays are perpendicular to one another. He discovered biaxial crystals.

Brewster was elected a fellow of the Royal society in 1815, and was awarded the Rumford gold and silver medal for his discoveries in connection with the polarization of light in 1818. In 1816 he invented the kaleidoscope (*q.v.*). He improved the stereoscope by suggesting the use of lenses to combine the dissimilar binocular pictures. More important was his work in persuading the British authorities to adopt the dioptric apparatus, perfected by Augustin Fresnel, in their lighthouses. He suggested its use for this purpose as early as 1820.

Brewster was one of the group of scientific men who assembled in the archiepiscopal palace at York and developed the idea of a British Association for the Advancement of Science, realized in 1831.

In 1838 Brewster became principal of the united colleges of St. Salvator and St. Leonard, St. Andrews, Scot., and from 1859 till a short time before his death was principal of Edinburgh university.

In spite of his activity in research and, in his later days, in university life, Brewster accomplished a mass of literary work. He edited the *Edinburgh Encyclopaedia* (1808–30), was one of the leading contributors to the 7th and 8th editions of the *Encyclopædia Britannica*, joint editor (1819–24) of the *Edinburgh Philosophic Journal*, and then (1824–32) editor of the *Edinburgh Journal of Science*. Among his many separate publications may be mentioned his *Treatise on Optics* (1831) and his *Memoirs of the Life, Writings and Discoveries of Sir Isaac Newton* (1855).

BREWSTER, WILLIAM (1567–1644), leader of the Plymouth colony in America, was born in England in 1567 and spent his early life at Scrooby, Nottinghamshire. He acquired his first Separatist ideas while at Peterhouse, Cambridge, which he attended for a short time, beginning in December 1580. In 1583 he became the personal secretary of William Davison, an Elizabethan diplomat. Because of disillusionment with diplomatic and court life and because of his father's illness, he returned to Scrooby in 1589 to become his father's deputy (and successor the next year) as bailiff and postmaster. At Scrooby he became the leader of the Puritan congregation that separated from the Established Church in 1606.

He and John Robinson were the leaders in the migration to Amsterdam in 1608 and the move to Leiden in 1609. In Holland he made his living by printing Puritan books by English authors and exporting them to England until pressure applied by the British government on the Dutch government forced the abandonment of his enterprise. He accompanied the first group of settlers on the "Mayflower" in 1620 and remained until his death one of the most important members of the Plymouth colony. Brewster, the only university-trained Pilgrim, was the real leader of the church as its senior elder, and he dominated the formulation of its doctrines, worship and practices. He was not a magistrate, but the governor, William Bradford, was so dependent upon him and so attached to him that he played a major role in civil as well as religious affairs.

Brewster died at "New Plymouth" in April 1644. (Ra. Mu.)

BRÉZÉ, the name of an Angevin noble family eminent in French history. Pierre de Brézé (1410?–1465), a trusted soldier and statesman of Charles VII, made his name in the English wars when in 1433 he joined with Yolande, the queen of Sicily, the constable Richmond, and others in chasing from power Charles VII's minister, La Trémoille. Brézé also won distinction in the Praguerie (*q.v.*), when he supported the royal cause against the dauphin Louis and the rebels, a service remembered against him after Louis came to the throne. He was made seneschal of Anjou in 1437 and of Poitou in 1441; fought the English in Normandy in 1440–41 and in Guienne in 1442; and became chamberlain to Charles VII and gained the chief power in the state through the influence of Agnès Sorel. The years of his ascendancy (1444–50) were the most prosperous period of Charles VII's reign. The dauphin Louis in 1448 brought against him accusations which led to a formal trial, resulting in a complete exoneration of Brézé and his restoration to favour. He played a large part in the reconquest of Normandy (1449–51), especially in the battle of Formigny, and became seneschal of the province in 1451. He made an ineffective descent on the English coast at Sandwich in 1457 and was preparing an expedition in favour of Margaret of Anjou when the accession of Louis XI brought him disgrace and a short imprisonment. He accompanied Margaret to Scotland with a force of 2,000 men in 1462 and brought her back to Flanders on the collapse of her plans in 1463. Brézé was reappointed seneschal of Normandy and fell in the battle of Montlhéry on July 16, 1465. He was succeeded as seneschal by his eldest son Jacques de Brézé (*c.* 1440–90), comte de Maulévrier; and by his grandson Louis de Brézé (d. 1531), husband of the famous Diane de Poitiers. This branch of the family became extinct in the 16th century.

The lordship of Brézé itself had been from the 14th century in the hands of another branch, the house of Maillé-Brézé, whose most eminent members were Urbain (1597–1650), marshal of France, and his son Armand (1619–46), grand admiral. At Armand's death the lordship passed to his sister, Claire Clémence, wife of the great Condé. She sold it to Thomas Dreux, who took the name of Dreux-Brézé when it was erected into a marquisate (1685). Henri Évrard (1762–1829), marquis de Dreux-Brézé, became master of the ceremonies to Louis XVI in 1781. During the meeting of the estates-general in 1789 his delay in notifying the third estate that Louis XVI was to hold a "royal session" was the cause of its famous meeting in the Jeu de Paume (tennis court) at Versailles on June 20, when it found the room that it usually occupied full of workmen preparing for the king's visit (*see* France: *History*). In 1792 Brézé emigrated to Italy for a time. At the Restoration he was made a peer of France and resumed his functions as guardian of an antiquated ceremonial. He died on Jan. 17, 1829, and was succeeded in the peerage and at court by his son Scipion (1793–1845).

BREZHNEV, LEONID ILYICH (1906–), a principal member of the Soviet Communist "collective leadership" that succeeded N. S. Khrushchev. Brezhnev was born on Dec. 19, 1906, at Kamenskoye (now Dneprodzerzhinsk) in the Ukraine, of a Russian working-class family. Trained from the 1920s in land improvement, he joined the Communist Party of the Soviet Union (CPSU) in 1931 and was then transferred to metallurgical engineering. Having been deputy chairman of his native city's executive committee (1937) and secretary of the party's Dnepropetrovsk regional committee (1939), he served as a political commissar in the Army during World War II, with the rank of major general from 1943. After more regional party posts in the Ukraine (from 1946), he became first secretary of the Moldavian Communist Party in 1950. Late in 1952 he was elected a member of the Central Committee (CPSU), a candidate member of its Presidium, and a member of its Secretariat.

After Stalin died (March 1953), Brezhnev was made deputy head of the chief political department of the Ministry of Defense. In 1954 Khrushchev made him second secretary of the Communist Party of Kazakhstan, and he was elected first secretary in 1955. Reelected to his posts in the Central Committee in 1956, he became a full member of its Presidium in June 1957, when Khrushchev overthrew his opponents. During Khrushchev's supremacy Brezhnev was chairman of the Presidium of the Supreme Soviet, or titular head of state, from May 7, 1960, until July 15, 1964, when he was returned to the Central Committee as its second secretary.

Brezhnev took part in the series of conventicles which prepared Khrushchev's downfall; and on Oct. 14, 1964, a plenary meeting of the Central Committee made him first secretary, or, as from October 1966, secretary-general (the pre-1953 title Stalin held). He was reelected at the 24th CPSU Congress in April 1971.

Brezhnev traveled to other Communist countries renewing treaties of alliance to reinforce socialist solidarity. In 1968, when Czechoslovakia under Alexander Dubček entered the road to "Socialism with a human face," Brezhnev was instrumental in elaborating a new doctrine (known in the West as "the Brezhnev doctrine") implying the right of intervention in cases where "the essential common interests of other socialist countries" were threatened by developments in one of their number. That doctrine was incorporated in the new Soviet-Czechoslovak treaty of alliance signed in Prague on May 6, 1970. (K. Sm.)

BREZINA, OTAKAR (pseudonym of Vaclav Ignac Jebavy) (1868–1929), one of the greatest of Czech poets, was born at Počátky, Bohemia, on Sept. 13, 1868. He spent most of his life as a schoolmaster in Moravia, isolated from the political and literary movements that influenced the work of many of his contemporaries. His lasting poetical achievement is contained in a lyrical cycle of five books: *Tajemne dalky* ("Secret Distances"; 1895), *Svitani na zapade* ("Dawn in the West"; 1896), *Vetry od polu* ("Polar Winds"; 1897), *Stavitele chramu* ("Builders of the Temple"; 1899), *Ruce* ("Hands"; 1901). Earlier poems, written under the pseudonym "Vaclav Dansovsky," are of less account. After completing the cycle he wrote only 13 more poems and a few essays. He died at Jaromerice, Moravia, March 25, 1929. From a position of metaphysical pessimism reminiscent of Schopenhauer, Brezina advanced to a positive love of humanity and acceptance of life. Nietzschean concepts played a part in this development, but the final synthesis is not derivative. It represents an original poetic vision of great power, the product of a religious but unorthodox mind. Further light is cast on his intellectual and spiritual development by his correspondence with the philosophical essayist Anna Pammrová. In form Brezina's verse moved from regular, largely trochaic stanza forms to free rhythms with a marked dactylic tendency. His influence on the development of later Czech poetry was considerable. (R. Ay.)

BRIALMONT, HENRI ALEXIS (1821–1903), Belgian soldier and military engineer, the leading European fortification engineer of the late 19th century, was born at Venlo, Limburg, on May 25, 1821. Educated at the Brussels military school, he entered the army in 1843. In 1855 he entered the staff corps, and became major general in 1874. He was then made director of fortifications in the Antwerp district, and in 1875 he became inspector general of fortifications and of the corps of engineers. He retired in 1886 and died on June 21, 1903.

At first Brialmont's plans followed the ideas of Vauban, and his original scheme for fortifying Antwerp provided for both *enceinte* and forts being on a bastioned trace. But in 1859, when the great entrenched camp at Antwerp was finally taken in hand, he had gone over to polygonal fortification and the ideas of Charles de Montalembert. About 20 years later Brialmont's own types and plans began to stand out amid the confusion of ideas that resulted from the introduction of long-range guns and from the events of 1870–71. The extreme detached forts of Antwerp and the fortifications on the Meuse at Liège and Namur were constructed with lavish use of armour to protect the artillery, suppression of artillery positions open to overhead fire, and multiplication of intermediate batteries. *See* Fortification: *Permanent Fortifications.*

BRIAN (941–1014), king of Ireland from 1002 to 1014, was known as Brian Boru from the ford, Béal Boruma, on the river Shannon near Killaloe, beside which he was born. He was a younger son of Cennedig (d. 951), ruler of a small state, later called Dal Chais, which grew strong during the 10th century through its persistent efforts to expel from its territory the Danes who had settled at Limerick (922). The vikings established on the river Suir (916) had been less successfully challenged by the Eoganachta rulers of Munster, who thus grew progressively weaker, and Brian's half brother, Mathgamain (d. 976), was able to occupy the rock of Cashel (964) and become king of Munster.

Brian became successor and avenger of Mathgamain, mysteriously murdered in 976 by the Eoganachta septs who resented his usurpation. Brian was a leader of high capacity, hardened by experience on the battlefield, and he destroyed first the Eoganachta and then the Northmen, constructing a fleet to drive them from the Shannon.

In 978 Brian defeated and killed Maelmuadh, the probable murderer of Mathgamain, in a battle at Belach Lechtha, in the north of the present county Cork. Brian was also remarkable as a diplomat, and under his rule Munster became a unified and powerful state. Brian invaded Ossory (983) and thus began a duel lasting nearly 20 years with the high king Maelsechlainn II. He won control of the southern half of Ireland from Maelsechlainn (997), replaced him as high king (1002), and in due course received the submission of every lesser ruler. The men of Leinster and the Northmen of Dublin united against him in 1013, enlisting help from abroad, especially from the earldom of the Orkneys and from the Isle of Man. The decisive battle was fought at Clontarf, beside Dublin, on April 23, 1014; Brian was too old to take an active part, and his forces were commanded by his son, Murchad, who achieved victory after a 12-hour struggle. A little group of Northmen, flying from the battlefield, stumbled on Brian's tent, overcame his bodyguard and hacked the aged high king to death. He was buried in the chief church of the nation, that of St. Patrick in Armagh. His fame as the victor of Clontarf and as a ruler of outstanding ability and energy was so great that the princes descended from him, the O'Briens, subsequently ranked as one of the chief dynastic families of the country. After their defeat at Clontarf, the Northmen never again exercised significant power in Ireland.

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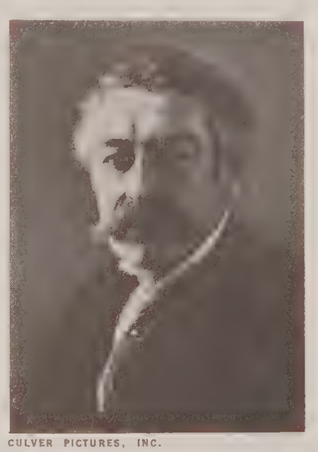
BRIANCHON, CHARLES JULIEN (1783–1864), French mathematician who was born at Sèvres, France, on Dec. 19, 1783, and died at Versailles, France, on April 29, 1864. He was educated for a military career at the École Polytechnique, where he gained first place in his class (1804), and at Metz (1806). While still a student he published (1806) the theorem by which he is known in treatises on conics and in histories of mathematics: joins of pairs of opposite vertices of a hexagon circumscribed about a conic are concurrent. This is obtainable as the dual of Blaise Pascal's theorem, and Brianchon discovered it thus. As an artillery officer in Napoleon's armies, Brianchon was distinguished for courage and ability, particularly in the Peninsular campaign. The rigours of field service affected his health and in 1813 he sought a professorship in the artillery school, which he obtained in 1818. His principal works were a memoir on curves of the second order (1808) and one on transversals. (E. T. B.)

BRIAND, ARISTIDE (1862–1932), French statesman, ten times premier of France and winner of the Nobel peace prize in 1926, was born at Nantes, March 28, 1862. As a law student he became associated with advanced movements in politics, writing articles for *Le Peuple* and for some time directing the *Lanterne*. From this he passed to the *Petite République*, leaving it to found, with Jean Jaurès, *L'Humanité*. At the congress of working men at Nantes in 1894 he secured the adoption of the general strike idea against the adherents of Jules Guesde, and became one of the leaders of the French Socialist party. In 1902 he was elected deputy and occupied himself with the question of the separation of church and state. He was appointed *rapporteur* of the commission charged with the preparation of the law and succeeded in carrying his project through with but slight modifications. He accepted the portfolio of education and religion in the Sarrien ministry (1906) so that he might apply the law for which he was largely responsible. Acceptance of a portfolio in a bourgeois ministry led to his exclusion from the Unified Socialist party (March 1906). As opposed to Jaurès, he contended that the Socialists should co-operate actively with the Radicals in all matters of reform. In Oct. 1906 Georges Clemenceau formed his first government, and in it Briand remained minister of education and religion. There were certain difficulties in the application of the Separation law due to the hostility of the Vatican. It was then that Briand gave proof of his essential liberalism. Though he held fast to the principle of the new legislation, he made possible the carrying on of the rites of the Roman Catholic Church under the laws as to associations and public meetings. In Jan. 1908 he was appointed to the ministry of justice.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BRIAND

When the government of Clemenceau fell in July 1909 Briand formed his first cabinet, himself taking the portfolio of home affairs and religion. He announced that he would adopt a policy of national understanding and tranquillity. In Oct. 1910 there was a threat of a general strike on the railways. Briand mobilized all the railwaymen who were still subject to military service, dismissed those who disobeyed and had the members of the strike committee arrested. A majority in the chamber approved his action, but it was bitterly condemned by the left wing, and the government resigned on Nov. 2, 1910. Briand immediately formed a new cabinet, of a more radical tendency than its predecessor. In Feb. 1911, when he was accused by the Radicals of failing in the strict application of the law with regard to religious houses, his majority fell to six and he resigned. After some months out of office, he became minister of justice in Raymond Poincaré's first cabinet on Jan. 13, 1912. When Poincaré was elected president of the republic in Jan. 1913, Briand succeeded him as premier. His most important work was to lengthen the period of military service from two to three years as a rejoinder to the increase in German armaments. On March 18, 1913, on the question of proportional representation, which he supported, he was overthrown by the senate.

Briand remained in retirement until the outbreak of World War I. On Aug. 26, 1914, René Viviani offered Briand the portfolio of justice. On the fall of Viviani, Briand on Oct. 29, 1915, formed a government in which he himself took over the direction of foreign affairs in a national coalition. By the end of the autumn of 1916, the Rumanian disaster, and especially the situation in Greece, made him the object of attacks. The question of the higher command was also causing much anxiety. At this time Joseph Joffre, who had been made a marshal, was replaced by Gen. Robert Georges Nivelle. Briand thought it advisable for all these reasons to reform his cabinet. He appointed Gen. Hubert Lyautey minister for war, and called in experts who were not in parliament to take charge of the more technical offices. On March 14, 1917, Lyautey resigned, and after a vain attempt to reform his government, Briand decided to resign.

For three years Briand took scarcely any part in public affairs. In Jan. 1921, on the fall of the Georges Leygues ministry, he was called upon to form a government, and himself took charge of foreign affairs. He interested himself particularly in the application of the treaty of Versailles, especially with regard to reparations. In the autumn he went to Washington, D.C., as the French representative at the conference on naval disarmament. He was fiercely attacked by those who accused him of having failed to safeguard the interests of his own country. This campaign reached its height when, early in 1922, the Inter-Allied conference met at Cannes, France, and Briand discussed with David Lloyd George the question of an Anglo-French mutual defense treaty. A telegram which he received from Alexandre Millerand, then president of the Republic, decided Briand to return to Paris and confront his enemies. When he arrived he realized that his position had become untenable. He announced his resignation to the chamber on Jan. 12, 1922.

In April 1925 he was offered the portfolio of foreign affairs in Paul Painlevé's cabinet, and he remained in the same office in the second government formed by this leader in October. The Locarno agreement in Oct. 1925 enormously increased the influence of Briand, who had played an important part in the negotiations. When Painlevé resigned on Nov. 22, Briand led the government. On March 6, 1926, Briand's ministry fell, the chamber having thrown out a financial measure which he considered necessary. He accepted office again, but the situation became more and more difficult because of the financial crisis and the continued depreciation of the franc. The government fell on June 15. But, once again, Briand reconstructed the ministry and brought in Joseph Caillaux as finance minister. A month later, on July 17, the ministry was again defeated, the chamber refusing to grant the special powers demanded for dealing with the financial problem. Édouard Herriot's ministry, which succeeded it, lasted only a few days and fell on July 21, 1926. Poincaré formed a coalition government in which Briand again became minister for foreign affairs. In this position for the following five and a half years (until Jan. 12, 1932) he continued to direct the foreign policy of France on the basis of European consolidation and reconstruction and acquired great influence within the League of Nations. He received the Nobel peace prize, as did the two other principal signatories of the Locarno treaties, Austen Chamberlain and Gustav Stresemann. Among postwar statesmen he was the firmest supporter of the idea of bringing about the renunciation of war as an instrument of national policy, and the antiwar treaty signed in Paris on Aug. 27, 1928, known as the Kellogg, or Briand-Kellogg, pact (*see* WAR). From July 27 to Oct. 22, 1929, he presided over his last (tenth) cabinet.

Briand died in Paris on March 7, 1932.

A great parliamentarian, although he broke with the extreme left wing in 1906, he retained his connection with many of the more advanced political thinkers. His liberal ideas and his constant endeavours toward national unity gained him the sympathy of the moderate parties. His ease and animation as a speaker, his parliamentary experience and his well-known ability in the conduct of foreign affairs all contributed to that great influence which made him, up to that time, premier more often than any other politician in France.

See R. Hesse, *Aristide Briand* (1939); G. Suarez, *Briand: sa vie, son oeuvre avec son journal et de nombreux documents inédits*, 6 vol. (1938–52). (P. B.; X.)

BRIBERY, a penal offense generally defined as the giving or receiving of consideration for official favour. Particular statutes vary regarding the kinds of officials covered, the kinds of consideration covered and the severity of the penalties authorized. The crime is typically punishable as a felony, and the offending official may be declared ineligible to hold office.

At an early stage of the law's development, only officials authorized to decide or to vote on matters pending before them were encompassed; other public servants, denominated "ministerial," were excluded on the theory that the evil to be dealt with was subversion of discretion, whereas ministerial employees have little or no discretion. The practical significance of this distinction was that one would not be guilty of bribery for giving tips, fees or presents to minor functionaries to induce them to perform their duties. Modern bribery legislation is usually drafted to cover all public employees. Sometimes this legislation, in its application to minor functionaries, is restricted to consideration given to induce the official to "violate his duty," thus also excluding the tipping situations referred to above. Special provisions have also been enacted to punish bribery of voters, jurors, witnesses and other lay participants in official and political proceedings. Finally, a number of codes penalize bribery in designated classes of private or commercial transactions; *e.g.*, bribery of labour union officials by employers.

As to the nature of the consideration which it is criminal to give or receive, the main issue is whether to limit bribery to cases where money or property is the inducement or to extend the crime to cases where "any benefit or advantage" is conferred or promised. Most statutes are of the latter form. It has been observed that few legislative or executive compromises could stand if such a principle were applied. The California Penal code, among others, does not leave the matter in doubt, authorizing imprisonment up to 14 years, for example, for any legislator who gives his vote in consideration of a reciprocal commitment from a fellow legislator. Needless to say, criminal prosecutions of this character are virtually unheard of, but there are occasional reports of civil proceedings challenging an official's right to hold office on this ground.

The statutes defining bribery frequently include an element of "corrupt" purpose. This does not mean that a defendant can avoid conviction by proving that the decision which he sought to buy was a proper one that the official should have given in any event, since the gist of the offense is the exertion of improper influence on decision-making. On the other hand, giving a gift or tip to a civil servant out of general friendship or gratitude and without intent to influence his official behaviour is not punishable as bribery, although it may be prohibited under the corrupt practices legislation. (L. B. S.)

In English law, the legislation relevant to bribery is contained in three statutes, namely the Public Bodies Corrupt Practices act, 1889, the Prevention of Corruption act, 1906, and the Prevention of Corruption act, 1916, collectively known as the Prevention of Corruption acts, 1889–1916; and, as to bribery at elections (including paid entertainment and undue influence), in s. 99 of the Representation of the People act, 1949. Of the former group of statutes, the first deals with corruption in municipal affairs, the second with the bribery of agents and others in business affairs and the 1916 act increases the maximum penalty in certain cases and provides that corruption shall be presumed, unless the contrary be proved, where some consideration has been given to a person in public employment by a person holding or seeking to obtain a contract with the employing authorities.

See also CORRUPT PRACTICES; ELECTORAL SYSTEMS: *The Influencing of Voters.* (W. T. Ws.)

BRICK, a small rectangular unit, usually of burned clay, used in the construction of foundations, walls, piers, buttresses, and arches of buildings and other structures, and of the ducts, flues, linings, and chimneys of furnaces. (*See* BRICKWORK; FURNACE, METALLURGICAL.) By massing bricks in quantity, with mortar joints, in definite patterns or bonds, greatly varied forms of construction can be erected, having massive or delicate proportions as required, to carry loads, to provide screens or protection against the weather, or to resist the action of heat.

Throughout their long history, bricks have varied greatly in size. Although today the term brick is usually associated with a unit approximately 8–9 in. long by $3\frac{3}{4}$–$4\frac{1}{2}$ in. wide by 2–3 in. deep, the larger hollow clay units, invented in the mid-19th century and quite widely used for building in Europe and the United States, can be considered to be a development of the brick. The raw material from which these larger units are made and the processes used for their manufacture are similar to those described for bricks, below. Though some refractory bricks for special high-temperature furnaces are made from materials other than naturally occurring clay, all refractories are made by one or other of the processes described for building bricks, and they are burned in similar kilns. (*See* FIREBRICK.) On the other hand, a few building bricks are made from a mixture of sand and hydrated lime pressed together in a high-pressure press and subsequently autoclaved; sand-lime bricks and concrete bricks have not been considered in detail in this survey of bricks and brickmaking.

History.—The history of the brick goes back to the earliest days of civilized man. By some it is averred that bricks were made more than 10,000 years ago, and, although such great antiquity cannot yet be proved, archaeologists working at the site of Ur of the Chaldees, the city of Abraham in the valley of the Euphrates, have accurately determined that the burned and unburned bricks in the lower levels of the great ziggurat or temple were made more than 5,000 years ago. It is probable that the Tower of Babel, for which "they had brick for stone, and bitumen for mortar" (Gen. 11:3) was another of these great brick temples raised above the surface of the flat river valley. Successive civilizations in the Euphrates-Tigris delta used clay bricks for building their houses, palaces, and temples; many of the original bricks, such as those used in the 6th century B.C. to build Nebuchadrezzar's great city of Babylon, were later taken from the ruins to build the towns of Ctesiphon and Baghdad. From western Asia the art of brickmaking appears to have spread westward toward Egypt and the Mediterranean and eastward to India and China.

In Egypt there are many examples of bricks made in the earliest and subsequent dynasties. Often their surfaces were impressed by the seals of the kings for whom they were made, and by these their date can be established. Most houses and some palaces, temples, and tombs were built with both sun-dried and kiln-burned bricks.

From Egypt brickmaking spread throughout the eastern Mediterranean to Rome, whose legionnaires carried the art throughout the Roman Empire. It flourished in England in the 3rd and 4th centuries until the Dark Ages, when it fell into disuse not only in England but throughout Europe. It was revived in the 12th century, first in Italy and a little later in France, Germany, and Flanders. Some bricks began to enter England from Flanders (the word "brick" is of Flemish origin) in the latter half of the 14th century, and by the beginning of the 15th century brickmaking was once more established throughout Europe. In England, the brick castles of Herstmonceux in Sussex (1440) and Tattershall in Lincolnshire (*c.* 1440) and the smaller manors of Stonor Park (14th century) and Shirburn Castle (15th century) in Oxfordshire are among the earliest English medieval brick buildings. The Tudor, Jacobean, and Queen Anne brickwork, which is so well suited to the countryside and climate of England, laid the foundations of a tradition for fine brickwork that has continued unbroken to the present day.

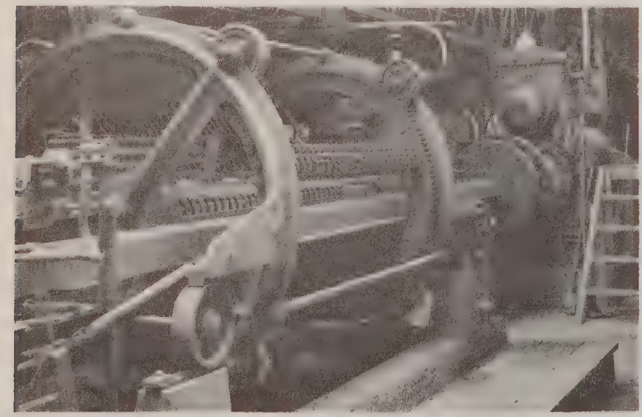
Bricks were first made in America in about the middle of the 17th century, but it was not until the latter half of the 19th century that the industry began to expand, when English machine makers went there to seek a market.

The Raw Material.—Most building bricks are made from clay, the product of the breakdown of rocks by weathering and other destructive agencies. Clays suitable for brickmaking are distributed very widely throughout the world. In Great Britain they are to be found in almost all the geological systems from the Devonian to the Pleistocene; in the U.S., clays suitable for brickmaking exist in 45 states. Most natural clays are complex mixtures of one or more of the clay minerals with salts of common elements, such as iron and calcium; the proportions of the various clay minerals and presence of these impurities not only dictate the quality and appearance of the finished product but also the process involved in brickmaking and burning. (*See* also ADOBE.)

BRICKMAKING PROCESSES

Until machinery was introduced in the mid-19th century, it was necessary to dig the clay in the early autumn and pile it in heaps, so that the winter weather would render it fit for forming by hand molding into brick shapes. In the spring the clay was dug down from the heaps, spread on the ground, watered, and then tempered by being trodden by men's feet until a suitable consistency was reached. The soft plastic clay was then thrown into molds to form the shape of the brick. This old method was superseded in the 19th century by the pugmill. The original pugmill consisted of a large wooden tub without heads, set upright on the ground and furnished with an iron spindle at the axis, carrying knives which cut and compressed the clay to force it through the tub and extrude it through a hole cut in the side or bottom.

From the latter half of the 18th century many attempts were made to mechanize the old manual process of filling molds, but, although soft-mud, machine-molded bricks were made in the U.S. as early as 1833, none of the earlier attempts to reproduce hand molding by machine appear to have been successful in England. There mechanization followed the development of the pugmill. By the middle of the 19th century a horizontal version of the pugmill was developed, and the plain, rectangular opening from which the clay emerged from the crude pugmill was replaced by properly designed dies. The column of clay emerging from the die was then cut off to brick size by a wire in the manner of a grocer cutting cheese, and bricks so made became known as wire cuts.



BY COURTESY OF STRUCTURAL CLAY PRODUCTS INSTITUTE

FIG. 1.—FORCED FROM THE PUGMILL THROUGH A DIE, A COLUMN OF CLAY PASSES ALONG THE CUTTING TABLE

The Wire-Cut Process.—In the early days of brickmaking, only surface clays were used, but with the increase of population and industry following the Industrial Revolution, it became necessary, particularly in the north of England and the Midlands, to work the harder clays of earlier geological age. In order to break down drier and harder clay it was crushed by passing it between pairs of heavy cast-iron rollers mounted above the hopper of the pugmill; to make it plastic it was mixed with water in trough mixers having one or two long shafts fitted with knives to chop the clay and carry it along the mixer.

Another type of grinding machine known as the wet pan has been added to the train of grinding equipment in the 20th century. It consists of a large, flat-bottomed cast-iron dish, from 7 to 9 ft. in diameter, with sections of the bottom perforated with holes or slots. A vertical shaft in the centre carries heavy cast-iron rollers on the two ends of a horizontal cross shaft. These two rollers, sometimes called edge runners, are carried rapidly round and round the pan, crushing the clay thrown into it and forcing it gradually through the perforations in the pan bottom.

A later development in the wire-cut process was that of de-airing the clay in the pugmill. Earlier it had been an approved practice to interrupt the flow of clay, to rest or "age" it just before it entered the pug machine. It is thought that this may have given time for the continued diffusion of water along the cleavage lines of the minute clay crystals and that it allowed some bacterial action to assist in further wetting of the dry internal surfaces. In about 1930 it was found that removing the air under a vacuum of from 15 to 29 in. gives similar, or even better, results, and at less cost and with less interference with production. De-airing reduces laminations in the brick, increases workability and plasticity, and promotes greater strength in the green and fired products. The cutting-off table has also been developed far beyond the original simple wire. Cutting off is now usually automatic, and often the bricks are taken off the table and loaded by machinery onto the pallets used to transport the comparatively soft green bricks to the drying plant.

In most European countries and in Australia, Canada, South Africa, the U.S. (where the process is known as stiff mud), and the U.S.S.R., most building bricks are produced by the wire-cut process. The exceptions are Great Britain and the Netherlands, but even in these countries more than a quarter of the total output is produced by this method.

The Semidry Process.—Toward the end of the 19th century the semidry process for making bricks from hard, almost dry, clays and shales was devised. The clay is ground without added water in a dry pan similar to the wet pan described above, but in which the pan revolves and the horizontal shaft carrying the two heavy grinding rollers is stationary; the inner ring of the pan base plate, on which the rollers revolve, consists of solid or "dead" plates, but the outer ring, annular in shape, consists of cast-iron plates perforated with fine holes. The dry clay is ground on the solid part of the pan bottom and is thrown by centrifugal force onto the outer perforated plates, so that the finely ground clay particles fall and are screened through the holes in the pan grids. After leaving the dry pan the powdered clay is again screened, and the finest portion is passed to the hopper of a powerful press. From the hopper an automatically measured portion is fed into strong steel molds with movable plungers operating from the bottom and the top of the mold. The plungers, actuated either by cam, lever, or toggle motion, or in some cases by hydraulic power, press the clay particles together until they coalesce into the form of a brick. The bottom plunger then pushes the pressed brick upward out of the mold, and the hard green brick is ready for drying and firing in the kiln.

A similar process known as dry press, in which the clay is first dried and then ground to a fine powder and pressed in a mechanical press, is used quite widely throughout the world for the manufacture of hard paving bricks, floor tiles, and refractory bricks. The semidry process (in which the clay is not first dried) is probably best known as the method used to make Fletton bricks in England. These bricks, which are made from a clay that occurs only in that country, account for more than 40% of the total British output—some 8% of the total production of the Western world.

Stiff-Plastic Process.—The stiff-plastic process of brickmaking is intermediate in character between the plastic wire cut and the semidry processes. The shale or clay is ground in a dry pan and moistened in a horizontal mixer until it contains about 12% of water. The moistened clay is fed into a short, vertical pugmill from which it emerges as an immature clot. This clot drops into a finishing mold of a mechanical press where it is pressed into its final form ready for setting in the kiln.

While nearly one-third of the bricks produced in Great Britain are made by the stiff-plastic process, which is particularly popular in the north of England and in Scotland for the manufacture of engineering bricks and other strong, dense products, it is not much used elsewhere. A similar process is, however, widely used in many European countries for the manufacture of roofing tiles.

Hand Molding.—Some bricks are still hand molded. The clay, either weathered or broken down in a wet pan, is pugged as in the wire-cut process, but the soft plastic clot of clay is rolled by hand in sand and is then thrown into a sanded or watered wooden stock or mold. When turned out onto a pallet the brick shows richly sanded surfaces on all sides.

Hand molding is still practiced in most European countries, although to an ever decreasing extent. But handmade bricks are still popular, and there is small but constant demand for them in England, Denmark, France, Germany, the Netherlands, Portugal, and Spain. The method is still widely used in underdeveloped countries in Africa and Asia.

Full-Plastic Process.—The mechanical imitation of hand molding was developed in the middle of the 19th century in the United States, where it is known as the soft-mud process. The brickmaking machine consists of a horizontal or vertical pugmill that extrudes very soft and plastic clay over a composite mold with compartments for 3–12 bricks which are located side by side in one frame. The washed and sanded wooden molds are fed in at the side of the machine, and a vertical plunger presses the clay into them. The set of molds is then automatically pushed forward, the surplus clay is struck off, and the filled molds are jolted to consolidate the clay. In some machines the bricks are automatically expelled onto pallets. The full-plastic process is quite widely used in the Netherlands, and to a lesser extent in England and in Denmark.

The Drying of Bricks.—Bricks molded by hand and those formed by the full-plastic and wire-cut processes are comparatively soft and weak when they are formed, so that it is necessary to dry them before they can be stacked in a kiln for firing. Even if, as in the case of stiff-plastic and semidry bricks, they are strong enough to be set directly in the kiln, it is still necessary to dry them at least partially to remove the shrinkage water before subjecting them to high temperature.

In the early days of brickmaking all bricks were dried naturally by the sun and air; open-air drying, or hack drying, as it is now called, is still employed in some seasonal works in England, on the continent of Europe, and in tropical, undeveloped countries. Labour costs, loss by storms, and damage by handling render this system more costly than it would seem, and since considerable space is also required, hack drying is being superseded by artificial drying in most industrial countries.

Hot-Floor Drying.—In the 19th century, when open-air drying was found to be too slow and too erratic for the rapidly growing brickmaking industry in the Midlands and the north of England, hot-floor drying was developed. As its name implies, the dryer consists of a heated floor in which the green bricks are set. The floor is built inside a shed that protects the bricks from the weather, but which, at the same time, allows the evaporated water to escape. The floors, which are of steel, cast iron, or concrete, may be heated by coal or coke fires, or by steam passing through pipes below the floor.

The Tunnel Dryer.—In order to speed up the drying still more, the tunnel dryer was developed both in the United States and in Europe in the late 19th century. The modern tunnel dryer consists of one or a series of tunnels, usually about 6 ft. square in cross section, and from 80 to 100 ft. long. Cars, carrying the green bricks either directly or on pallets, are pushed at regular intervals through the tunnel. The bricks are dried by hot air, which can either pass longitudinally through the tunnel from the exit end toward the entrance, or can be forced transversely from one side to the other. The use of saturated air to heat the wet bricks before removing any moisture, known as humidity drying, is essential for fast-drying practices. At the entrance of the tunnel the air meeting the wet bricks is saturated with water; as a given brick proceeds along the tunnel it encounters progressively drier air.

Chamber Dryers.—Chamber dryers are also widely used throughout the world. They consist of a series of adjacent chambers, often about 9 ft. high by 5 ft. wide and up to 80–100 ft. long; on the continent of Europe they are often built above kilns to take advantage of waste heat. Whereas in tunnel dryers the bricks pass steadily through the dryer, in chamber dryers the bricks are left in the position in which they are set until they are dry. They are sometimes placed in the chamber on trucks, but more often special finger cars transfer loaded pallets of green bricks from the brickmaking machine to the dryer racks. The chambers are usually heated by hot air which has passed over steampipes below the floor of the dryer, but sometimes hot air is taken from the cooling zone of a kiln associated with the dryer. Modern chamber dryers also adopt the principle of humidity drying; the humidity and temperature of the drying air and, therefore, the rate of drying is adjusted as drying proceeds.

KILNS

The resistance of building bricks to the action of weather, the resistance of refractories to heat, their strength, colour, and other essential properties are imparted to green clay by burning or firing the bricks in kilns to a temperature approaching the vitrification point of the clay of which they are composed.

There are many different types of kilns in use in the industry. In some the hot gases that burn the bricks flow upward; in others they are drawn downward. In some the bricks are stationary during firing; in others they pass through a fixed furnace or heating zone. It is convenient here to make a broad distinction between the types that are intermittent in operation and those that are continuous.

Intermittent Kilns.—*Updraft Scotch Kilns.*—From the earliest days brickmakers have used small brick-built ovens in which the necessary heat is produced by burning wood or coal in furnaces below the bricks. Kilns of this type are now known as Scotch kilns, and a few are still in use. They consist of four permanent brick walls which are perforated at intervals with fire holes or grates from which hot gases pass into the unroofed kiln and flow upward through the tricks by buoyancy. In these kilns fuel consumption is high and control is difficult.

Downdraft Kilns.—The downdraft kiln is much more advanced and is very generally used in the United States and in Great Britain, particularly for firing face bricks, engineering bricks, and refractories. Some are circular with domed roofs, while others are rectangular, usually with arched roofs. The kilns are permanent brick structures, and the walls are pierced with a number of fire holes or furnaces, the gases from which, on entering the kiln, are forced up over the bricks and then down through them to underground flues leading to a small chimney. Although, since there is no heat recovery the fuel efficiency is not high, the temperature distribution within the kiln chamber is very uniform, and the quality of materials produced in a downdraft kiln is high. It is comparatively easy to control the kiln atmosphere (and hence the colour of the fired bricks) by adjusting the air flow through the fire holes. In order to increase fuel efficiency a number of these kilns are sometimes linked together with flues so that waste heat from cooling kilns can be used to preheat air for drying or for combustion in other kilns that are being fired. Mechanical stokers also give improved fuel consumption.

Clamp Burning.—A method of burning bricks in what are called clamps in England and scove kilns in the U.S. was devised toward the beginning of the 19th century. Clamps are still used quite widely for burning London stock bricks and some facing bricks in the south of England, and they are common in northern France and Belgium. Clamps are large heaps of bricks stacked systematically as closely as possible. In England they are built of various sizes holding from 100,000 to 1,000,000 bricks and are generally about 10–12 ft. high; on the continent of Europe they are much larger and higher and may contain as many as 3,000,000 bricks. In the United States scove kilns are built inside a permanent shed, and the pattern of bricksetting is somewhat different from that in Europe.

The fuel for burning is usually incorporated in the clay mix, with a certain variable amount sprinkled between the layers of bricks. Fires are started in small channels at the bottom and serve to ignite the fuel in and between the bricks. When once the fire has started in the bottom courses no more stoking is needed, and the heat spreads gradually throughout the mass. The fuel is economically applied, but the results are uncertain and dependent on weather conditions; waste by over- and underburning is always considerable.

Continuous Kilns.—Most building bricks and many refractories are burned in one or other of the two principal types of continuous kilns.

The Hoffmann Kiln.—The Hoffmann ring kiln consists of a tunnel of brick construction built as a continuous ring with an arched brick roof. Openings or wickets pierce the outer walls to give access to the tunnel, and flues controlled by dampers lead the gases of combustion from the burning bricks to a tall chimney which provides the draft for operating the kiln. In its modern form the ring tunnel has been replaced by a series of separate, but side-by-side, chambers, each about 15 ft. wide and up to about 80 ft. in length. Each chamber is spanned by its individual brick arch. A single-fire kiln usually has about 16 chambers, 8 on each side of a large flue or smoke chamber leading to the central chimney. Trace holes in the separating walls allow the gases to pass from one chamber to the next, the flow of the gases being determined by the opening or closing of dampers leading to the smoke chamber.

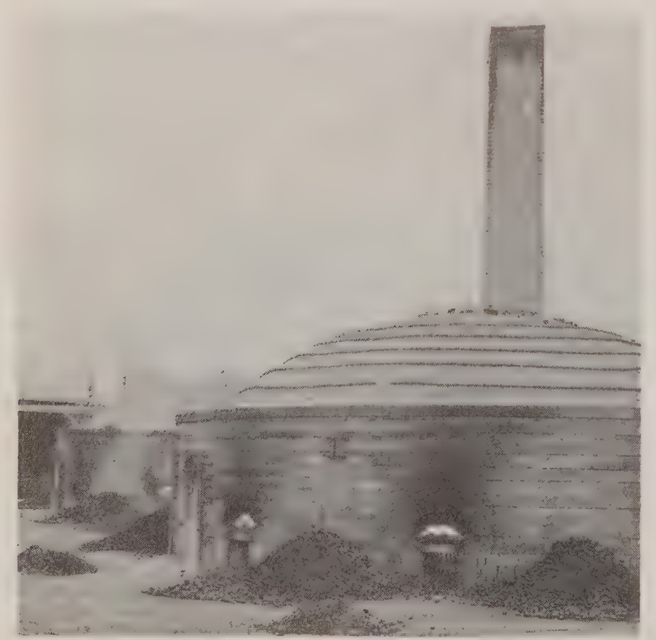


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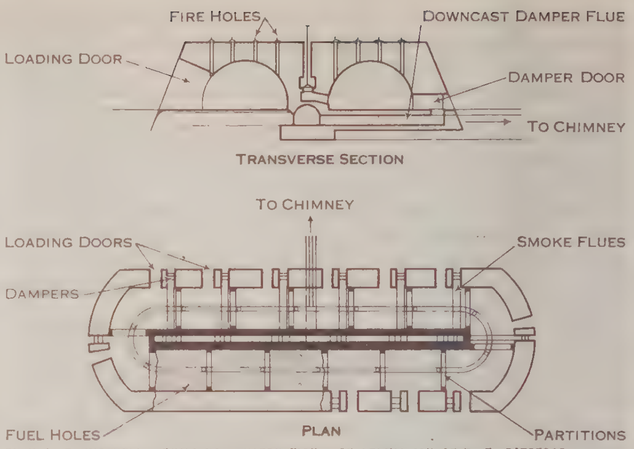
FIG. 2.—DOWNDRAFT OR BEEHIVE KILN



FROM C. F. MITCHELL, "BUILDING CONSTRUCTION," BY PERMISSION OF B. T. BATSFORD

FIG. 3.—PLAN AND CROSS SECTION OF A HOFFMANN KILN

Once the kiln has been filled with green bricks and the fire started in one chamber, the fire front moves forward at the rate of about one chamber per day. When the burned bricks have cooled they are drawn from the chamber, which is then reset with green bricks, so that in about 16 days the fire travels through the complete circuit of the kiln and continues to do so for as long as is required.

The air needed for combustion enters the kiln at or near the chamber that is being drawn and passes through several chambers of cooling bricks via the trace holes in the walls between chambers. In so doing the air picks up heat from the cooling bricks and is preheated on its arrival at the firing zone. It is also possible to divert some of the preheated air through hot air flues above the arches to aid drying in the forward chamber. This recovery of heat for both combustion and drying accounts for the high fuel efficiency of the Hoffmann-type kiln.

There are many variations of the original Hoffmann ring kiln, each having some special characteristic. These include the Belgian kiln, in which the fuel is fed on grates external to the chambers and the zigzag kiln, in which the path that the fire travels, instead of being circular or elliptical, follows a zigzag pattern.

In Europe automatic stokers are now commonly used for firing continuous kilns. For top-fired kilns, batteries of stokers, each feeding one fire hole through the arch of the kiln, are moved forward day by day as the fire progresses. Oil-burning equipment was also developed after World War II.

Tunnel Kilns.—The tunnel type of continuous kiln differs from the Hoffmann type in that the bricks travel continuously through a tunnel, while the fire zone, located near the middle of the kiln, remains stationary. The principle of heat recovery is the same for the two types. The tunnel, usually about 300 ft. long, is rectangular in cross section. Kiln cars, each carrying about 1,200 bricks, travel on rails set on the tunnel floor; sand seals and the massive refractory decks of the cars protect the undercarriages and the rails from the heat of the kiln. The cars are pushed by hydraulic or gear-driven rams at the rate of about one 6-ft. car per hour, so that the bricks traverse the whole length of the tunnel in about 50 hr.

For refractory bricks and other expensive ware that must not come into direct contact with fuel ash, the kilns are fired from the sides into muffled combustion chambers. For building bricks the muffle is dispensed with, and the kiln can be fired either from the sides or from the top. Coal, oil, producer gas, and natural gas are all used for firing bricks in tunnel kilns.

Modern Trends.—Until 1907, when the first steam shovel was introduced into a clay pit in Peterborough, Eng., all clay for brickmaking was dug by hand, and it was usually transported to the brickworks either by handbarrow or by pony and tram. Today the clay is dug by one of many machines, including compressed-air-operated spades (for working small pockets of clay); multibucket excavators, in which a series of buckets scrape thin cuts from a fairly flat pit face; forward-crowd shovels, which operate from the pit floor; and drag-line excavators. Nearly all the clay is now transported mechanically from the pits to the works, either by

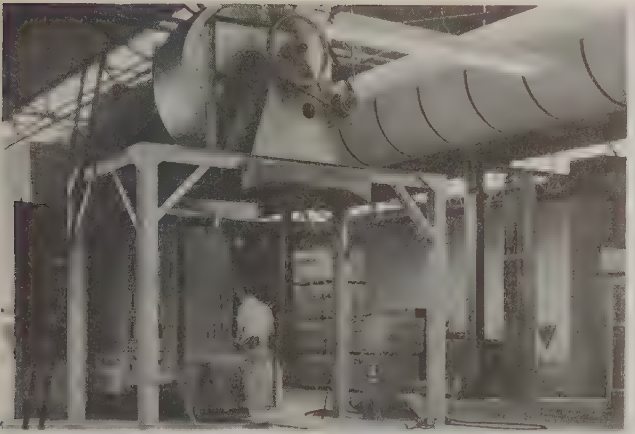


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FIG. 4.—CARLOAD OF BRICKS BEING PLACED IN A TUNNEL KILN FOR BURNING

railway or by trucks, overhead cableways, or conveyor belts. Within the factory itself the raw material is moved from stage to stage either by conveyors or by automatic feeders, and many complex devices are used to handle the green bricks. After 1945 the use of forklift trucks revolutionized the heavy manual task of setting bricks in dryers and kilns and the still heavier labour of drawing the fired bricks.

Finally, brick distribution systems are being developed to meet the call for greater mechanization on building sites. In the United States, self-unloading trucks, sometimes equipped with cranes, are used; in England, bricks are packaged with steel bands to facilitate unloading by crane and special barrows direct to the scaffold.

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(T. G. W. B.)

BRICKELL, HENRY HERSCHEL (1889–1952), U.S. literary critic and editor, who was an authority on Latin-American literature and history, was born in Senatobia, Miss., on Sept. 13, 1889. After studying at the University of Mississippi, he worked for several southern newspapers from 1910 to 1919, when he became a copyreader for the *New York Evening Post.* Four years later he became a book columnist. He was general publications editor of Henry Holt & Co., publishers, for five years before returning to the *Post* as its literary editor in 1934. He was appointed senior cultural relations officer to the U.S. embassy at Bogotá, Colombia, in 1941, and assistant chief in charge of the Latin-American branch of the cultural cooperation division of the U.S. state department in 1944. From 1946 to 1947 he was chief of the division of international exchange of persons, and in 1951 toured Latin America for the state department. Brickell died in Ridgefield, Conn., on May 29, 1952.

Brickell was a prolific writer. *Cosecha Colombiana* (1943) is a collection of essays and speeches in Spanish. He was co-translator of a life of José de San Martín by Ricardo Rojas (1945).

BRICKER, JOHN WILLIAM (1893–), U.S. senator, was born on Sept. 6, 1893, in Pleasant township in Madison county, Ohio. He received a law degree from Ohio State university in 1920. During World War I he served as a first lieutenant in the army. Bricker was assistant attorney general of Ohio, 1923–27, and attorney general, 1933–37. Elected governor of Ohio on the Republican ticket for the 1939–41 term, Bricker was re-elected twice. Bricker ran unsuccessfully as the Republican vice-presidential candidate in 1944. Two years later, he was elected senator from Ohio and re-elected in 1952; he was defeated in 1958.

In the senate he led in efforts to curb the powers of the president in international relations. He sponsored a proposed constitutional amendment that would have required congressional or at least senatorial approval of executive agreements. The Bricker amendment thus would have left to the congress or even to state legislatures the internal enforcement of international agreements made by the United States. Proposed in 1953, it was debated at length but did not come to a vote. The following year a modified version, the George resolution, was brought to a vote in the senate and failed by one vote to win the support of the necessary two-thirds majority.

BRICKFIELDER: *see* WIND: *Local Winds: Local Names for Winds.*

BRICKWORK. Building construction in Western civilization has until very recently been almost wholly of masonry (*q.v.*). Although timber has played a prominent secondary role, important and lasting buildings have been built of inorganic material dug and fashioned from the earth: stone, clay, sand, lime and cement. Men have been building with brick for at least 5,000 years. The masonry tradition embraces two rival techniques, stone and brick. Brickwork is ordinarily considered a humble cousin of stone masonry; yet the vault was probably introduced in brick made of common clay, and brickwork remains a vital technique even in industrialized countries where the stone industry languishes.

In the beginning the choice between stone and brick was forced by local geographical circumstances. The cost of transportation still remains an important factor in the availability of these heavy materials. In cities built on the alluviums of broad valleys, far from limestone or sandstone deposits, the arts of brickmaking and bricklaying were developed. Abundant fuel was also needed for kiln-firing.

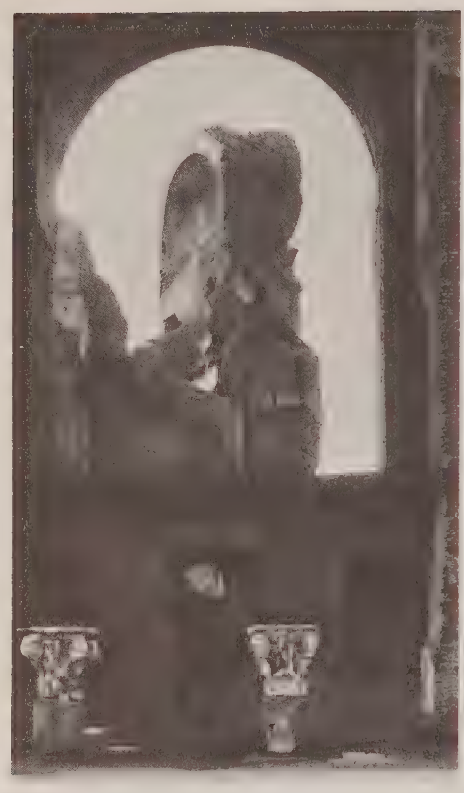
Stonemasonry involved the difficulty of handling large pieces of stone or the cost of cutting at the quarry. Bricks could be cast or extruded into whatever size and shape was best suited to transportation and construction. Some antique bricks weighed as much as 90 lb., but most bricks are small and light enough to be held in one hand. Moreover, standardization of size and shape brought uniformity of pattern and modularization of dimensions. Bricks were the first prefabricated building elements; cutting and fitting on the site were minimized. In spite of the multiplicity of joints, a brick wall requires less labour than a stone wall of comparable workmanship. Yet brick is not inferior to stone in load-bearing capacity or in resistance to fire, decay and weather.

HISTORY

Brickwork is related in its origins to rammed earth (*q.v.*). Primitive bricks were always sun-dried; a major advance was the process of burning the bricks in a kiln. Sun-dried bricks can only be used in climates having low humidity and rainfall, and even then they require safeguards against dissolution. Adobe construction, used in Spanish colonial architecture, was introduced into Spain by the Saracens, but was originally developed in the Tigris-Euphrates valley.

The Etruscans are believed to have come from Asia Minor to colonize central Italy, and they may have brought with them a knowledge of the ancient brick construction of that region. The Romans acquired this knowledge and passed it on to the Byzantines who, in turn, influenced the Seljuk and Ottoman Turks. Byzantine brick buildings in Italy furnished prototypes for the great Lombard development of brick architecture beginning in the 11th century. Inspired by the Italian example (and perhaps also by the east through the crusades), brickwork then began to appear elsewhere and came to dominate the architecture of northern Germany, Denmark, the Low Countries and parts of England.

Egyptian and Mesopotamian.—The surviving monuments of Egyptian architecture were primarily built of the excellent limestone, sandstone and red granite which the Egyptians had at their disposal. However, the firm black mud of the Nile, mixed with sand or straw to reduce shrinkage cracking, made excellent brick; excavations reveal both sun-dried and kiln-burnt examples. As early as the 1st dynasty, Egyptians made their bricks only slightly



(LEFT) ALINARI, (ABOVE) RADIO TIMES HULTON PICTURE LIBRARY

(ABOVE) RELIEF OF A YOUNG BULL DECORATING THE ISHTAR GATE, BABYLON; 5TH OR 6TH CENTURY B.C. (LEFT) BATHS OF CARACALLA, ROME; 3RD CENTURY A.D.

larger than modern ones and gave them the same proportions. Mortar was composed of the same mud and sand as the brick material. Contrary to some accounts, the Egyptians also knew the vault; it appeared in utilitarian buildings, such as the laminated vault granaries of the Ramesseum at Thebes.

The most primitive construction is thought to have been mud reinforced by reeds, and brickmaking may have been developed from it before the development of stonemasonry. The Egyptians used brickmasonry for houses and palaces and for mastaba tombs. Pyramids at Dahshur and Abu Roash were of brick in their main mass, faced with stone.

In Mesopotamia (modern Iraq) the Sumerians were perhaps the earliest to develop brick architecture. On the flood plain of the Tigris-Euphrates, enormous elevated platforms were required to protect important installations. These platforms were built of solid earth. Clay compressed in molds and dried in the sun was the most convenient form where everything depended upon unaided human labour. Abundant deposits in the region supplied bitumen for dampproofing the mortar; kiln-burnt bricks were used for facing.

The palace of Sargon at Khorsabad (713 B.C.) dates from late in the period of Assyrian supremacy. Its platform is cut by drains built in vault form, and the plan of its superstructure shows long narrow rooms defined by brick walls massive enough to have supported brick-vaulted roofs.

The Persians (538–333 B.C.) produced friezes of great beauty formed of colour-glazed bricks. Large-scale brick vaults are commonly supposed to have been in use at a very early date in Mesopotamia. The Sassanian dynasty palace at Ctesiphon near Baghdad (A.D. 550) contains the remains of an elliptical vault spanning 85 feet. This span compares favourably with the somewhat earlier Roman vaults.

The early origin of the arch, vault and dome in Mesopotamia seems probable in view of the shortage of stone or timber capable of spanning openings with one member. In brickwork a curved surface of large radius compared to the brick size can be constructed without special brick shapes simply by varying the joint thickness. Mesopotamian vaults were apparently made by first projecting courses into the opening (corbeling) to diminish the span before constructing on this haunch a wooden centring to support the remainder during the construction of the vault. The horizontal joint at the haunch was a statically imperfect but empirically workable solution.

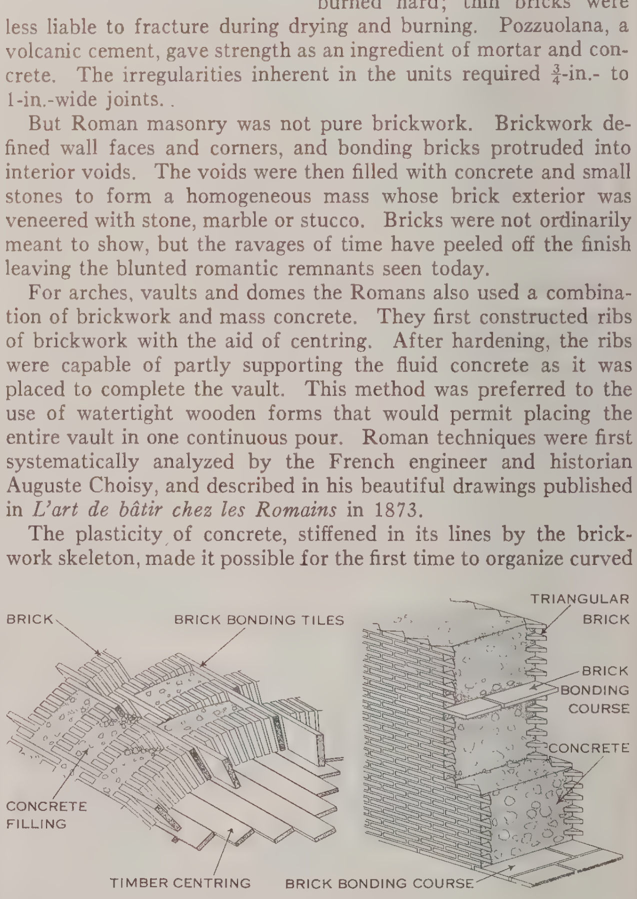
The dome is a more complex form than the vault, but more stable and more amenable to construction, since in small sizes it can be built almost without centring. Concentric rings of masonry have an arch action in the horizontal plane which tends to prevent the elements of the incomplete dome from falling inward. Brickwork provides the ideal material for experiments in domical structures. (*See* also ARCH AND VAULT; DOME.)

Roman.—The Romans improved the durability of both brick and mortar, and throughout the regions of the ancient empire, Roman brickwork may still be seen thrusting up through fields or seeming to support buildings in the towns. Roman bricks were formed square and flat (about 18 in. square × 1½ in. thick) and burned hard; thin bricks were less liable to fracture during drying and burning. Pozzuolana, a volcanic cement, gave strength as an ingredient of mortar and concrete. The irregularities inherent in the units required $\frac{3}{4}$-in.- to 1-in.-wide joints.

But Roman masonry was not pure brickwork. Brickwork defined wall faces and corners, and bonding bricks protruded into interior voids. The voids were then filled with concrete and small stones to form a homogeneous mass whose brick exterior was veneered with stone, marble or stucco. Bricks were not ordinarily meant to show, but the ravages of time have peeled off the finish leaving the blunted romantic remnants seen today.

For arches, vaults and domes the Romans also used a combination of brickwork and mass concrete. They first constructed ribs of brickwork with the aid of centring. After hardening, the ribs were capable of partly supporting the fluid concrete as it was placed to complete the vault. This method was preferred to the use of watertight wooden forms that would permit placing the entire vault in one continuous pour. Roman techniques were first systematically analyzed by the French engineer and historian Auguste Choisy, and described in his beautiful drawings published in *L'art de bâtir chez les Romains* in 1873.

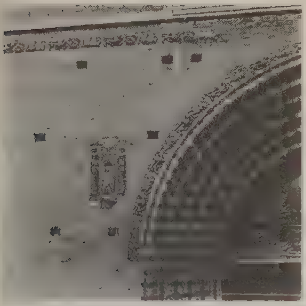
The plasticity of concrete, stiffened in its lines by the brickwork skeleton, made it possible for the first time to organize curved

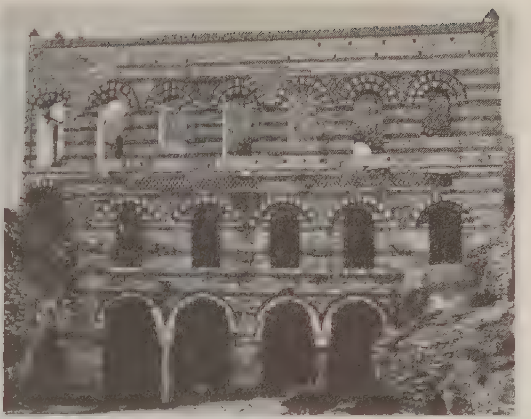


DRAWN BY JOSEPH YOHANAN FOR "ENCYCLOPÆDIA BRITANNICA"

FIG. 1.—ROMAN BRICK CONSTRUCTION

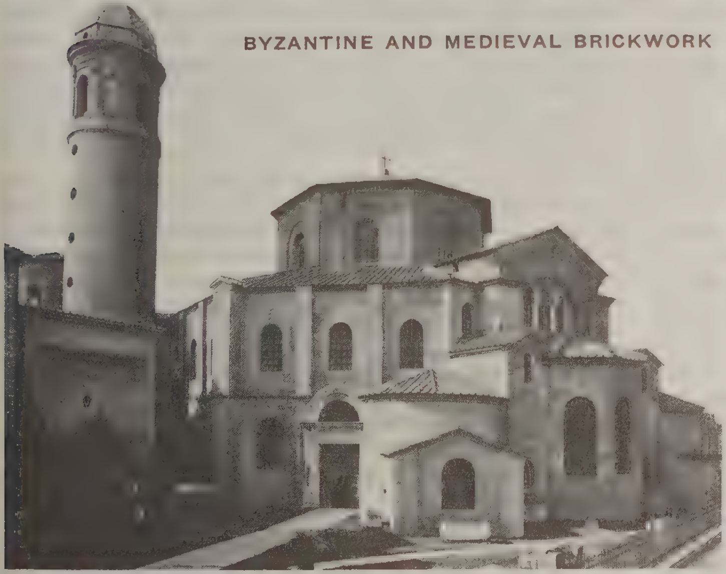
(Left) Vault using brick ribs and (right) wall construction using brick and concrete

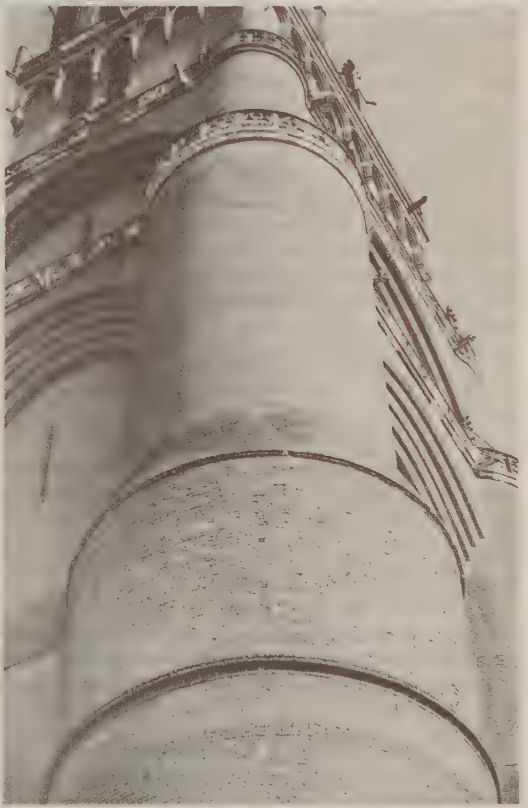




(Above) Detail of frieze and portal, Georgen-Kirche, Wismar, Ger.; 14th century. (Right) Pier and vaulting in the cathedral at Roskilde, Den.; 13th century. (Top right) Wall of a Byzantine palace, the so-called Tekfursaryi, Istanbul, Turk.; 14th century. (Bottom right) Buttress of the cathedral of Albi, France; 13th century. (Below) Campanile and church of S. Vitale, Ravenna, Italy; 6th century

BYZANTINE AND MEDIEVAL BRICKWORK





BY COURTESY OF (TOP CENTRE) NATIONALMUSEUM, COPENHAGEN; PHOTOGRAPHS, (TOP LEFT) FOTO MARBURG, (TOP RIGHT) THA—KEYSTONE, (BOTTOM LEFT) ALINARI, (BOTTOM RIGHT) P. DEVINOY

structural surfaces with large dimensions. Roman architects designed spaces which are superb in their control of geometrical form. The baths of Caracalla, one of a number of great public thermae, had vaulted halls 108 ft. high spanning 79 ft.; the dome of the Pantheon (A.D. 120–124) spanning about 142 ft., is the only large vault surviving relatively undamaged. (*See* also ROMAN ARCHITECTURE; BATH.)

Byzantine.—Following the decline of Rome and the division of the empire, new sites of government and culture developed at Constantinople and Ravenna. In the 6th century A.D. the great monuments of the first fully mature Christian art appeared in these centres. The financial power and the slave-labour pool of the Romans had been swept away, but the emperor Justinian commanded adequate resources for a major building program. Byzantine architects and artisans called on their ingenuity to produce new solutions out of local materials. They used bricks proportioned essentially like Roman bricks. Sometimes, as at S. Vitale, they built domes with hollow terra-cotta jars to save weight.

Their major architectural problem was that of the dome. In the Pantheon, the Romans had already used the dome as a way to enclose the top of a circular room, but the Byzantines developed organic structural solutions to the problem of supporting the dome on polygonally arranged piers. Spatially their crowning dome grew out of contributory domed spaces, enlarging and enriching the envelope as an architectural enclosure. Structural brickwork was left bare on the exterior, humble in appearance, but enlivened with a few patterns natural to the material. Interiors, on the other hand, were covered with marble and with breathtaking golden mosaics. Ravenna, on the edge of the alluvial plain of the Po, and once an Adriatic port, is a town still dominated by brick churches and church towers. The church of S. Vitale, consecrated by Justinian in 547, has a dome spanning 55 ft. The sides of its octagonal base, about 65 ft. high below the dome, are pierced by semicircular niches crowned with semidomes; the niches in turn are pierced by galleries, also vaulted. The transition from the octagon to the circular base of the main dome is made by squinch

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LOBBY AREA IN THE JOHNSON'S WAX ADMINISTRATION BUILDING, RACINE, WIS., BY FRANK LLOYD WRIGHT; 1939

arches thrown across the interior angles.

One of the greatest buildings of all time is the Byzantine church of Hagia Sophia in Istanbul (532–537). No more daring piece of brickwork exists. The main dome (rebuilt following an earthquake in 558, and further damaged by earthquakes in the 10th and 14th centuries) covers a central space 107 ft. square, surrounded by four massive piers supporting four great arches. Nearly spherical triangles (pendentives) rest on the shoulders of the arches to produce a circular base at the level of the tops of the arches; this is the most satisfactory means by which a circular dome may be placed over a square structure. The arches to east and west open into great semidomes each of which is in turn cut by three smaller radiating semidomes. The tremendous unity of this great oval interior (107 ft. by 225 ft.) is due to the perfect spatial relationships of these spherical surfaces. (*See* also BYZANTINE ART AND ARCHITECTURE.)

Medieval.—Brickwork is a craft requiring economic stability and labour organization. Time is needed for digging the clay, curing, reworking, molding, drying and burning. During the unstable early middle ages, very little brick architecture was produced in Europe except by the Byzantines. Italy alone possesses a continuous tradition of brickmaking.

By about the year 1000, however, Romanesque church-building was flourishing. In the Po valley, where Roman and Byzantine traditions were strong and building stone scarce, a brick architecture called Lombard was produced. Magnificent examples remain in Parma, Pavia, Milan, Venice, Padua, Mantua, Modena, Cremona and Bologna. Best known is the basilica of S. Ambrogio at Milan, whose several parts date from the 9th, 11th and 12th centuries.

The plain extending along the North Sea and the Baltic from Flanders through southern Scandinavia and northern Germany was the next region to embrace brickwork. Here brick first appeared in Sjaelland about 1150 and rapidly became preferred for the enormous new building program of the church. The 12th century saw the construction of innumerable small country churches, often enlarged or added to in later periods, particularly in the late-Gothic 15th century. Larger churches include the cathedral at Roskilde in Denmark and the Marienkirche in Lübeck in north Germany. Flemish, Dutch, German and Danish churches were the counterparts, in brick, of the medieval stone architecture of northern France.

In southwestern France the medieval brickwork had a quite different regional character. The cathedral of Albi was begun in 1282 by a bishop who, anxious for the prestige of the church following the suppression of the Albigensian heresy, created a smooth-walled brick fortress with small high windows and a flat roof, in spirit totally unlike any of the other large churches of the time. Great silo-shaped buttresses show how the vibrant texture of brick delineates curved surfaces. Together with the adjoining archbishop's palace, the cathedral of Albi is outstanding in special character resulting from the use of brick. Spain also had its revival of brick construction in medieval times; Moorish cultural dominance is evident, as in the tower (once a minaret) in Seville called the Giralda (1159?). From Moslem origins came the idea of the screen or grille, so easy to execute in brickwork, although the Moors also used several other materials for it. As for England, bricks were imported from Flanders in the latter part of the 14th century, and local manufacture soon developed.

The artistry shown in medieval European brick churches testifies to the high standards of the brickmasonry guilds. Lombard architects invented a great range of elements all based on the brick arch; their facades were rich with forms admirably suited to workmanship in brick. North German brickwork successfully executed tracery, groin moldings and thin-shell vaults of Gothic architecture. In half-timber work (*q.v.*), structural carpentry was combined with brickmasonry in countless minor buildings of great charm.

Insofar as medieval architecture was concerned with craftsmanship, a sense of the fitness of materials, and spatial conceptions consistent with logical structural principles, brickwork was equal to the task. Only the fact that its grain was too coarse for carved sculptural detail kept it from full parity with limestone and marble.

Renaissance and Later.—Renaissance architects had different objectives from those of their predecessors; their preoccupation with visual harmony conflicted with interest in materials, workmanship and structural purity. Gothic architects had been master builders; Renaissance architects assumed greater prestige as creative personalities, but lost the close association with building craftsmen that had prevailed earlier. The apparent formal organization of a Renaissance building did not necessarily coincide with its hidden structural organization. Brickwork continued as a reliable and economical structural material. Brunelleschi's dome in the Duomo of Florence (1420–37), Michelangelo's in St. Peter's in Rome (1546–90) and Wren's in St. Paul's in London (1675–1710) all have structural shells of brick. However, it is difficult to find Renaissance buildings with a character peculiar to brick architecture.

Throughout northern Europe many brick castles, manor houses and chateaux were built during the early Renaissance. The early portion of Hampton Court palace has brickwork characteristic of the Tudor style in England, in the south and east of which, at this time, good-quality brickwork was characteristic. There are also many examples, particularly in French architecture, of happy combinations of stone and brick. Much of the minor secular architecture in European towns continued to be executed in brick, sometimes trimmed with carved features in stone, terra cotta, stucco or wood. Large cities were built almost wholly of brick; *e.g.*, Amsterdam and Copenhagen. The Georgian period in England (1702–1830) produced many fine houses of classical proportions executed in brickwork of great refinement. There, and also in Maryland and Virginia, bricks were "rubbed and gauged" after burning, to obtain trapezoidal shapes for flat arches and accurate rectangular bricks that could be laid with very tight joints to form pilasters, quoins and belt courses. Philadelphia and Boston have fine brick structures from this period, but normally their decorative features are of wood.

20th Century.—Growing revulsion against aimless 19th-century eclecticism stimulated the use of materials in straightforward recognition of their properties. Traditional brickmaking countries produced restatements of the medieval principle of the maximum use of a single material. Grundtvigs Mindekirke in Copenhagen by P. V. J. Klint (1921–40) and the stock exchange in Amsterdam by Hendrik Berlage (1898–1903), though divergent in feeling, are two examples. But the role of brickwork was soon eclipsed by the entry of new technology. Steel inevitably became prominent. Embedded in concrete, it endowed this material with new properties. Great savings in bulk and weight made the building envelope independent of its structural armature.

In large buildings stone and brick began to lose their load-bearing function and were relegated to the role of enclosing space without supporting it. Brickwork could especially play such a role with great elegance, but it was soon apparent that industry, which had provided better support, would also improve on enclosure material. Brickwork is fireproof, resists weather, and should need little maintenance, but it is heavy and it has to be laid by hand. Its future is therefore problematical.

Frank Lloyd Wright seemed to have captured the essence of north European brickwork tradition; he made use of the grain of a brick surface as well as its warm colour in the Johnson's Wax building at Racine, Wis. (1939), and in many of his houses. Ludwig Mies van der Rohe, on the other hand, made brickwork express the precision and modular clarity of the machine in spite of its patent handcraft origin. His Promontory apartments (1946) in Chicago are a pure example of the use of brickwork for nonbearing (or curtain) walls in a multistory skeleton-frame building. The separate roles of the skeleton and brick walls are satisfyingly apparent.

TECHNIQUE

Brickwork Dimensions.—The height, width and length of modern bricks are given the approximate proportions $\frac{1}{3}:\frac{1}{2}:1$, including the presumed dimension of the mortar joint. In England and Scandinavia the usual module is 3 in. per brick course; this requires a brick whose actual dimension is about $2\frac{1}{2}$ in. × $4\frac{1}{4}$ in. × 9 in. In the United States the standard brick is more nearly $2\frac{1}{4}$ in. × $3\frac{3}{4}$ in. × 8 in., providing three horizontal joints for 8 in. of vertical measurement. The 4-in. horizontal increment of modular co-ordination requires a somewhat shorter brick.

Brickwork resists efforts at complete modularization. Joint thickness is necessarily variable according to the conditions encountered and the effect sought. Its variability is valuable to offset the variations and inaccuracies in the structural frame. For rough brick quite variable in size, a joint $\frac{3}{4}$ in. to $\frac{7}{8}$ in. may be appropriate for horizontal joints, but the vertical joints will probably be smaller. Machine-made brick, especially as interior finish, may approach jointing of $\frac{1}{4}$ in. or even $\frac{1}{8}$ in. The dimension of the joint should not be less than twice the variation expected in the bricks themselves. The architect anticipates these factors in determining the dimensions of openings and piers; the brickmason determines their feasibility in the light of the materials provided. Thick joints are likely to leak more than thin joints.

Brick-wall thicknesses are modular increments of brick width plus mortar. This thickness, in the U.S., is expressed in terms of withes, a withe being the width of a single brick. In England the term withe refers only to the thickness of brickwork separating two chimney flues, and walls are said to be a half-brick (single withe), one brick (two withes) or a brick-and-a-half thick. At the University of Virginia, Charlottesville, Thomas Jefferson demonstrated beautifully that a single withe of brick was adequate for stabilizing a garden wall of serpentine form. Double-thick walls are convenient where brickwork must be dressed on both sides, because the individual brick may be placed with regard for only one exposure. In all but the drier climates, three brick withes are necessary for exterior walling to provide watertightness. Such a wall, slightly over a foot thick, has great loadbearing capacity; greater thickness may be required to prevent overturning in the case of high walls without lateral support.

Bonding.—Stability in masonry walls requires that the separate units cling together so that the masonry will retain its character as one piece. Vertical loads that compress all parts are less feared than are unequal settlement, movement due to changes in temperature, and stresses induced by the pulling or pushing of floors and roofs. Masonry is relatively inflexible; cracks weaken the wall, admit the weather and are unsightly.

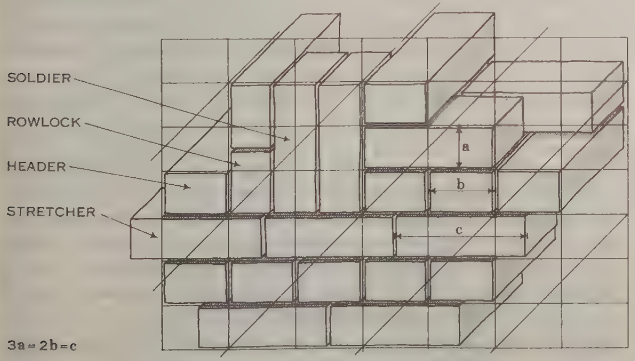


FIG. 2.—BRICK PROPORTIONS AND DEFINITIONS

Bonding is the staggering or overlapping of units to break the vertical joints according to a definite pattern. A sense of how bonding strengthens a wall may be obtained by laying up small sections of brickwork dry. Every vertical joint in masonry is a potential plane of cleavage; the more discontinuous these joints can be made, the stronger the wall becomes (assuming always that the mortar, or the bond between mortar and brick, is weaker than the brick itself). The incipient crack is thereby required to extend in a zigzag manner, overcoming the resistance offered by the interlocked units.

Considering a single withe of brickwork, bonding is a two-dimensional problem with one best solution: running bond with plumb alignment of alternate vertical joints. In walls composed of several withes the vertical joints parallel to the wall face must be interrupted, and the problem is three-dimensional. There are several traditional solutions. English bond consists of courses of headers alternating with courses of stretchers—in a variant called English cross bond the vertical joints of each stretcher course break joint with the stretcher course below. In Flemish bond the bricks of each course are alternately header and stretcher, laid so that a header is always over a stretcher. Other bonds are variations.

In English bond one-half of the surface has headers penetrating two withes deep, in Flemish bond one-third of the surface is headers. Either bond provides a tremendous interlocking effect, which can be carried through the wall to interrupt every vertical mortar withe, no matter how many. The satisfying and subtle patterns of good bonding reflect a structural order within the wall.

Such bonding is a disappearing craft. In most walls only the outer withe is of face brick, made to be seen and to withstand weather. The core is made of cheaper back-up brick. Bonding requires more face bricks, increasing the expense. Often back-up material is hollow concrete or burned clay-tile blocks much larger than bricks, and bonding would require special shapes for interlocking. A decline of handcrafts accompanies mechanization of production, and in brickwork there has been a tendency to eliminate complexities. Skeleton construction has diminished the need for high strength in brickwork, and has made interlocking of units less important.

Workmanship.—Traditional procedures in building were revolutionized by the industrialization, early in the 19th century, of the production of portland cement. Mortars for masonry were greatly strengthened by this new ingredient. Mortar usually makes up about one-third the volume of brickwork. Portland cement did not eliminate the need for lime, and except where high compressive strength or unusual resistance to moisture are required, the addition of lime putty or hydrated lime to the cement, sand and water is advantageous. Lime helps mortar to retain water, to flow easily and to have workability, a fatty consistency that both clings and spreads. Lime produces a low-modulus mortar which can absorb local strains without undue accumulation of movement. Workability enables the mortar to be forced into all the voids between the bricks. (*See* also MORTAR IN BUILDING.)

Brickmasonry can therefore be primarily directed toward provision for watertightness and relief from the inevitable movement due to exposure, rather than loadbearing. A well-laid wall is permanent protection against rain, but poor brickwork is a liability difficult to correct. Brick and mortar are moderately porous; their slow absorption provides protection against exterior wetness. Brickwork must be protected at openings and at the intersections of roof planes with sheet-metal or waterproof-fabric flashings built in to form barriers. Water may penetrate wherever the bond between mortar and brick is imperfect, and it will collect and flow into any unfilled voids.

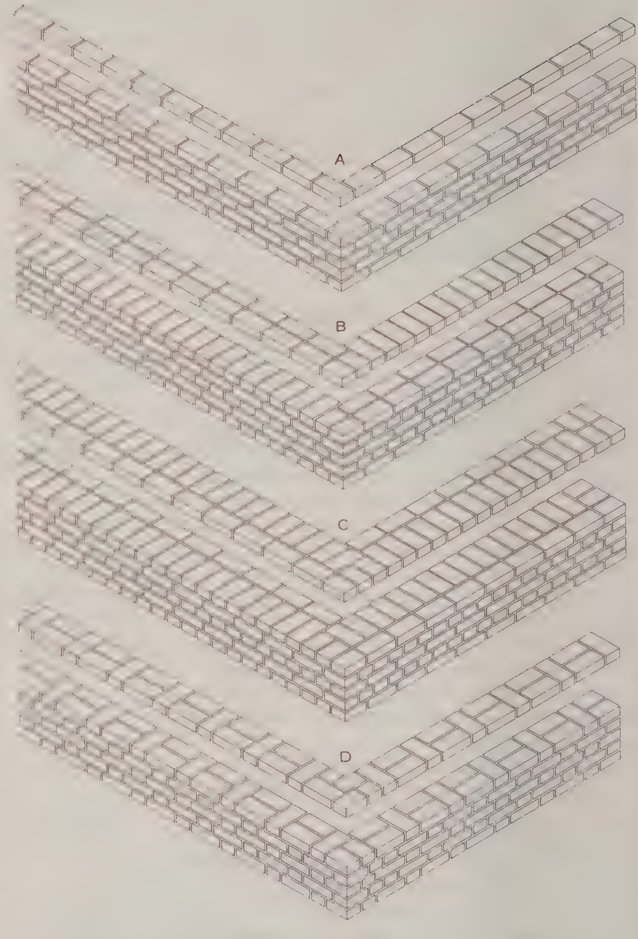
To obtain good bond and to fill the voids the brickmason uses techniques described by key words of the trade. When he "spreads" mortar horizontally to receive a row of bricks, he should do so for only a few bricks at a time, so that the mortar will remain plastic until covered. While smoothing it to the proper thickness, he should avoid excessive "furrowing" with his trowel as this may leave a trough under the bricks. The end of each brick, as it is picked up, should be "buttered" so that the mason may place it in its bed and shove it laterally against the next stretcher to assure full contact. After tapping for alignment he should not further disturb it. Laying against a back-up brick already in place, he may "pick-and-dip," throwing mortar on the wall with one hand and immediately shoving a brick into it so that mortar squeezes out of all three joints. A way of assuring water-tightness is to lay the back-up brick ahead and then to "parge" its surface by plastering on a coat of mortar ⅜ in. thick before bringing the facing up to level. The reverse procedure, leading with the facing and parging its back surface, is less desirable because the lateral pressure may break the moist joints of the face brick. It is better to parge than to "slush"; slushing attempts to fill the vertical joint by throwing mortar into it after the units are placed. Where these vertical voids are too deep they cannot be adequately filled, and if pressure is used to ensure filling, the face brick may be forced out of line. The above method, known as "overhand work," is less commonly used in England than the alternative technique in which the bricklayer works away from himself, from left to right if he is right-handed. Similarly, details of good practice vary slightly in different countries.

Accuracy is assured by the use of long spirit levels to plumb the corners and by strings stretched horizontally as guides. The bricklayer or mason begins by laying out bricks from corner to corner to determine the thickness of heading joints and the necessity for cutting. It is customary to wet highly absorbent bricks with a hose to correct excessive suction on the water in the mortar. However, the methods commonly used do not produce the desired result, and the practice is questionable.

Exposed joints in brickwork are finished in a separate operation, pointing, that affects both its appearance and its weathering. It is best to wait until the mortar is partly hardened, so that substantial pressure is required to produce a smooth, dense finish, the mortar being forced into intimate contact with the brick. Exposed faces must not be stained with mortar; its removal may require the use of hydrochloric or muriatic acid, which also attacks the tooled mortar joint.

Efflorescence is a defect in brickwork caused by the presence of excess water in the wall. Whitish salts are deposited by the evaporation of water containing dissolved salts from the mortar and brick. Aside from avoiding ingredients containing soluble salts, the best defense is to design a watertight wall and to minimize the amount of entrapped water. Research suggests that headers employed for bonding may be disadvantageous for watertightness; they interrupt a continuously parged mortar withe, which is an effective barrier to water penetration. Galvanized-steel wall ties laid in the bed joints are supplanting bonding for anchoring parallel brick withes together. In freezing weather, the materials and the finished work must be kept warm. Circumstances will determine whether the additional cost of cold weather operation can be justified.

Cavity Walls.—Since a solid wall only two brick withes thick is rarely leakproof, an alternate construction using no more material has been devised. In cavity walls two 4-in. or 4½-in. withes are separated by a 2-in. air space so that the total thickness is 10–11 in. Additional back-up withes can be added if needed for load-bearing, or the back-up can be made of insulating blocks or other masonry material. The withes on either side of the continuous air space are connected only by galvanized metal ties. These are incapable of carrying water across the air space and provide some flexibility for difference in expansion and contraction between the inner and outer withe due to temperature differences. They also furnish valuable lateral stiffening so that the wall may bear loads. The air space must not become filled with mortar during construction, and if droppage cannot be prevented, strips of wood must be placed on the metal ties. Drawing these up to remove the mortar must be done carefully to avoid breaking the joints in the face bricks. Water coming through the outer withe will run down its inner face instead of penetrating; the bottom of the air space is protected by a stepped through-wall flashing, and in the lowest exterior brick course the heading joints are left open for drainage. The air space is not only a protection against rain penetration, but is fairly effective as thermal insulation, overcoming a weakness of solid brick walls. The air space may be filled with either loose- or rigid-board insulation, if materials that are completely durable and nonabsorbent are used. The effects of freezing and thawing on cavity walls should always be considered.



DRAWN BY JOSEPH YOHANAN FOR "ENCYCLOPÆDIA BRITANNICA"

FIG. 3.—TYPES OF BRICK BONDS

(A) Running bond; (B) English bond, 8 in. thickness; (C) English bond, 12 in. thickness; (D) Flemish bond, 8 in. thickness

So-called brick veneer construction is often used in small houses in the U.S. A wood frame house is covered with rough wood sheathing and building paper; a parallel withe of face brick is then laid with air space and anchorage as in a cavity wall. The flexibility of the metal ties overcomes incompatibility in the movements of the two materials, but the combination is architecturally unsatisfactory.

Reinforced Brick Masonry.—Masonry materials can carry heavy compressive stresses, but in shear or tension they are relatively weak. Gothic architects were ingenious in avoiding tensile stress. Renaissance architects were not above embedding iron chains or hoops in their domes and they sometimes used visible iron tie rods. In the 19th century, engineers in France and England realized that new structural forms could result from systematically combining steel with concrete or brickwork. Mathematicians developed theories to predict the distribution of stresses in structures. An unreinforced masonry beam may fail of its own weight, but can be made very strong by building steel bars lengthwise into its lower cross section. In any concrete or masonry structure the correct positioning of steel reinforcement makes a combination utilizing the strongest qualities of both materials.

Reinforced brick masonry, called R-B-M, although now virtually unknown in England, was originated by an English engineer, Marc Isambard Brunel, who first used it in 1813 in chimney construction, then built reinforced brick caissons for the Thames tunnel in 1825, and in 1836 began to design and test reinforced brick beams. (Patents for reinforced concrete were first obtained in the 1850s.) The reinforcing bars are laid in the wet mortar. Formed systems of bars may be fastened together and positioned before brickwork is built up around them. Reinforcing bars must remain thin; when thicker bars are required, either the mortar joint must be thickened or special bricks employed. R-B-M utilizes the compressive strength of brickwork to a large degree, hence strong mortar is necessary. Often a fluid mortar (grout) is poured into the inner joints to assure filling all voids. The danger of grouting lies in excessive shrinkage which may cause interior strains to open up the face joints.

The advantages of R-B-M over reinforced concrete are similar to those that made the Romans use a brick framework for their concrete vaults. Vertical surfaces can be built without formwork, and forms for soffits need not be watertight. In spite of its advantages and its somewhat earlier development, R-B-M has proved less useful than reinforced concrete. Brick imposes limitations on shapes and dimensions, whereas, in concrete work, form building in lumber and plywood or steel is more flexible. Brickwork introduces incipient planes of cleavage; the bricks interfere with the most advantageous placement of reinforcing steel, especially when it must be bent or curved. Nevertheless if brickwork is the desired medium, R-B-M is acceptable because it is capable of withstanding complex loading, such as that encountered in earthquakes.

Appearance.—Whenever brickwork is used as an exposed structural system, as curtain walling or as walk pavement, its visual qualities are important and subject to the designer's control. The rhythm, colour and scale appeal to the senses, and its fabric has many possible variations. It may appear either rich or austere, hand- or machine-wrought, variegated or monotonous, glowing in colour or muddy, according to subtle differences in these variables. Clays burn to different colours, and the product of one kiln may have uniformity or be highly varied in colour, shape and size. The manner of stacking in the kiln and the time of burning are sources of variability—single bricks contain characteristic variations in colour. Bricks may be burned so as to be vitreous, or glazes may be applied by second burning. Bonding is quite important to the appearance of brickwork.

Both in structure and appearance, mortar joints play a disproportionate part. At a distance the mortar colour and brick colour tend to be mixed by the eye. Mortar colour contrasted to brick colour, *e.g.* cold versus warm, produces vibrancy. Colour is controlled by choice of ingredients, and further by the addition of pigments, of which red or black are the most used. Whiteness, formerly obtained through the addition of oyster shells, can now be obtained through the use of white cements. Joint thickness is important, as is the method of pointing it. Deeply raked, it will cast shadows to model the surface; in contrast is a technique in which mortar is rubbed into the joint with a piece of sacking or the face of a brick held in the hand so that low points in the wall are submerged in a flush mortar surface. In Virginia and Delaware, joints were accented by a narrow groove cut into the centre of a rather fat and variable joint, giving discipline and refinement; similar "tuck pointing" was frequently done in England during the Georgian period.

Qualities of brickwork that depend on the skill of the brickmason have tended to disappear. However, sound and beautiful brickwork is still being produced, resulting from high standards of manufacture and selection, conscientious construction procedures, scientific controls and a full appreciation of the variables affecting the appearance of bricks and mortar.

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BRIÇONNET, GUILLAUME (*c.* 1472–1534), one of the most energetic personalities in the French church at the beginning of the Reformation, was the son of Charles VIII's counselor Guillaume Briçonnet (1445–1514), who after his wife's death took holy orders and became bishop of St. Malo, archbishop of Reims, archbishop of Narbonne and cardinal. The younger Guillaume was made bishop of Lodève (1489), abbot of St. Germain-des-Prés (1507) and bishop of Meaux (1516). He took part in the Council of Pisa in 1511 and was entrusted by Francis I of France in 1516 with the negotiations in Rome over the application of the Concordat of Bologna.

It is thought that the influence of some Italian bishops of the Oratory of the Divine Love—particularly Gian Matteo Giberti, bishop of Verona—prompted Briçonnet to begin reforms in his diocese of Meaux, where he made frequent visitations, encouraged devotion to the Blessed Sacrament and to the Virgin Mary and promoted a religious revival by means of sermons and tracts printed in his own palace. This activity won him such a reputation that he became the spiritual director of the king's sister Margaret.

Briçonnet moreover was the leader of the "Meaux group" of evangelicals. This group, which included Jacques Lefèvre d'Étaples, Gérard Roussel, Guillaume Farel, Jodocus Clichtove, François Vatable and Martial Mazurier, combined humanism with a return to the study of the Bible and, especially, of St. Paul's epistles as the primary source of Christian doctrine. Its members, however, differed in their attitude to Lutheranism, to which Farel adhered while Briçonnet condemned it (1523). Even so, Briçonnet had to appear twice before the Paris *parlement* on suspicion of heresy. The group was finally dispersed about 1525. Briçonnet, still a Catholic, died at St. Germain-des-Prés on Jan. 24, 1534.

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BRIDE, the term used of a woman on her wedding day. It appears in many combinations, some of them obsolete; *e.g.*, "bride bell" (wedding bells), "bride banquet" (wedding breakfast). The bridecake, or wedding cake, had its origin in the Roman *confarreatio*, a form of marriage, in which the couple ate a cake made of salt, water and flour, and the bride held three wheat ears, symbolical of plenty. In the middle ages the wheat ears were worn or carried by the bride. It became the custom for young girls to assemble outside the church and throw grains of wheat over the bride. Later wheat grains were cooked into thin dry biscuits, which were broken over the bride's head. In 16th-century England, these biscuits took the form of small rectangular cakes made of eggs, milk, sugar, currants and spices. Every wedding guest had at least one, and the cakes were thrown at the bride as she crossed the threshold.

In rural parishes of England, even into the 20th century, wheat was thrown over the bridal couple with the cry, "Bread for life and pudding for ever," expressive of a wish that the newly wed might be always affluent. The throwing of rice, a very ancient custom but later than the wheat, is symbolical of the wish that the bridal may be fruitful. The bridecup was the bowl or loving cup in which the bridegroom pledged the bride, and she him. The bridecup was also sometimes a bowl of spiced wine prepared at night for the bridal couple. Bride favours (or bride lace) were at first pieces of gold, silk or other lace, used to bind up the sprigs of rosemary worn at weddings. Later these took the form of bunches of ribbons. Bridegroom men, or groomsmen, represented a survival of the primitive days of marriage by capture, when a man called his friends to assist to "lift" the bride. Bridesmaids were usual in Saxon England. The senior of them attended the bride for some days before the wedding. The making of the bridal wreath, the decorations for the wedding feast, the dressing of the bride, were among her special tasks. The senior groomsman (the best man) was the personal attendant of the husband. The bride-wain, the wagon in which the bride was driven to her new home, gave its name to the weddings of any poor couple, who drove a "wain" round the village, collecting small sums of money or articles of furniture toward their housekeeping. These were called bidding weddings, or bidales. The bride's veil is the modern form of the *flammeum* or large yellow veil which completely enveloped Greek and Roman brides during the ceremony.

See also MARRIAGE.

BRIDEL, PHILIPPE SIRICE (1757–1845), Swiss man of letters, known as *le doyen* Bridel, whose work was aimed at arousing a national consciousness in Swiss thought and writing, was born at Begnins (Vaud), Nov. 20, 1757. After studying at Lausanne he became a pastor, first at the French church in Basel and later at Château-d'Oex and Montreux, occupying himself largely with literature, national history, linguistic questions and the natural sciences. His purpose was to endow his country with a literature completely native to it—a movement continued by the patriotic poet Juste Olivier. Of his own writings, *Poésies helvétiennes* (1782) have only documentary value, but his *Glossaire du patois de la Suisse romande* (1866) and the series of *Étrennes helvétiennes* (1783–87) and *Conservateur suisse* (1813–31) are a source of information, anecdote, legend and graphic description. Bridel's influence helped to bring together French- and German-speaking Swiss on the political as well as literary and scientific level. He died at Montreux, May 20, 1845.

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BRIDEWEALTH is the payment made by the groom to ratify marriage in certain primitive societies. (*See* MARRIAGE, PRIMITIVE.) As it is not always a form of wife purchase, the older term "bride-price" has been replaced by "bridewealth." It can be found in all parts of the globe in one form or another but, as an instrument for the ratification of marriage, it is most highly developed in Africa, and in many African societies the husband may not assume his full marital status until a standard proportion of the bridewealth has been transferred; often, until this is done, he cannot affiliate his children to his own descent group or claim damages against an adulterer or receive bridewealth for his own daughter. The payment of bridewealth provides a criterion for distinguishing cohabitation, with no legal consequences, from marriage with all it implies for succession and the definition of incest categories. Consistently, a marriage is not reckoned to have ended until the return of bridewealth signifies divorce.

Often the bridewealth is part of a long series of exchanges between the two families. Those made by the bride's family are sometimes called dowry, misleadingly, since there is no clear analogy with the European dowry system.

Bridewealth also consolidates friendly relations between intermarrying families which are not already united by ties of kinship. It is a pledge that the bride will be well treated and is in some sense a compensation for her loss, and so is comparable to blood-compensation or "bloodwealth." In marriages between aristocrats and commoners, it may carry implications of tribute or of payment for social advantages.

The goods transferred as bridewealth vary considerably from specified amounts of livestock, spears or cowries to drink and food, money or even an exchange of women. Where bridewealth is not required the groom is often expected to serve his father-in-law for a set period.

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BRIDEWELL, a district of London, Eng., between Fleet street and the Thames, so called from the well of St. Bride or St. Bridget. It was open ground until Cardinal Wolsey built Bridewell palace where in 1525 Henry VIII entertained the emperor Charles V. In 1553 Edward VI made it over to the City of London as a place of training and education for its homeless apprentices. Bridewell Royal hospital and Christ's hospital, founded at the same time, worked closely together. Subsequently the cells, meant for recalcitrant apprentices, came to be used for political and religious prisoners, vagrants and prostitutes; this practice continued side by side with the teaching of apprentices until the mid-19th century when the prison was closed. By 1863 the palace was demolished. Bridewell Royal hospital, now a charity, maintains King Edward's school, Witley, Surrey, opened in 1867, which became coeducational in 1953. The name bridewell, in general usage, has come to mean prison or house of correction.

BRIDGE, FRANK (1879–1941), English composer and, in several fields, one of the most accomplished musicians of his day. Born at Brighton, Sussex, Feb. 26, 1879, he started to study the violin at the Royal College of Music, London, then changed to the viola, of which he became a virtuoso player. After a short time as deputy in the Joachim quartet (1906), he became a permanent member of the English String quartet until 1915, and this experience of chamber music was valuable to him as conductor and composer. As a symphonic and operatic conductor he was much respected, but was musically and personally perhaps too fastidious to attain wide recognition. As a composer, his activity was almost lifelong: he won a composition scholarship in 1899 and remained consistently productive until his death (at Eastbourne, Sussex, Jan. 10, 1941). Although he worked freely in all branches of composition, it was in the smaller forms, such as the Phantasie Quartet for piano and strings of 1910, and in numerous songs and piano pieces, that he was most successful. His music was widely performed and shows great technical skill and the effectiveness that comes from practical insight into problems of performance, although he seldom achieved a personal style. In a busy life he sometimes found time to teach, and among his pupils was the schoolboy Benjamin Britten. (TH. A.)

BRIDGE, a name applied to each of three card games, bridge whist, auction bridge and contract bridge, derived from whist (*q.v.*). The essential features of these games, as of whist, are: four persons play, two against two as partners; a full 52-card pack is dealt out one at a time clockwise around the table so that each player holds 13 cards; the object of play is to win tricks, each trick consisting of one card played by each player. Another feature is that one suit may be designated as the trump suit (*i.e.,* any card in that suit will take any card of the other suits), but the methods of designating the trump suit (or of determining that a hand will be played with no-trump suit) differ, as explained below.

Since about 1896 these games have successively been the principal intellectual card games of the English-speaking countries. The third game of the series, contract bridge, spread throughout the world and in some respects constituted a social phenomenon unparalleled in the history of games. By the second half of the 20th century there were an estimated 50,000,000 players of contract bridge in all civilized countries, constituting about equal numbers of men and women, at least half of them in the United States. The literature of the game comprised more than 9,000 volumes and at least 100 periodicals were published in 17 countries and 13 languages. There were at least 5,000 clubs devoted to the game. International bridge competitions were treated with as much gravity as that accorded the Olympic or other athletic games.

This article is divided into eight broad sections dealing with the principal aspects of bridge. A summary of bridge laws is presented below, and a table lists conventional contract bridge leads. Following are the main divisions of this article:

I. The Bridge Games
    1. Bridge Whist
    2. Auction Bridge
    3. Contract Bridge
II. How to Play Contract and Auction Bridge
    1. The Deal
    2. The Auction
    3. The Play
III. Scoring
  A. Contract Bridge Scoring
    1. Vulnerability
    2. Undertrick Penalties
    3. Honours
    4. Slams
    5. Unfinished Rubber

- B. Auction Bridge Scoring
- IV. The Development of the Game
    - 1. Development of Auction Bridge
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- V. Party, Duplicate and Tournament Bridge
    - A. Party Bridge
        - 1. Pivot Bridge
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        - 3. Scoring
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    - C. Tournament Bridge
- VI. Laws of Bridge
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    - A. Bidding Systems
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        - 1. Valuation
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        - 5. Choice of Suits
        - 6. Responses
        - 7. Responses to Suit Bids of One
        - 8. Responses to Suit Bids of Two
        - 9. Responses to Pre-emptive Bids
        - 10. Responses to a One No-trump Bid
        - 11. Responses to a Two No-trump Bid
        - 12. Responses to a Three No-trump Bid
        - 13. Rebids by Opening Bidder
        - 14. Rebids by Opening No-trump Bidder
        - 15. Defensive Bidding
    - C. Slam Bidding
        - 1. Blackwood Convention
        - 2. Gerber Convention
        - 3. Cue Bidding
        - 4. Four-Five No-trump Convention
        - 5. Asking Bids
    - D. Other Bidding Systems
        - 1. Two-club System
        - 2. British (Acol) System
        - 3. Italian Systems
        - 4. French System
        - 5. Roth-Stone System
    - E. Leads
- VIII. Bridge Problems
    - 1. The Whitfield Six
    - 2. Vienna Coup

I. THE BRIDGE GAMES

The first game of the series was originally called simply bridge, but is now called bridge whist to distinguish it from the two later games. Upon its introduction to New York in 1893 and to London in 1894 it almost immediately supplanted whist in the card rooms of men's clubs and before 1900 it was the favourite diversion of fashionable mixed gatherings. Bridge whist was itself supplanted with almost equal rapidity by auction bridge, which was introduced in England about 1904 and which became, from 1907 to 1928, the most universally popular card game theretofore known. Auction bridge had at least 15,000,000 adherents when in 1930 it became secondary to contract bridge.

Though contract bridge won and greatly extended the popularity of auction bridge, it did not entirely replace auction bridge. A survey in the 1950s indicated that there then remained about 5,000,000 auction-bridge players in the United States. Bridge whist, however, had been obsolete since 1910.

1. Bridge Whist.—In bridge as in whist there are four players in two partnerships, each player being dealt 13 cards. But in whist there is always a trump suit, determined by turning up the last card dealt to the dealer, and each player holds and plays his own hand. The principal innovations of bridge whist were: selection of the trump suit by the dealer or his partner, after they saw their hands; the option of playing at no-trump; the exposed dummy (the hand of dealer's partner), which was played by the dealer; a different method of scoring; and the right to double (the scoring values).

In bridge whist, after the cards were dealt, the dealer could make the declaration (name any suit as trump, or decide to play without any trump); or he could transfer this duty to his partner. Before leading the player on the dealer's left (eldest hand) could double, or could pass that privilege to his partner; and if either doubled, dealer or his partner could redouble, and so the redoubling might continue indefinitely (except that many clubs placed a limit upon the number of doubles).

The player on the dealer's left then led. Dealer's partner, called the dummy, placed his entire hand face upward on the table in front of him and dealer played both his own cards and dummy's, from each hand in proper turn. Otherwise play was as at whist.

The side that won the majority of the tricks scored, for each odd trick (trick over six): if spades were trumps, 2 points; clubs, 4; diamonds, 6; hearts, 8; no-trump, 12; these values doubled and redoubled as previously determined. The first side thus to score 30 or more points won game, and a fresh game was begun. The first side to win two games won rubber and received a 100-point bonus. Other bonuses, which did not count toward game, were scored by a side holding three or more honours (ace, king, queen, knave (jack) and ten of the trump suit, or, at no-trump declarations, three or more aces; for making slams (12 or 13 tricks won); and for chicane (a player's holding no card of the trump suit).

2. Auction Bridge.—The essential feature added by auction bridge was that all four players bid for the right to name the trump suit and that the high bidder or his partner (not necessarily the dealer) became declarer and played the dummy's hand. In other respects the procedure at auction bridge underwent constant and frequent change (see *Laws of Bridge*, below).

3. Contract Bridge.—In its mechanics contract bridge differs from auction bridge only in the scoring. At auction bridge declarer's side scores toward game each odd trick that it wins, whether or not it contracted to win such a trick. At contract bridge, the odd tricks won by declarer cannot be scored toward game unless declarer's side previously contracted to win those tricks. Values of tricks, penalties and premiums are higher in contract than in auction bridge, and large bonuses are awarded for bidding and making slam contracts. See *Scoring*, below.

II. HOW TO PLAY CONTRACT AND AUCTION BRIDGE

The full pack of 52 cards is used, the suits ranking downward in order: spades, hearts, diamonds, clubs; and the cards ranking downward in order: ace (A), king (K), queen (Q), knave or jack (J), 10, 9, 8, 7, 6, 5, 4, 3, 2.

Four play, two against two as partners, who face each other across the table. To determine partners a pack may be spread face down and each player draws a card (not valid are one of the four cards at either end). The players drawing the two highest cards play as partners, the highest having choice of seats and cards (when two packs are used) and becoming the first dealer.

If five or six wish to play in the same game, the draw establishes precedence: A player lowest in order of precedence sits out until the end of the first rubber, when he replaces the next lowest in the order. If two players draw cards of the same rank, the card of the higher-ranking suit takes precedence over the other.

1. The Deal.—The player at dealer's left shuffles the cards. Preferably two packs are used so that one may be shuffled while the other is being dealt. Dealer transfers the shuffled pack to his right, where his opponent cuts it into two packets, each containing at least five cards. Dealer completes the cut.

The rotation in contract bridge is always from player to player to the left. Dealer deals the cards in rotation, one at a time face down, the first card to the player at his left and the last card to himself, so that each player's *hand* (cards received for one round) has 13 cards.

2. The Auction.—The deal completed, each player in rotation beginning with dealer has a chance to call. A call is a pass, a bid, a double or a redouble.

A pass signifies disinclination to contract to win any number of tricks.

A bid contracts to win a specified number of odd tricks with a specified trump or at no-trump. Thus, a bid of one heart assumes a contract to win seven tricks with hearts as trumps; a bid of one no-trump, seven tricks with no-trump suit. The highest possible bid is seven, a contract to win all 13 tricks.

Each successive bid must overcall, that is, be higher than, any preceding bid. It must name a greater number of odd tricks, or the same number of odd tricks in a higher-ranking suit. In the auction, no-trump is highest ranking. Thus, two no-trump will overcall a bid of two in any suit but may be overcalled by three clubs or any higher bid.

A player may double the last preceding bid if it was made by an opponent and has not previously been doubled. A player may redouble the last preceding bid if it was made by his own side, doubled by an opponent and not previously redoubled. A bid may be overcalled as usual whether or not it has been doubled or redoubled.

Each time a player's turn comes in rotation, he must make a call and he may not change that call once it is made. A call out of rotation, or a change of calls, is subject to penalty (see *Laws of Bridge*, below).

The auction continues until any call is followed by three consecutive passes. If there was no bid, the next player in rotation deals. If any bid was made, the highest bid becomes the contract. The suit (if any) named in the contract becomes trump. The contractor who first named that suit (or no-trump) becomes declarer. His opponents become defenders. The auction period is ended and the play period commences.

3. The Play.—The object of play is to win tricks. A trick consists of four cards, one played from the hand of each player in rotation. The first card played to a trick is the lead.

The defender at declarer's left leads to the first trick. Declarer's partner then spreads his hand face up before him on the table, grouped in suits with the trumps, if any, to his right; this player, and his hand, are dummy. Declarer plays both his own cards and dummy's; but each in proper turn.

Each player in rotation must follow suit to the card led (play a card of the same suit, if he has one). If unable to follow suit he may play any card, including a trump, if he wishes. A trick containing any trump is won by the highest trump; any other trick is won by the highest card of the suit led. One member of each side gathers in all tricks won by his side, turns them face down, and keeps them separated sufficiently to make their number and sequence apparent. The winner of each trick leads to the next.

When all 13 tricks have been played the result is scored. The next dealer in rotation deals a new hand.

III. SCORING

A. CONTRACT BRIDGE SCORING

Each player is entitled to keep a score; it is preferable for one member of each side to keep a score. Scores are entered on a score sheet (U.S.) or bridge block (British). Scores earned by the scorekeeper's side go to the left of the vertical line (conventionally designated "We"), scores earned by his opponents, to the right (designated "They"). Below the horizontal line is the trick score, and above the line is the honour score.

Provided declarer's side has at least fulfilled its contract, it scores, for each trick over six:

If trumps were

♤ or ♡	♢ or ♧		no-trump
30	20	for the first odd trick	40
30	20	for each subsequent odd trick	30

Such of these tricks as were included in the contract go in the trick score; the value of additional tricks (overtricks) goes in the honour score. If the contract was doubled, trick points scored below the line count twice their normal value, while overtricks count 100 each above the line if declarer's side was not vulnerable (a term explained below) and 200 points each if declarer's side was vulnerable. If the contract was redoubled, these values are again multiplied by two. A side fulfilling any doubled or redoubled contract receives also a bonus of 50 points on its honour score.

When either side has scored 100 or more trick points below the line (whether they were scored in one or more hands), it wins a game. Another horizontal line is drawn across the score sheet, below the trick score, to signify the end of the game, and a new game is begun. Only trick scores count toward game, all other points score above the line.

When either side has won two games, it wins the rubber and receives a bonus of 700 if its opponents have not won a game, or 500 if its opponents have won a game. All the trick and honour points of each side are totaled, and the side with the higher total wins the difference from its opponents' score. For purposes of settlement or of keeping a running score, this difference is usually reduced to the nearest 100, a difference of 50 or more counting as 100 and a smaller portion of 100 being disregarded. After each rubber there may be a new draw for partners, seats and deal.

1. Vulnerability.—When a side has won a game it is said to be vulnerable and is exposed to heavier undertrick penalties but receives larger bonuses for overtricks at doubled and redoubled contracts, and for slams. Vulnerability also may be determined by rotation (see *Kinds of Bridge*, below).

2. Undertrick Penalties.—If declarer fails to fulfill his contract, his opponents score for each trick by which he falls short ("goes down," or "is set"):

	If declarer were:					
	Not vulnerable			Vulnerable		
	Undbld.	Dbld.	Redbld.	Undbld.	Dbld.	Redbld.
1st undertrick	50	100	200	100	200	400
Each subsequent undertrick	50	200	400	100	300	600

3. Honours.—The ace, king, queen, knave (jack) and ten of the trump suit are honours. If any player holds four trump honours in his hand, his side scores 100 above the line; if any player holds all five trump honours, or all four aces at a no-trump contract, his side scores 150.

4. Slams.—For bidding and making a contract of six (little slam or small slam) a bonus of 500 is scored if not vulnerable, 750 if vulnerable. For a grand slam (all seven odd tricks) bid and made, the bonus is 1,000 if not vulnerable, 1,500 if vulnerable. A side bidding six and making seven scores only the small-slam bonus plus one overtrick. A side bidding seven and making only six has not fulfilled its contract and its opponents score an undertrick penalty.

5. Unfinished Rubber.—If a player has to leave before the rubber is completed, and no satisfactory substitute is available, a siding having the only game scores 300 points; a side having the only part score (trick score of less than 100) in an unfinished game scores 50.

B. AUCTION BRIDGE SCORING

If declarer's side has won at least as many odd tricks as it bid for, it scores below the (horizontal) line for each odd trick won: if clubs were trumps, 6; diamonds, 7; hearts, 8; spades, 9; no-trump, 10. This trick score is multiplied by two if the contract was doubled, by four if it was redoubled.

A game ends when one side has scored 30 or more trick points. A rubber ends when one side has won two games, and that side receives a bonus of 250 points.

If declarer's side has not fulfilled its contract, its adversaries score 50 points for each undertrick (100 at a doubled contract, 200 at a redoubled one). These points go into the honour score and do not count toward game. Other entries in the honour score are:

For holding three of the honours (A, K, Q, J and 10 of the trump suit, or the aces at no-trump), 30 points; four honours, divided between the declarer's and his partner's hands, 40; five honours, divided, 50; four trump honours in one hand, 80, or 90 if partner holds the fifth; five trump honours in one hand or all four aces at no-trump, 100. For winning 12 tricks (little slam, or small slam), 50; for winning all 13 tricks (grand slam), 100. These scores are credited to the side earning them, regardless of who is declarer.

If declarer fulfills a doubled contract, he receives a bonus of 50 points plus 50 points for each odd trick he wins above his contract (100 points in each case at a redoubled contract). These go in the honour score.

The side that has scored the greater total of honour plus trick points wins the rubber, whichever side has won two games.

IV. THE DEVELOPMENT OF THE GAME

Bridge was probably born of three-hand whist games. Inveterate whist players, unwilling to forego their game merely because there were only three available players, played a game called "dummy" (with one hand exposed) long before any bridge game was known or willingly played.

The origin of bridge whist is not definitely known, but a similar game appeared in Constantinople before 1870, under the name Khedive, and almost the same game had been played in Greece before that. Khedive, whose name had for some reason become Biritch, was played on the French Riviera in the 1870s. A pamphlet entitled *Biritch,* or *Russian Whist,* was issued in London in 1887 and very nearly described bridge whist. There is a story that Ludovic Halévy, in 1893, tried to persuade some whist-playing friends in Paris to play bridge with him, but they refused. In the same year, however, it was played at the Whist club of New York, and in 1894 Lord Brougham, penalized for failure to turn the last (trump) card in a whist game at the Portland club, apologized with the excuse that he forgot he was not playing bridge, "the finest card game ever introduced."

Whist players were prompt to deplore the arrival of bridge, almost unanimously asserting that whist, with all four hands hidden, was far more scientific than bridge. The fallacy of this soon became apparent, for exposure of the dummy provided clarity in thousands of situations in which the whist player had had to guess blindly. This provided new opportunities for analysis and greatly stimulated the study of skilful play. By 1897 almost all the leading whist players had succumbed to the attractions of the new game, and even "Cavendish" (Henry Jones, *q.v.*), who had refused for a period in 1897–98 to enter the Portland club because whist had been all but abandoned there, was converted to bridge before his death in 1899.

Bridge whist was the first game of the whist family to appeal to women as much as to men. It quickly became the favoured game of the fashionable world but did not supplant euchre and the other card games among the middle and lower classes, as auction bridge did later.

1. Development of Auction Bridge.—Several accounts of the origin of auction bridge have been advanced. It is probable that just as bridge whist developed from three-hand whist, auction bridge developed from three-hand bridge whist. A letter in the *Times* (London), Jan. 16, 1903, signed by Oswald Crawfurd, describes "auction bridge for three players." A book by "John Doe" (F. Roe), published in Allahabad, India, in 1904, presents three-hand auction bridge as an invention of Roe and two other members of the Indian civil service when, at an isolated post, they had no "fourth" for bridge whist. Experimental games in England and America apparently followed immediately on the publication of the Crawfurd letter, for by 1904 the best club players were turning to auction bridge. The Portland club adopted auction bridge in 1907, the Whist club and other American clubs in the two years following. By 1910 bridge whist was all but obsolete and auction bridge was virtually the only card game played by fashionable society and its emulators.

The widespread appeal of auction bridge is attributable partly to the character of the game, partly to the social conditions into which it was born. The science of auction bridge was more complex and more nearly inexhaustible than that of any previous game, creating a demand for large numbers of instructors in skilful play. The instructors, as a professional class, served as proselytizers. Concurrently, the rapid growth of the leisure class increased the demand for means for the entertainment of guests, and auction bridge was found to fill this need ideally. The gradual relaxation of church opposition to cardplaying, but not to gambling, stimulated acceptance of auction bridge, a game most often played without stakes and never for high stakes in the sense that gambling games are.

2. Development of Contract Bridge.—This game was developed almost concurrently with auction bridge but was slower to win popularity. At least as early as 1915, auction-bridge players tried a variant in which one could score toward game only the odd tricks he had bid for. The committee on laws of the Whist club considered incorporation of this principle into the auction-bridge laws in 1917 and again in 1920. They refrained in both instances because they thought such a difficult game would compromise the popularity of auction bridge.

A French game called plafond, embracing the same principle as contract bridge, was played in Paris in 1918. From about 1922 to 1931 it was more popular than auction or contract bridge in most of the French and Belgian clubs. It was barred from the New York clubs because of the opposition of the auction-bridge authorities.

In the middle 1920s there was a growing demand for faster and higher-scoring games that provided higher-stake gambling. This spirit was responsible for the introduction into auction bridge of the "goulash" or "mayonnaise" deal: when all four players passed, their hands, unshuffled, were stacked and dealt five and three cards at a time to produce more unusual hands and more daring bidding. The atmosphere was still more conducive to adoption of a higher-scoring game.

Harold S. Vanderbilt of New York was one of the expert auction-bridge players who had experimented with contract bridge. In the early winter of 1926, voyaging by sea from the Pacific coast to New York through the Panama canal, he played in plafond games on shipboard. In the course of these games he devised a new schedule of scoring values, multiplying auction-bridge values five times or more; large slam bonuses; and the factor of vulnerability. (With minor changes this became and remained the contract-bridge scoring schedule.) By 1927, this scoring schedule had made contract bridge popular; by 1928, contract bridge had all but supplanted auction bridge among the leading American players and was widely played in English clubs; by 1929 it had become the standard club game on both sides of the Atlantic, though in France it did not fully replace plafond until 1934.

Until 1931 most of the casual players, constituting a great majority, continued to play auction bridge. The publicity whereby contract bridge found its way to such players was supplied by another of the former auction-bridge experts, Ely Culbertson of New York. Culbertson established contract bridge as the leading card game and himself as its principal authority by a succession of tournament victories and by various maneuvers devised to publicize contract bridge and Culbertson personally. In 1930 Culbertson's teams won nearly every one of the principal American tournaments, then went to England and defeated three leading British teams, including one headed by Lieut. Col. Walter E. Buller, who was then and until his death in 1937 the most vociferous proponent of British bridge (permitting no conventional signals in bidding). In the winter of 1931–32 Culbertson and his wife, Josephine Culbertson, played and defeated in a 150-rubber match one of the most prominent players among the former auction-bridge authorities, Sidney S. Lenz. The progress of the match, called by American newspapers "the bridge battle of the century," was featured for more than a month on their front pages. The Culbertsons won by 8,980 points. The unprecedented publicity made contract bridge a fad not only in the U.S. but also in South American and European countries.

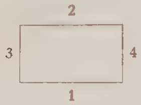
By 1935 the white heat of the fad had cooled. Nevertheless the sales of books and playing cards for contract bridge increased steadily. Periodicals devoted to contract bridge were still published throughout the world. The 800 bridge clubs that New York had known in 1932 had dropped to 400 in 1935 and to 200 in 1955, but nearly all were profitable enterprises whereas few of the larger numbers had been. The 4,000 or more professional teachers in the 1930s dropped to 1,000 by the 1950s, but almost all of the latter were successful professionally. When one young married couple went to have dinner with another young married couple, it was still probable that after dinner they would play bridge. Contract bridge had settled down to a quiet but substantial role in the lives of people throughout the world. By 1938 its function as such was acknowledged. By the second half of the 20th century it had become so commonplace that it was no longer a remarkable phenomenon. The number of bridge players continued to increase in almost direct proportion to the growth of population. Two-thirds of all U.S. and British newspapers carried regular articles of contract-bridge instruction. Throughout the 1950s and into the 1960s about 200 new books on bridge were published each year, and of new and old books combined about 1,000,000 copies were sold each year in the U.S., about 150,000 in Great Britain.

V. PARTY, DUPLICATE AND TOURNAMENT BRIDGE

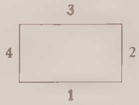
Contract bridge is the game most often used for the entertainment of guests and for card parties. Often the group merely forms separate tables of contract bridge, and the games progress independently without any attempt to make a tournament. Pivot bridge provides an arrangement whereby four or five players can be assured that each will play at least once as the partner of each other. Progressive bridge is the favoured American method for social gatherings of 16 to 40 players. More serious players play duplicate bridge.

A. Party Bridge

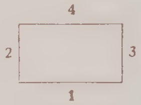
1. Pivot Bridge.—When there are four players, they cut as usual for partners and play three rubbers as follows:



1st round

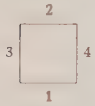


2nd round

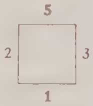


3rd round

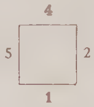
Five players cut for precedence, no. 1 being highest and no. 5 lowest. They play five rubbers as follows:



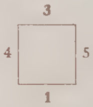
5 out



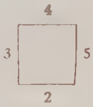
4 out



3 out



2 out



1 out

These schedules cause each player to have each other player once as his partner, once as his right-hand opponent and once as his left-hand opponent, and each player sits out one round in turn. When time permits, the process may be repeated after a full round is completed.

2. Progressive Bridge.—This game is played with either contract or auction bridge scoring. There should preferably be equal numbers of ladies and gentlemen, and each pair should consist of one member of each sex; but this is not essential. The tables are numbered consecutively, table 1 being the head of the room. Prior to the game, the hostess or game director prepares tally cards in two contrasting colours, marking one tally of each colour with a table number and pair or couple number, there being two couples for each table. As guests arrive, the gentlemen draw tallies of one colour, the ladies draw the other colour, and thus the original partnerships and seats are determined by lot.

A signal is given to commence play, and four deals are played at each table. Players deal in rotation, drawing for the first deal. If a deal is passed out it passes to the dealer on the left. On the first deal, neither side is vulnerable; second and third deals, dealer's side only is vulnerable; last deal, both sides vulnerable. Each player enters his own and his opponents' totals for the round, in the places provided on his tally. The couple with the higher total for the round moves to the next lower-numbered table, and the other pair remains. Partners are exchanged and a new round is begun. At table 1, the head table, the winning pair remains seated and the losing pair moves to the highest-numbered table.

3. Scoring.—In progressive contract bridge, for making game (100 or more trick points) in one hand, a bonus of 300 points is scored when not vulnerable, 500 when vulnerable. For making any contract of less than game, there is a bonus of 50 points. Rubber bonuses are not scored. Other scoring is as in regular contract bridge, but no score higher than 1,000 points may be counted in any one deal, except by bidding and making a slam.

In progressive auction bridge, there is a bonus of 125 for making game in one hand. Lower trick scores receive no bonus and do not carry over to the next deal.

4. Progressive Rubber Bridge.—This is the same game except that six deals are usually played in each round and rubbers are scored instead of bonuses for games and part scores. The game may be interrupted at the end of any round and the net scores of all players computed to determine the winner. The laws of the game require that each player subtract his opponent's points from his own to determine his net total, plus or minus. As most people play, however, the opponents' scores are disregarded and the highest-scoring player has won, no matter how many points have been scored against him.

B. Duplicate Bridge

The purpose of duplicate bridge is to eliminate, as nearly as possible, the element of luck from the game. After the usual deal and auction, the four players in playing their cards do not gather them up as tricks; instead, each shows the card he plays, then turns it down and keeps it on the table in front of him. After the result of the play has been ascertained and scored, the four hands in their original form are placed in a duplicate board, or tray, which is a rectangular container having four pockets, one for each hand. This board is then passed on to another table, where it is played by four other players. Thus it is possible to compare results made with identical cards, the conclusion being that the pair making the higher score must have been more skilful.

1. Scoring.—The result of each deal at duplicate contract bridge is first scored as in regular contract bridge, with these exceptions: there are no rubber bonuses; when declarer's side fulfills a game contract it receives 300 points if not vulnerable, and 500 points if vulnerable. For a trick score of less than 100 points the bonus is 50 points regardless of vulnerability. The bonuses for honours held in one hand are not scored in match point play (*see* below).

Dealer and vulnerability are assigned by the markings on the duplicate board. Sixteen such boards comprise a full set; and although approximately 30 boards are usually played in one session, the series from 17 . . . 32, 33 . . . 48, etc., are respectively identical to the series 1 . . . 16. North is dealer on board 1, east on board 2, and so on in rotation. Neither side is vulnerable on boards 1, 8, 11, 14; north-south only are vulnerable on boards 2, 5, 12, 15; east-west on boards 3, 6, 9, 16; and both sides on boards 4, 7, 10, 13.

Total point, or cumulative, scoring is used in matches between two teams of four and sometimes in pair contests. The team or pair scoring the greatest number of points is the winner.

Match-point scoring is used in all individual contests, most pair contests, and most team-of-four contests in which more than two teams compete. Each pair's (or team's) score for a board is compared with the scores made on that board by all other pairs that played precisely the same hands. A pair receives 1 match point for every such comparison in which it has the higher score, ½ match point for the same score. The pair or team amassing the most match points during the session is the winner.

The European system of match-point scoring in team matches combines the total-point and match-point ideas. This system has been widely adopted in the United States. A team scores international match-points (IMP), in proportion to its margin of victory on each board, thus:

International Match-Point Scale

The difference in scores on each deal is converted into match-points on the basis of the scale below:

0–10 = 0
20–40 = 1
50–80 = 2
90–120 = 3
130–160 = 4
170–210 = 5
220–260 = 6
270–310 = 7
320–360 = 8
370–420 = 9
430–490 = 10
500–590 = 11
600–740 = 12
750–890 = 13
900–1090 = 14
1100–1290 = 15
1300–1490 = 16
1500–1740 = 17
1750–1990 = 18
2000–2240 = 19
2250–2490 = 20
2500–2990 = 21
3000–3490 = 22
3500–3990 = 23
4000 and plus = 24

2. Movements.—The first schedule for conducting pair contests at duplicate whist was devised by John T. Mitchell of Chicago, Ill., in 1892, and is still the most popular method of duplicate play for relatively small groups (8 to 40 pairs). The Mitchell movement requires half the pairs to be assigned to north-south seats and the other half to east-west seats. A set of boards is placed at each table, shuffled and played; thus, with 18 pairs at 9 tables playing 27 boards, boards 1, 2, 3, would start at table 1, boards 4, 5, 6 at table 2, and so forth. When a round is completed, each east-west pair moves to the next higher-numbered table (and from the highest-numbered table to table 1) while each set of boards is moved to the next lower-numbered table. North-south pairs retain their seats. When all pairs have played all boards, the game ends. With an even number of tables, a relay stand must be used; it serves as a table in the rotation of the boards. Thus, with eight tables, boards 13, 14, 15 would be placed on the relay stand and not on table 5; no boards would be placed on table 8; and tables 8 and 1 would share the same boards in each round, one set always being out of play on the relay stand and, at the end of the round, moving to the next lower-numbered table.

When the Mitchell movement is used, there must be two independent winners, for the scores of the north-south pairs are compared only with the scores of other north-south pairs, and the same is true of the east-west pairs. Therefore Edwin C. Howell of Boston, Mass., devised, and published in 1897, a circulating movement for pair contests. This permits each pair to play against each other pair once during the session. The Howell schedules are good for as many as 16 pairs, but the use of printed guide cards is necessary to direct the movement of the pairs and boards.

In large tournaments, when more than 50 teams of four, or 150 pairs, often play through two, three or four sessions to determine the winner, far more complex schedules are required.

C. TOURNAMENT BRIDGE

The idea of duplicate play achieved great popularity in the United States after Cassius M. Paine and J. L. Sebring patented the duplicate tray in 1891. Duplicate auction bridge became similarly popular in the 1920s, and championship tournaments were played regularly, but the game did not spread to Europe until contract bridge had arrived. The international matches between American and British teams in 1930 so stimulated interest that nearly all serious students of contract bridge took up duplicate play within the next two years. From 1934 until war and the threat of war interrupted them, national and European championships were held annually, the latter attracting teams from as many as 17 different countries. In 1947, international play was resumed.

In the U.S., championship tournaments at auction bridge were conducted by the American Whist league, 1924–35, the American Bridge league, 1927–37, and the U.S. Bridge association, 1933–37. Also there was an annual team-of-four tournament for the Harold S. Vanderbilt cup, the first trophy given (1928) for a national championship at contract bridge. In 1937 all came under the control of a new, consolidated association, the American Contract Bridge league (A.C.B.L.). Its membership grew from 9,000 in 1940 to more than 70,000 by the 1970s, and its principal tournaments attracted 4,000 or more players twice a year.

Similar contests were held annually in Great Britain by the British Bridge league, founded in 1932, and European championships were conducted by the European Bridge league, founded the same year. These tournaments continued through 1937 and were resumed in 1946.

International matches were played by an American team against three British teams in 1930; by American teams, against British teams in 1933 and 1934 for a trophy given by Charles M. Schwab of New York; and by an American champion team against a French team, European champions, in 1935. The American teams won all these matches. In 1937, two American teams competed in the last prewar tournament of the European Bridge league. Also entered were teams representing Austria, Belgium, Czechoslovakia, Denmark, Estonia, Finland, France, Great Britain, Hungary, the Netherlands, Norway, Romania, Sweden and Yugoslavia. Austria won, with America second. Other prewar European champions were: Austria, 1933; Hungary, 1934; France, 1935; Austria, 1936.

In 1950 the U.S. resumed international play in a match at Bermuda among champion teams of the United States, Great Britain and Europe (represented by Sweden). The U.S. won and the Bermuda bowl given as a trophy for victory remained the emblem of the world championship. From 1952 through 1957, an annual match was played between the champion team of the American Contract Bridge league and the European Bridge league; in 1958 the champion team of the South American Bridge federation was admitted, to make a three-cornered match.

At the annual tournament of the European Bridge league held at Oslo in 1958 a World Bridge federation was formed, to control the world-championship matches as previously played and to conduct an olympiad world championship open to all continents and countries beginning in 1960 and renewable each four years thereafter and, in olympic years, replacing the international team matches for the Bermuda bowl. Twenty-nine nationals from all six continents took part in the first world bridge olympiad, at Turin, Italy. Six teams reached the finals which were won by the French team. The British team finished second, United States teams third, fourth and fifth, and the Italian team sixth. Fourteen countries were represented in the concurrent first world olympiad event for women's teams, won by the United Arab Republic. France finished second, Denmark third, Great Britain fourth and the United States fifth.

Teams in international competition have six players each, of whom four play at a time, plus a nonplaying captain. Scoring of matches is by international match points (*see* above). Finalists and winners since 1950 are shown below.

Year	Finalists	Winner
1950	U.S., G.B., Sweden	U.S.
1951	U.S., It.	U.S.
1952	Postponed	
1953	U.S., Sweden	U.S.
1954	U.S., France	U.S.
1955	U.S., G.B.	G.B.
1956	U.S., France	France
1957	U.S., It.	Italy
1958	U.S., Arg., It.	Italy
1959	U.S .. Arg., It.	Italy
1960*	U.S., G.B., France, It.	France
1961	It., Arg., France, U.S.	Italy
1962	It., Arg., G.B., N. Amer.	Italy
1963	It., Arg., France, N. Amer.	Italy
1964*	It., G.B., U.S., Can.	Italy
1965	It., G.B., Arg., N. Amer.	Italy
1966	It., N. Amer., Venez., Neth., Thai.	Italy
1967	It., N. Amer., Venez., France, Thai.	Italy
1968*	It., U.S., Neth., Can.	Italy
1969	It., U.S., Braz., France, For.	Italy
1970	U.S., For., It., Braz., Nor.	U.S.

* World Bridge Olympiad.

See also SPORTING RECORD.

VI. LAWS OF BRIDGE

As descendants of whist, the several bridge games have always had more detailed laws than those of any other nonathletic game except chess. The Portland club of London and the Whist club of New York became traditionally the lawmaking bodies for rubber auction bridge, the game played chiefly in clubs and private homes. With the rise of duplicate and tournament bridge in the 1930s and '40s, the A.C.B.L. and the European Bridge league became predominant in lawmaking.

The Portland club adopted a code of laws for bridge whist in 1895, the Whist club a different code in 1897. The Whist club's laws were revised in 1902, the Portland club's never. In 1909 the Portland club published the first code of laws for auction bridge (revised 1914, 1924, 1928), and in 1910 the Whist club published its first auction-bridge laws (revised 1912, 1913, 1915, 1917, 1920, 1926). After 1910 auction bridge was never officially played under identical laws in Great Britain and elsewhere. Under the American laws, a bid of (for example) three in any suit would overcall a bid of two in any suit. Under British laws, a bid of one no-trump, worth 12 points, would overcall a bid of five spades, worth $5 \times 2 = 10$ points. The American principle prevailed, and by 1930 had become universal.

The scoring values were changed several times in both countries. At first the scoring was as it had been in bridge whist. Then for a time the game was called royal auction because the spade suit had alternative values: a player might bid either spades, worth 2 points per trick, or royal spades (in the U.S. often called "lilies"), worth 9 points per trick. The same suit would be trumps in either case, but the declarer's profit or risk would depend on which scoring value he had established by his bid. The count for chicane was dropped after the first few years.

The first laws of contract bridge were published by the Knickerbocker Whist club of New York in 1927, but when later in the same year the Whist club issued a code the Knickerbocker laws were withdrawn. The Portland club issued a code in 1929. In 1932 representatives of the Portland and Whist clubs met and agreed on the first International code, to which the Commission Française du Bridge subscribed. Since then, except for a 1941 American code (published 1943) issued unilaterally because the European correspondents were at war when it was written, every code has been international, and the revisions of 1948 and 1949 were promulgated by the A.C.B.L. and the European Bridge league, to which the Whist club and Portland club had ceded their claims of prerogative.

Among all contract-bridge players and nearly all auction-bridge players, irregularities are rectified or penalized under the 1948–49 code, which is summarized below.

Summary of Bridge Laws

New Deal.—There must be a new deal if it is ascertained before the last card is dealt:

1. That the shuffle, cut or deal was irregular.
2. That a card was faced in the pack or elsewhere.
3. That the deal is out of turn (provided some player demands a new deal).
4. There must be a new deal if it is discovered before the first call is duly made, that one player has picked up and looked at the wrong hand.
5. There must be a new deal if it is discovered at any time before the cards are mixed together that one player has too many cards, another player too few; or that the pack is imperfect (contains the wrong number of cards, or a duplication of cards).

When there is a new deal, the same dealer deals again (unless he was dealing out of turn) with the same pack, and there is a new shuffle and cut.

Penalty Cards.—A card improperly exposed during the auction and play periods may become a penalty card. No card of declarer's or dummy's may become a penalty card. A defender's penalty card must be left face upward on the table and must be played at his first legal opportunity (subject to his duty to follow suit and to comply with any other penalty that declarer is permitted by the laws to impose.)

Card Exposed During the Auction.—One exposed card, if lower than a knave, may be picked up without penalty; but two low cards, or a knave or higher card, or any card prematurely led, becomes a penalty card.

Lead Penalties.—If declarer has led from the wrong hand, he may be required to lead a card of the same suit from the correct hand (if it has such a card). If a defender leads out of turn, the card so led may be treated as a penalty card or the offender's partner may be forbidden (by declarer) to lead a card of that suit.

Barred Player.—When during the auction a player makes an irregular call, his partner may in certain cases be barred. A player barred for one round must pass in his next turn; a player barred from the auction must pass at every turn thereafter.

Reviewing the Previous Calls.—In his turn to call, a player may ask to have all previous calls restated (preferably by an opponent).

Slip of the Tongue.—If corrected practically in the same breath, there is no penalty. This does not sanction a change of mind. If a player makes two separate calls in the same turn, and permits his first call to stand, his partner is barred for one round of bidding; but the offender may substitute another call if he wishes, in which case his partner is barred until the next hand is dealt.

Insufficient Bid.—Unless the authorized opponent condones it, expressly or by making any call over it, an insufficient bid must be replaced by a sufficient bid or a pass. If the offender chooses the lowest sufficient bid in the same denomination (suit or no-trump), there is no penalty. If the offender makes any other bid, his partner is barred throughout the auction. If the offender passes, his partner is barred throughout the auction and the declarer, if he is an opponent of the offender, may require or forbid the opening lead of a specified suit.

Call Out of Rotation.—The improper call is canceled and the offender's partner is barred from the auction; unless it was a pass made before the first bid, or any call made when it was the offender's right-hand opponent's turn, in which case the offender must pass at his next turn.

Bid After the Auction Closes.—The bid is canceled, and if it was made by a defender, declarer may require or forbid the lead of a specified suit from the offender's partner at his next turn to lead.

Played Card.—A defender's card is played when his partner sees its face. Declarer plays a card when it touches the table after he detaches it from his hand with apparent intent to play. Dummy plays a card when declarer touches it, except to arrange dummy's cards. Any player plays a card when he names it as his intended play. A played card may not be taken back except to correct a revoke.

Revoke.—Failure to follow suit when able, or to comply with a penalty in leading or playing, when able. A revoke becomes established when the offender or his partner leads or plays to the next trick. If it is corrected before that, the card played in error becomes a penalty card. A revoke by dummy, or by failure to play a faced card, is not subject to penalty but must be corrected on demand before it becomes established.

A revoke on the 12th trick never becomes established but must be corrected without penalty before the cards are mixed for the next deal. For any other established revoke, the penalty is two tricks transferred to the nonoffending side and scored exactly as though won in play. The penalty tricks may be transferred only from tricks won by the offending side after the revoke occurred (including the revoke trick).

Lead Out of Turn.—If a defender leads out of turn, declarer may either: condone the lead; or forbid the lead of the same suit by the offender's partner (at his next turn, if it was not his lead at the time); or call the card led in error a penalty card. If declarer leads from the wrong hand, the authorized opponent may condone the lead or require him to lead a card of the same suit from the correct hand; declarer may then lead any card of the same suit from the correct hand and is not required to play from the other hand the card he led in error. If declarer has no card of the proper suit in the correct hand, he may lead any card from that hand.

Claim or Concession.—If declarer claims or concedes one or more tricks, he should make a statement of how he intends to play the remaining cards. If he fails to make such a statement, a defender may demand it. Declarer must play on if a defender so requires, and may not depart from his statement.

If a defender claims or concedes one or more tricks, he should show his hand to declarer only. His concession is not valid unless his partner also concedes.

A concession is void if the trick conceded could not be lost by any play of the cards.

Premature Lead or Play.—If a defender leads or plays out of rotation before his partner has played to the current trick, declarer may require the offender's partner to play his highest or lowest proper card, or to discard a specified suit.

Precedence of Obligations.—A player must follow suit if able; next, he must respond if able to a proper lead or play penalty; third, he must play a penalty card if able. If a player is unable to comply with a penalty in leading or playing, because of his duty to follow suit or because he has no card of the suit required, the penalty is deemed satisfied.

Proprieties.—"The Scope of the [Bridge] Laws" is stated, in part, as follows:

"The laws are designed to define correct procedure and to provide an adequate remedy in all cases where a player accidentally, carelessly or inadvertently disturbs the proper course of the game, or gains an unintentional but nevertheless unfair advantage . . . The laws are not designed to prevent dishonorable practice . . ."

Appended to the laws are statements of the proprieties, ethics and etiquette of the game. The principal points are covered in the following paragraphs.

The dealer should refrain from looking at the bottom card before completing the deal.

A player should refrain from varying the formula used in calling. The recommended phrases are: "Pass" (U.S.) or "No bid" (British); "One heart"; "One no-trump"; "Double"; "Redouble"; "Six spades"; etc.

Undue delay, emphasis, inflection or intonation in calling or playing should be avoided.

An intentional breach of law, even when the player is prepared to pay the penalty, is considered dishonourable conduct.

It is improper to use any method of calling whose significance is known to partner by prior agreement and which has not been fully explained to the opponents.

Partner's hesitation, remark or manner should not be permitted to influence a call or play.

A review of the previous calls or information as to the score should not be requested except for one's own information.

It is improper to watch the place in a player's hand from which he draws a card and to draw any inference therefrom.

It is proper to keep silent as to irregularities committed by one's side. It is not proper to commit a second offense (such as a revoke) to conceal a prior offense.

It is proper to draw conclusions from information gratuitously supplied by an opponent, but only at one's own risk.

It is proper to warn any player against infringing any law of the game.

It is not proper for a defender to play out of turn even if declarer has played from both hands.

VII. STRATEGY OF CONTRACT BRIDGE

The object in contract bridge is to score as many points as possible and to permit the opponents to score as few points as possible. The strategy employed by the best players in pursuit of this object embraces a technique that in complexity approaches the technique of chess; and, in addition, a scope for deductive analysis, psychology, alertness and mental ascendancy over one's opponents. Thus it is an art, which can hardly be taught or even described. The best players of the game (like the best players of bridge whist and auction bridge before them) combine unusual aptitude, interest amounting virtually to obsession, and experience derived from constant play with and against their peers.

Nevertheless the general rules, called systems, enable the casual player to emulate the expert standard in most cases. In whist, the progenitive game, the science was meagre; in bridge whist it improved; in auction bridge, the best players were competent but the literature of the game never reflected the best practices; in contract bridge, the most popular systems, if strictly followed, have produced nearly 90% efficiency.

The factors in the systems of contract bridge bidding and play are: (1) *Valuation.* The player who bids accepts danger; if unable to fulfill his contract he will be subject to penalties. Therefore he must be able to estimate the trick-taking power of his hand. (2) *Information.* Bridge is essentially a partnership game. Each partner must inform his partner as to the nature and strength of the hand he holds. Assuming such information has been given and received, one partner should be able to decide the best contract for the combined hands. (3) *Strategy.* A bid defeats its own purposes if the information it gives is more valuable to the opponents than to the bidder's partner. Therefore, ideally, each bid should be designed to inform the bidder's partner only to the extent necessary, while withholding information from the opponents.

Only a few general principles can be stated for the play of the cards, but to the extent possible they have been exhaustively treated in the literature of the several bridge games (see *Bibliography,* below). The ethics of the game permit information to be given only by the card led (see *Leads,* below) or the card played to a trick. Convention has endowed certain plays with meanings generally understood.

A. Bidding Systems

Bidding systems have preoccupied the student of bridge since the earliest appearance of contract bridge. The first system proposed was that of Harold S. Vanderbilt, who created the game that became successful as contract bridge (see *The Development of the Game,* above). The Vanderbilt Club system provided that a player with a strong hand bid one club, the lowest bid; his partner with a weak hand would bid one diamond and with a strong hand would make some other bid. Despite its technical excellence, the Vanderbilt Club system was not widely accepted. The most successful system of the first twenty years of contract bridge was devised by Ely Culbertson of New York and was called the Culbertson system or approach-forcing system. This system required a player to value his hand by a schedule of high-card combinations called honour tricks and then to bid in accordance with established requirements based on the number of honour tricks held and the length of the player's suits.

Despite competition from other systems advanced by those who had been the principal authorities in auction bridge (the official system), by leading players such as P. Hal Sims (the Sims system), and by leading teams such as the Four Aces (the Four Aces system), all during the early 1930s, the Culbertson system was paramount throughout the world until the late 1940s.

In 1949, Charles H. Goren of Philadelphia proposed a method of valuation called the point count, an extension of similar methods proposed as early as 1904 but not previously made applicable to more than a fraction of the many hands a bridge player might hold. In other respects Goren's system was similar to or identical with the methods advocated by Culbertson and the Four Aces.

(A. H. Md.)

B. The Goren System

1. Valuation.—Each player counts for the high cards in his hand: Ace, 4 points; king, 3; queen, 2; jack (knave), 1. In all there are 40 points among the four hands. A hand with 11 or more points is above average. In the combined hands of a partnership, 26 points will normally produce a game; 33 points a small slam; 37 points a grand slam.

To points for high cards add: for opening bids, 3 for a void suit, 2 for a singleton in any suit, 1 for a doubleton. When raising partner's suit, 5 for a void suit, 3 for a singleton, 1 for a doubleton.

Opening bidder adds 1 for all four aces, deducts 1 for an aceless hand. Player raising partner's bid adds 1 to the value of each honour in partner's suit unless he has already counted 4 or more for honours in that suit. Player rebidding when his partner has raised adds 1 for a fifth card in his trump suit and 2 for the sixth and each subsequent card in the trump suit.

Player raising deducts 1 point if he has only three cards in his partner's suit or if he has 4-3-3-3 distribution. Any player deducts 1 for an unguarded honour, such as Q-x, J-x, or singleton king, queen or jack (knave).

To open the bidding a player must have, besides the required number of points, at least 2 quick tricks, counted: A-K of the same suit, 2 quick tricks; A-Q, 1½; K-Q, 1; Ace, 1; K-x, ½.

2. Biddable Suits.—To name a suit in opening the bidding, a player must have a four-card suit including 4 or more points (permissible exception: Q-J-10-x), or any five-card suit. To name a suit in responding or rebidding a player must have at least Q-10-x-x, K-x-x-x, or better (four-card suits) or any five-card suit.

To rebid a suit a player must have at least a five-card suit, Q-J-9-x-x, K-Q-x-x-x, or A-J-x-x-x, or better, or any six-card suit.

3. Opening Suit Bids.—(1) 14-point hands must be opened. (2) 13-point hands may be opened if a good rebid is available, as a rebiddable suit or a second biddable suit. (3) All opening hands must contain 2 quick tricks. (4) An opening in third position (after two passes) is permitted with 11 points if the hand contains a good suit. All the foregoing are one bids.

Two Bid in a Suit.—An opening two bid in a suit is forcing to game; partner may not let the bidding die before game has been reached or the opponents have been doubled. (1) 25 points with a good five-card suit; 1 point less with two good five-card suits. (2) 23 points with a good six-card suit. (3) 21 points with a good seven-card suit.

Three, Four or Five Bid in a Suit.—Any of these is a preemptive bid, an intentional overbid to interfere with the opponents' bidding, even though the contract undertaken may be defeated. Usually it indicates no more than 10 points in high cards, but ability to win within two tricks of the contract (without help from partner) if the bidder is vulnerable and within three tricks if he is not vulnerable. Usually it is based on a good seven-card or longer suit.

4. Opening No-trump Bids.—These usually are based on 4-3-3-3, 4-4-3-2 or 5-3-3-2 distribution, with no doubleton weaker than Q-x.

One no-trump, 16 to 18 points
Two no-trump, 22 to 24 points
Three no-trump, 25 to 27 points

5. Choice of Suits.—Usually bid the longest suit first. With two five-card suits bid the higher-ranking first. With two or more four-card suits bid the four-card suit next lower in rank to the shortest suit (for this purpose, bid spades if the shortest suit is clubs). Examples:

♤ 5 ♡ K-8-4-3-2 ♢ A-7-5 ♧ A-K-Q-9
Bid one heart, the longest suit.
♤ 7 ♡ K-J-10-6 ♢ K-Q-5-3 ♧ A-K-J-3
Bid one heart, the suit immediately below the singleton.
♤ A-Q-J-5 ♡ 3-2 ♢ A-10-5 ♧ K-J-6-5
Bid one club, the first biddable suit below the doubleton. (The diamonds are not biddable.)

6. Responses.—The requirement for most game contracts is 26 points. Partner's opening bid promises at least 13 of these, but he may have more. Therefore every effort should be made to keep the bidding open so that he will have a second chance to bid. A response should be made with as little as 6 points.

One-round Forcing Bids.—The bid of a new suit by the responding hand is forcing on the opening bidder. Each time the responder bids a new suit, the opener must bid again. If responder makes a jump bid (one more than necessary), the bid is forcing to game.

Game Bids.—Assuming a satisfactory fit can be found, game (four odd tricks) in a major suit is easiest to make. The next-easiest game is three no-trump. The most difficult is game (five odd tricks) in a minor suit, requiring 28 to 29 points.

With a mediocre hand (fewer than 10 points), worth only one constructive bid, responder should prefer to raise his partner in a major suit but to bid one in his own suit, if possible, rather than raise a minor-suit bid. With 11 or 12 points, responder can make two bids without being forced but should not force to game. With 13 points or more he should see that the bidding does not stop before a game contract is reached. With 19 points he should make a strong effort to reach a slam.

7. Responses to Suit Bids of One.—*Raise.*—To raise partner's suit responder must have adequate trump support. This consists of J-x-x, Q-x-x or x-x-x-x, or better, for a non-rebid suit; and Q-x, K-x, or x-x-x for a rebid suit. Points required are: Raise to two: 7 to 10 points and adequate trump support. Raise to three: 13 to 16 points and four trumps. Raise to four: no more than 9 high-card points plus five trumps and a short suit (singleton or void).

Bid of a New Suit.—At one-level: 6 points or more (this response may be made on anything ranging from a weak hand to a very powerful one). At two-level: 10 points or more. Jump in a new suit: 19 points or more. (This jump shift is reserved for hands that make a slam very likely. Responder should hold an independent suit or strong support for opener's suit.)

No-trump Responses.—One no-trump: 6 to 10 points in high cards. Two no-trump: 13 to 15 points in high cards, all suits not bid by partner stopped (the hand can eventually win a trick in any unbid suit led by the opponents), and a balanced hand. (Forcing to game.) Three no-trump: 16 to 18 points in high cards, all unbid suits stopped, and 4-3-3-3 distribution.

8. Responses to Suit Bids of Two.—An opening bid of two in a suit is unconditionally forcing to game and responder may not pass until game is reached, no matter how weak his hand may be. With 6 points or less he bids two no-trump, regardless of his distribution. With 7 points and one quick trick or 8 points and ½ quick trick he may show a new suit or raise opener. With 8 or 9 points and a balanced hand, responder bids three no-trump.

9. Responses to Pre-emptive Bids.—A pre-emptor has overbid his hand by two or three tricks, depending on vulnerability. Primary tricks—aces and kings—and potential ruffing (trumping) values are the only factors for responder to consider when contemplating a raise. One or two trumps is sufficient support.

10. Responses to a One No-trump Bid.—*Balanced Hands.*—Raise to two no-trump with 8 or 9 points, or 7 points and a good five-card suit. Raise to three no-trump with 10 to 14 points. Raise to four no-trump with 15 or 16 points, to six no-trump with 17 to 18 points, to seven no-trump with 21 points.

Unbalanced Hands.—With fewer than 8 points plus a five-card suit in diamonds, hearts or spades, bid two in that suit. With 8 points or more and a four-card major suit, bid two clubs. This is an artificial bid asking opener to show a major suit if he has one. (See *Stayman Convention*, below.) With 10 points and a good suit, bid three of that suit. With a six-card major suit, and fewer than 10 points, in high cards, jump to game in the suit.

11. Responses to a Two No-trump Bid.—*Balanced Hands.*—Raise to three no-trump with 4 to 8 points; to four no-trump with 9 or 10 points; to six no-trump with 11 or 12 points; to seven no-trump with 15 points.

Unbalanced Hands.—With a five-card major suit headed by an honour, plus 4 points, bid three of the suit. Show any six-card major suit.

12. Responses to a Three No-trump Bid.—Raise to four no-trump with 7 points, to six no-trump with 8 or 9 points, to seven no-trump with 12 points. Show any five-card suit if the hand contains 5 points in high cards.

13. Rebids by Opening Bidder.—When bid was one in a suit the opener's rebid is frequently the most important call of the auction. It gives him his first opportunity to reveal the exact strength of his opening bid. His opening is valued accordingly:

13 to 16 points,	minimum hand
16 to 19 points,	good hand
19 to 21 points,	very good hand

Minimum Hand—13 to 16 Points.—If partner has made a weak response (one no-trump or a single raise) opener should pass, as game is impossible. (When responder has bid one no-trump, opener may rebid a new suit of lower rank—provided his distribution is unbalanced—or his own suit, even though he has a minimum hand.) If partner bids a new suit at the one level, opener may offer a single raise with good trump support, or rebid his own suit or a new suit if he does not go past the level of two in his original bid.

Good Hand—16 to 19 Points.—If partner has made a weak response (one no-trump or a single raise) opener should bid again. If responder has bid a new suit, opener may make a jump raise with four trumps, jump in his own suit if he has a six-card suit or bid a new suit.

Very Good Hand—19 to 21 Points.—If partner has made a weak response (one no-trump or a single raise) opener may jump to game in either denomination, according to his distribution. If responder has bid a new suit, opener may make a jump raise to game in a major suit with four trumps, or jump to game in his own suit if it is solid. With a balanced hand and 19 or 20 points he should jump to two no-trump, and with 21 points to three no-trump. With 22 points and up he should jump in a new suit, forcing to game and suggesting a slam.

14. Rebids by Opening No-trump Bidder.—*Stayman Convention.*—When the responder bids two clubs, the opening bidder must show a four-card biddable major suit if he has one.

With four spades, he bids two spades.
With four hearts, he bids two hearts.
With both majors, he bids two spades.
With no major, he bids two diamonds.

Opening No-trump Bidder Must Pass.—When responder raises to two no-trump and opener has a minimum (16 points). When responder bids two diamonds, two hearts or two spades and opener has only 16 or 17 points and no good fit for responder's suit. When responder bids three no-trump, four spades or four hearts.

15. Defensive Bidding.—*Overcalls.*—An overcall is a defensive bid made after the opposing side has opened the bidding. Overcalls are based not on a specified number of points but rather on a good suit. The overcaller should be able to win in his own hand within two tricks of his contract if vulnerable and within three tricks if not vulnerable.

One No-trump Overcall.—An overcall of one no-trump is similar to a one no-trump opening bid and shows 16 to 18 points with a balanced hand and with the opening bidder's suit stopped.

Jump Overcall.—Any jump overcall is pre-emptive and shows a hand weak in high cards but with a good suit that will produce within three tricks of the contract if not vulnerable and within two tricks if vulnerable.

Take-out Doubles.—When a defender doubles and: (1) his partner has made no bid; (2) the double was made at the doubler's first opportunity; (3) the double is of one, two or three of a suit; the double asks partner to bid his best (longest) suit. This defensive bid is employed on two types of hand: (1) a hand of opening-bid strength where the doubler has no good or long suit of his own but has good support for any of the unbid suits; and (2) where the doubler has a good suit and so much high-card strength that he fears a mere overcall might be passed out and a possible game missed. The high-card strength required is usually 13 or 14 points and may be more.

Overcall in Opponent's Suit (*Cue Bid*).—The immediate cue bid (example: opponent opens one heart; defender bids two hearts) is the strongest of all defensive bids. It is unconditionally forcing to game and shows approximately the equivalent of an opening two bid. It normally announces first-round control of the opening bidder's suit (ace or void) with very fine support in all unbid suits.

Action by Partner of Overcaller.—The overcall is usually based on a good suit. Less than normal support is required to raise (Q-x or x-x-x). A raise should be preferred to bidding a suit of one's own, particularly when the overcaller has bid a major. The partner of the overcaller should not bid a weak hand.

Action by Partner of Take-out Doubler.—The doubler requests his partner to bid, so the only justification for a pass is the expectation of defeating the doubled contract. Partner's response guarantees no specified number of points. Preference is normally given to a major suit.

Action by Partner of the Opening Bidder.—When the opening bid has been overcalled, the responder is no longer under obligation to keep the bidding open. Every bid shows strength. A bid of one no-trump or a raise should be based on a hand of about average strength (10 points). Over a take-out double, the responder has only one way to show a good hand—a redouble. Any other bid, while not indicative of weakness, shows only mediocre high-card strength. (C. H. G.)

C. Slam Bidding

When a partnership has been able to ascertain that it has at least 33 points in the combined hands plus an adequate trump suit, the only thing that remains is to make certain that the opponents are unable to cash two quick tricks. For this purpose control-showing bids are used. Three are most popular: Blackwood, Gerber and cue bidding.

1. Blackwood Convention.—In this convention, devised in 1934 by Easley Blackwood of Indianapolis, Ind., a bid of four no-trump asks partner to show his total number of aces. A response of five clubs shows no aces (or all four aces); five diamonds shows one ace; five hearts shows two aces; five spades shows three aces. After aces have been shown, the four no-trump bidder may ask for kings by bidding five no-trump. The responder now shows kings as he showed aces in response to the four no-trump bid, by bidding six clubs with no king, six diamonds with one king, etc.

2. Gerber Convention.—This was devised in 1938 by John Gerber of Houston, Tex. An unnecessary bid of four clubs, when the bid could not possibly have a natural meaning (such as, opener bids one no-trump, responder bids four clubs) asks partner to show the number of his aces. A response of four diamonds shows no ace; four hearts shows one ace, etc. If the asking hand desires information about kings he bids the next higher suit over his partner's ace-showing response. Thus if the responding hand has bid four hearts over four clubs to show one ace, a call of four spades would ask him to show kings and he would reply four no-trump to show no king, five clubs to show one king, etc.

3. Cue Bidding.—The individual method of ace showing (cue bidding) is used when both partners have shown strength or when the trump suit has been agreed on. For example, opener bids two spades, responder bids three spades; a bid of four clubs by opener now would show the ace of clubs (or a void) and would invite responder to show an ace if he had one.

4. Four-Five No-trump Convention.—Cue bids were the first control-showing method, devised about 1930. In 1933 Ely Culbertson proposed wholesale control showing. A bid of four no-trump showed two aces and the king of the trump suit, or three aces; a response of five no-trump showed the other two aces in the partner's hand. The Blackwood and derivative conventions were based on this. In the United States, Blackwood supplanted the Culbertson convention; in Great Britain and parts of Europe the Culbertson convention continued to be played.

5. Asking Bids.—Another Culbertson innovation (1936), this method permitted a player to ask his partner about second-round controls (kings and singletons). For example: Opener bids one spade; responder bids three spades; opener bids four clubs. The four-club bid asks the responder to show an outside ace if he has at least the king or a singleton in clubs. Without any club control the responder must sign off at four spades. The asking bids have many and complex ramifications. They never became popular in the United States but were played in Europe, especially in Scandinavian countries.

D. Other Bidding Systems

Hundreds of different bidding systems have been proposed for contract bridge and at all times several dozen systems are in use. Some of these are modifications of the Goren system, described above, or are substantially the same as the Goren system with the addition of a few special bidding conventions; others are radically different. Bidding systems can be divided into two main groups, natural systems, in which the bidder usually has strength in any suit he bids, and artificial systems, in which most bids are signals designed to show the general strength of the bidder's hand but do not necessarily promise any strength in the suit bid. In the late 1950s the conspicuous success of European teams in world-championship play directed international attention to the various systems used by British, French and Italian teams. The most popular systems in those years were:

1. Two-club System.—An opening bid of two clubs is forcing to game but is artificial, showing a hand usually of 23 or more points but not necessarily a club suit. The partner of the player who bids two clubs must respond two diamonds if he does not hold at least an ace and a king or three kings, but responds naturally if he holds at least that much high-card strength. Other opening two bids are weak bids, showing a six-card suit in a hand of 6 to 12 points. Most American champion teams since 1950 have used this system. (A. H. Md.; C. H. G.)

2. British (Acol) System.—While British players, in common with the rest of the world, first played systematic bridge "according to Culbertson," they later developed a style of their own. The Goren method, with its reliance on a point count at almost every stage of the bidding, has never been accepted. The best-known system in Great Britain is Acol. This system—or one that is similar in most respects—is played by almost all the leading tournament players. The system derives its name from a London club frequented by some of the best British players in the middle 1930s.

The strong bid in Acol is a conventional two clubs. This is forcing to game except when the opener, following a minimum response of two diamonds, rebids two no-trump. The two-club opener should have five quick tricks. In this type of valuation, an A-K in the same suit counts as 2 quick tricks, A-Q as 1½, A or K-Q as 1, K as ½.

The responder to a two club opening bids two diamonds on a valueless hand. With one quick trick and a suit that can be bid at the range of two, he can respond two of the suit. For a response at the range of three, generally 1½ honour tricks are required. Two no-trump shows a balanced hand with upwards of 9 points or so.

The other strong call is the Acol two bid—an opening two spades, two hearts, or two diamonds. This call shows a hand of power and quality, generally with 3½ to 5 quick tricks and good playing strength. The bid is forcing for one round, the weakness response being two no-trump.

The usual 4-3-2-1 point count is used for no-trump bidding only. Not vulnerable, one no-trump shows 12 to 14 points; vulnerable, 15 to 17. Two no-trump is not so strong as in America: generally 20 to 22 points (rather than 22 to 24 points). An opening bid of three no-trump is a tactical maneuvre generally based on a long minor suit. On strong no-trump hands, two clubs is opened.

For slam bidding, Acol traditionally uses the Culbertson four-five no-trump convention, though many players prefer the simpler Blackwood. Cue bids are freely used.

The main difference between Acol and the American systems lies not in the conventional bids mentioned above, but in the general style and approach. Acol is an attacking system in which the tactical plan is to come into the bidding early and bid high as soon as a fit has been found. Thus, opening bids are freely made on 10 or 11 points when a good six-card suit is held. A response of two no-trump shows 11 to 13 points and is not forcing. A double (jump) raise—one spade to three spades—is not forcing, and a raise to four is stronger than a raise to three.

To afford protection to the weaker opening bids, there are more sign-off bids in Acol than in the American systems. One heart—two no-trump—three hearts is discouraging and will normally be passed.

While a reverse by responder (one club—one heart, two clubs—two spades), or a new suit at the range of three, is forcing, other changes of suit are not forcing. In general, Acol bidding is direct and leans less heavily on the approach style than does Goren. An aphorism that may be taken as expressive of the Acol outlook is: "You bid what you think you can make, and you pass when you feel like it."

3. Italian Systems.—The Italian team that won the world championship 10 out of 11 years used two systems—the Neapolitan club and the Roman. In the Neapolitan club opening bids of one diamond, one heart and one spade show the suit named and bidding proceeds normally, though on the basis that the opening hand is limited in strength. All strong hands, with 17 points or more, are opened with a bid of one club. Responder shows his values by a step system. Counting a king as one control and an ace as two controls, he responds one diamond with no control, one heart with one control, one spade with two controls, one no-trump with three controls, and so on. Thereafter the bidding proceeds normally. (J. T. R.; C. H. G.)

Hands containing a club suit that are not good enough for the conventional one club are opened one no-trump. An opening bid of two clubs shows the equivalent of a weak no-trump. Other two bids are similar to the American weak two—a good suit and less honour strength than is required for an opening bid of one.

Two no-trump is a conventional opening that promises a long, solid suit. Responder bids three clubs and then the opener shows his suit. An opening of three in a suit shows a long, broken suit.

The Roman club system is more complicated. The opening bid of one club is conventional but may be one of three different types of hand: a minimum opening, a club suit, or a very strong hand. The weakest response to one club is one diamond. One heart or one spade shows the suit and fair values; one no-trump is stronger.

An opening bid of two clubs shows a moderate hand with at least four clubs and four hearts. Two spades and two hearts are the weak two. Two diamonds is a special bid denoting 5-4-4-0 or 4-4-4-1 distribution. If partner has no suit to show he responds two hearts. An opening one no-trump is normal. Two no-trump shows a hand containing nine cards in the minor suits.

In short, the Roman club system has a conventional bid for practically every type of hand. In defense, also, there are many artificial bids that show distribution and have no relation to the suit named. (J. T. R.)

4. French System.—French, and to a certain extent Italian and other continental, bidding methods were influenced by the original ideas of Pierre Albarran of Paris, who proposed that the bidder begin with a relatively weak suit and rebid in his strongest suit. This approach to bidding is called canapé.

5. Roth-Stone System.—Most radical of the popular American bidding systems was that proposed by Alvin Roth of Washington, D.C., and Tobias Stone of New York city. In this system any opening bid in spades or hearts promises at least a five-card suit, a one no-trump response to an opening bid of one spade or one heart is forcing, opening bids and overcalls are stronger than in other systems, and there are other points of difference. The Roth-Stone system has influenced many other popular systems.

E. LEADS

The card led against declarer is selected so as to give information to the leader's partner. Certain conventional meanings of leads were establishing during the bridge whist period and with slight changes persisted in contract bridge. The conventional meanings of leads in contract bridge are indicated in the table.

The lead of the fourth-best card from a long suit permits use of the "rule of eleven" (*see* WHIST).

In winning or attempting to win a trick to which some other player led, a defender plays the lowest equivalent of his highest card; as, the 10 from Q-J-10-8.

A standard defender's signal is the high-low, or come-on: the play or discard of an unnecessarily high card, followed if possible by a lower card of the same suit on a subsequent trick. This denotes a desire to have that suit led.

There are many other signals and conventions in defender's play. These do not violate the spirit of the game if they are known to the opponents. Not even the opponents of bidding conventions object to signals in the play.

Declarer need not observe any system in the selection of cards, for he has no partner to inform.

Contract Bridge Leads

Holding	Lead	
	At Suit Bids	At No-trump
A-K-Q-J	K, then J	A
A-K-Q-4-3	K, then Q	K, then Q
A-K-6	K	K
A-K alone	A, then K	K (but avoid)
A-K-J-10	K	A
A-K-J-3	K, then A	K
A-K-J-7-4-3-2	K	A
A-K-J-7-2	K	7 (fourth-best)
A-K-10-9-2	K	10
A-K-6-5-4	K	5 (fourth-best)
A-Q-J-4-3	A	Q
K-Q-J-7-5	K, then J	K, then Q
K-Q-10-7-3	K	K
K-Q-7-5-4	K	5 (fourth-best)
Q-J-10-3-2	Q	Q
Q-J-9-4-2	Q	Q
Q-J-6-5-4	Q	5 (fourth-best)
10-9-8	10	10
A-Q-10-9-5	A	10*
A-Q-8-5-4	A	5 (fourth-best)
A-J-10-7-5	A	J
A-10-9-7-5	A	10
K-J-10-4-3	J	J
K-10-9-7-5	10	10
Q-10-9-6-4	10	10
A-5-3	A	3
K-J-6	6	6
Q-9-7	7	7
J-8-6	6	6
7-6-3	7	7
Any other four-card or longer suit	Fourth-best	Fourth-best
Leads in Partner's Suit		
Any two cards	Highest	Highest
K-Q-4; Q-J-4-5; J-10-9-5; 8-6-3	Highest	Highest
A-J-4; A-9-7	A	Lowest
K-7-5; Q-8-6; J-6-3; 10-7-6	Lowest†	Lowest
K-Q-7-6; Q-J-8-7; J-10-7-6	Highest	Highest
A-7-6-4	A	Lowest
Any other four card or longer suit	Lowest†	Lowest

*The queen is led when leader suspects that the king is in dummy.

†The highest may be led when it may win the first trick and the leader wants to hold the lead.

VIII. BRIDGE PROBLEMS

Proficiency at the play of the cards in bridge is enhanced by study of double-dummy problems (in which the location of all unplayed cards is known). Putting such knowledge to practical use has been much better accomplished in contract bridge than in any of its predecessor games. For example, a prime problem at whist was the Great Vienna coup, with which the expert whist players had difficulty even when they could see all four hands. Execution of this and similarly difficult plays is commonplace among contract-bridge players far below the highest rank.

Most double-dummy problems embrace the squeeze (so named by Sidney S. Lenz of New York, because it reminded him of a play so-called in baseball), in which a player has winning cards in two or three suits but is forced to discard one of them. The throw-in play and the trump pickup (generic term for the group of plays which included the grand coup of whist) are other favourite themes of problem constructors.

1. The Whitfield Six.—The most famous of all double-dummy problems was proposed by W. H. Whitfield in 1885 and is called the Whitfield six because each hand has six cards. Whist players of the day could make nothing of it, and despite the advancement in the science of cardplaying it would cause trouble even to most experienced contract-bridge players.

NORTH
♤ —
♡ 8-7
♢ J-5
♧ A-2

WEST
♤ Q-7
♡ —
♢ Q-7
♧ J-3

EAST
♤ J-6
♡ —
♢ 10-8-6
♧ 8

SOUTH
♤ 10-9
♡ —
♢ A-K-9
♧ 10

Hearts are trumps; South leads and must win all six tricks.

Trick 1: South leads ♢ K; west ♢ 7; north ♢ J; east ♢ 6.
Trick 2: South leads ♤ 10; west ♤ 7; north, ♡ 7; east ♤ 6.
Trick 3: North leads ♡ 8; east ♧ 8; south ♧ 10; west ♤ Q.
West cannot discard a club or north's ♧ A-2 would both win tricks.

West cannot discard ♢ Q or north, after taking ♧ A, could lead ♢ 5 and south could win two tricks with ♢ A-9 by a finesse against east's ♢ 10-8.

Trick 4: North leads ♧ A. East is squeezed. If he plays ♤ J, south plays ♢ 9, if east plays ♢ 8 or 10, south plays ♤ 9. In either case south wins both remaining tricks.

2. Vienna Coup.—The characteristic of the Vienna coup is that a high card must be played early, apparently establishing a card in an opponent's hand but actually subjecting him to a squeeze that could not have been effected had the high card remained unplayed.

NORTH
♤ 3
♡ A-3
♢ A-J

WEST
♤ —
♡ 8-5-2
♢ 9-2

EAST
♤ J
♡ K-Q
♢ K-Q

SOUTH
♤ Q-10
♡ J-6
♢ 3

Spades are trumps; south leads and must win all five tricks. The key is: south leads ♡ 6 and north wins ♡ A. This gives east the highest heart. North leads ♤ 3 and south wins ♤ Q and ♤ 10, north discarding ♡ 3 on the latter. East cannot discard a heart without making South's ♡ J good, nor a diamond without making North's ♢ J good. If the ♡ A had not been taken first, east could have discarded a heart on this trick since south could never have returned to his hand to win the ♡ J.

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(A. H. Md.; C. H. G.)

BRIDGEND (Pen-Y-Bont Ar Ogwr), a town and urban district of Glamorgan, Wales, on the river Ogmore (Ogwr) at the northern edge of the vale of Glamorgan, 19 mi. N.W. of Cardiff by road. Pop. (1961) 15,174. This residential and market town, which is divided by the river into Newcastle on the west bank and Oldcastle (the main part) on the east, grew steadily after the 1930s, chiefly because of the large industrial estate on the outskirts and the steel works at nearby Margam. Bridgend owed its initial growth to the erection of the old stone bridge across the river (*c.* 1435) which linked the village of Newcastle with the hamlet of Nolton. The ruins of a 12th-century castle rise above the church of St. Illtyd in Newcastle, below which is a 15th-century building, the Old Hospice, owned by the Order of St. John. Also in the vicinity is the Unitarian chapel, founded about 1702. Ewenny priory, 1½ mi. S., founded by Maurice de Londres, lord of Ogmore, in 1141, is an early Norman building of both monastic and military character. This is apparent from its crenellated central tower (12th–13th century), portcullis, and the *meurtrières* (apertures) in its surviving gateways. The ruins of Ogmore castle are in the neighbourhood, and the castle of the Turbervilles (12th–13th century) is at Coity, 2¼ mi. N.E. by road. Bridgend is on the main line railway from London to Fishguard and the civil airport of Rhoose, near Cardiff, is 18 mi. away. (Jo. S. B.)

BRIDGEPORT, a city in southern Connecticut, U.S., about 56 mi. N.E. of New York city. It is the hub of the New York city-New England area. Pop. (1970), Bridgeport city, 156,542; standard metropolitan statistical area (Bridgeport and Shelton cities; Fairfield [*q.v.*], Stratford, Monroe, Trumbull, Milford and, from 1963, Easton towns), 389,153. For comparative population figures *see* table in Connecticut: *Population.*

It was settled in 1639 by residents of Fairfield and Stratford and was first known as Newfield and later as Stratfield. In 1800 it was incorporated as a borough and named Bridgeport for the first drawbridge over the Pequonnock river. In 1821 it was incorporated as a town. Because of its advantageous geographical location, situated around an excellent harbour on Long Island sound, the early settlers turned from agrarian to mercantile and manufacturing pursuits. After its incorporation as a city in 1836 Bridgeport grew from a shipping community of 3,000 persons to a world-famous industrial centre, attracting thousands of immigrants from central-eastern Europe at the turn of the 20th century. In politics, the election of Jasper McLevy as Bridgeport's first and only Socialist mayor won international attention; he began a 24-year reign as the nation's most publicized mayor on Nov. 13, 1933, at a time when the dispirited, bankrupt city was in the throes of corruption and despair. In the election of Nov. 5, 1957, at the age of 79, he was defeated by Samuel Tedesco, a Democrat. Another well-known mayor was the showman P. T. Barnum (*q.v.*), whose residence is now a dormitory of the University of Bridgeport and whose memory is commemorated annually by the Barnum festival. Manufactures include electrical supplies, machinery, corsets, hardware, sewing machines, silverware, brake linings, brass goods, valves, ammunition, aircraft, drugs, steel products, machine tools, asbestos products, plastics, home appliances, meters, automotive parts and accessories and steel.

Bridgeport has an airport and rail service; the Connecticut turnpike from New York to Rhode Island, completed in 1958, runs through the city. The University of Bridgeport (1947) continues the work instituted by the Junior College of Connecticut, the oldest legally chartered junior college (1927) in the 11 northeastern states. The Bridgeport Engineering institution presents engineering courses on the college level. The city operates a number of parks and other recreational facilities. (J. S. Ro.)

BRIDGES, CALVIN BLACKMAN (1889–1938), U.S. geneticist who devoted much work to the chromosome theory of heredity and sex determination, was born at Schuyler Falls, N.Y., on Jan. 11, 1889. In 1912 he graduated from Columbia university, where in 1916 he received the degree of doctor of philosophy and was research assistant to T. H. Morgan during 1910 to 1915. From 1915 to 1919 he continued his research under grants from the Carnegie institution, of whose staff he became a member in the latter year. He died in Los Angeles, Calif., on Dec. 27, 1938. His publications include (with T. H. Morgan and others) *The Mechanism of Mendelian Heredity* (1915); *Sex-Linked Inheritance in Drosophila* (1916); *Genetics of Drosophila* (1925); a number of papers; and (with K. S. Brehme) *Mutants of Drosophila Melanogaster* (1944).

BRIDGES, ROBERT SEYMOUR (1844–1930), English poet laureate, who won permanent fame as a lyrical poet, and is remembered also as a student of prosody and a champion of "pure English," was born at Walmer, Oct. 23, 1844. He was sent to Eton in 1854. Going up to Corpus Christi college, Oxford, in 1863, he met Gerard Manley Hopkins (*q.v.*) who became a lifelong friend and whose poems he edited in 1918. From 1869 until 1882 Bridges worked as a medical student and physician in London hospitals. In 1873 he published a volume of verses which he later tried to suppress, and in 1879 printed privately the first of a series of collections of his poems. He retired from medical practice in 1882; two years later he married Mary Monica Waterhouse, and he spent the rest of his life in practically unbroken domestic seclusion, first at Yattendon in Berkshire, then at Boar's Hill, Oxford. Though he knew the leading literary and other figures of his time, and was keenly interested in new developments in science, art and thought, Bridges devoted his life almost religiously to poetry, contemplation and the study of prosodical and phonetic problems.

Bridges published several long poems and poetic dramas (*Prometheus the Firegiver*, 1883; *Eros and Psyche*, 1885; Eight Plays, 1885–94; *Demeter*, 1905) which, though they contain passages of great beauty, are mainly interesting as exercises in poetic method; his reputation rests rather upon the lyrics collected in *Shorter Poems* (Bks. I–IV, 1890; Bk. V, 1894), of which A. E. Housman said "probably no single volume of English verse has ever maintained such perfection." Always interested in the technique of verse, Bridges had published (1893) a study of Milton's prosody and a critical essay on Keats when in 1895 he was asked to stand for the professorship of poetry at Oxford; he declined, for he did not feel that criticism was his *métier*, though his *Collected Essays* (1927–36) contain many shrewd and bold judgments about poetic technique and inspiration and reveal his deep sensitiveness to the quality of poetry. Though his *Collected Poems* had appeared, in six volumes, between 1898 and 1905, Bridges was little known to the public when he was appointed poet laureate in 1913, and he published little official laureate verse. His wartime anthology, *The Spirit of Man* (1916), achieved wide popularity. *New Verse* (1925) contained experiments in "neo-Miltonic syllabics," and this was the metre of the long philosophical poem, *The Testament of Beauty*, which was published on his 85th birthday and brought him fame almost upon his deathbed. He had already (June 3, 1929) been awarded the Order of Merit. He died on April 21, 1930.

Bridges was in every sense a distinguished figure, and the serenity and aristocratic refinement of his work reflect like qualities in its author. (J. Sp.)

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BRIDGES. A bridge is a structure surmounting an obstacle such as a river, road, or railway and used as a passageway for pedestrian, motor, or rail traffic. In this article the development of bridge design and construction is dealt with chronologically from early times. Consideration is given to the wide variety of foundations required, the superstructures of all types of bridges (*i.e.*, girder, arch, suspension, and combinations thereof), the different materials available for construction and their strengths and properties, advances in theory and methods of calculation, and the evolution of erection techniques. In conclusion, the latest developments and trends are discussed. The article is divided into the following sections:

I. Earliest Bridges and Basic Types
II. Bridges Previous to the Railway Age
  1. Roman Bridges
  2. Bridges from the 5th to the 16th Century
  3. Bridges from the 16th to the 18th Century
III. Iron Bridges and the Railway Age
IV. Early Steel Bridges
V. Reinforced Concrete Bridges
VI. Long-Span Bridges
  1. Cantilever Bridges
  2. Arch Bridges
  3. Suspension Bridges
  4. Toll Bridges
VII. Modern Developments: General
  1. Loadings and Forces
  2. Aerodynamic Stability
  3. Foundations
  4. Aesthetics
VIII. Modern Developments: Steel
  1. High-Tensile Steel
  2. Shop Fabrication and Erection
  3. Brittle Fracture
  4. Fatigue
  5. Protection of Steelwork
  6. Battle Decks and Composite Construction
  7. Box Girders and Trusses
IX. Modern Developments: Concrete
  1. Prestressed Concrete Bridges
  2. Modern Reinforced Concrete Bridges

For considerations of the theory of structures and other aspects of engineering science upon which modern bridge design is based, reference should be made to the articles Elasticity; Materials, Strength of; and Architectural Engineering. For information on pontoon bridges and other military types, *see* Bridging, Military.

I. EARLIEST BRIDGES AND BASIC TYPES

The earliest bridges were natural, such as the huge pointed arch of rock that spans the Ardèche River at Ardèche, France, or the rock bridge near Lexington, Va. The first man-made bridges may have been flat stones or tree trunks laid across a stream to make a girder bridge or possibly festoons of creepers hung across in suspension.

Three types of bridge—beam (or girder, including the floating pontoon for military use), arch, and suspension—have been known and built from the earliest times. The essential differences between the varieties are that whereas the ends of beam or girder bridges simply rest on the ground, arch bridges are in compression and thrust outward at the ends, and the cables of suspension bridges are in tension and pull inward on their anchorages (fig. 1). The type of bridge to be preferred at any site depends on the nature of the ground, the span of the bridge, the kind of traffic it has to carry, and the materials of construction available. For some of the early bridges in Persia, where the river bed was stony and no timber was available, a site was selected where there were outcrops of rock across the river on which to build the piers. The resulting structures, such as the bridge over the Karun River at Shustar, were not straight but wound across from outcrop to outcrop. Alternatively, mounds of stone could be built upon the river bed, or, if the ground was not too hard, timber piles could be driven through the water to form trestles, as in Caesar's bridge over the Rhine (55 B.C.). It is said that in the construction of some of the early bridges, such as that over the Euphrates at Babylon, the river was diverted so that the piers could be built on the dry river bed. It is doubtful, however, whether this would have been practicable in those days, unless the flow of the river dwindled to a trickle in the dry season.

II. BRIDGES PREVIOUS TO THE RAILWAY AGE

1. Roman Bridges.—The Romans were among the greatest bridge builders of antiquity. Perhaps their three most important contributions to this art were the discovery of a natural cement; the development of cofferdams, in which the cement could be used to make concrete foundations underwater; and their magnificent exploitation of the circular masonry arch. The cement, called pozzolana, was mixed in the ratio of two parts by weight to one of lime (*see* Cement). Their cofferdams were made by driving timber piles to enclose the site of the pier and then pouring in concrete through the water. Alternatively, if the river bed was very soft, they drove a double row of sheathing piles and filled in the space between with clay to make the cofferdam watertight. They could then empty the cofferdam with water wheels, dig out the greater part of the soft ground inside it, and concrete the pier in the dry. The Sant' Angelo Bridge in Rome stands on cofferdam foundations built in the Tiber River more than 1,800 years ago.

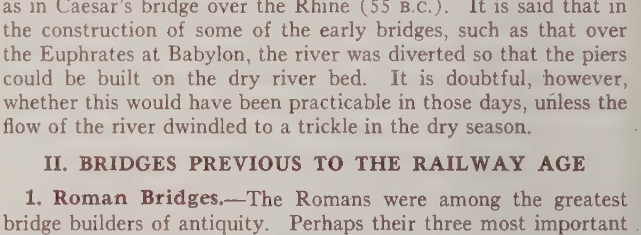

FIG. 1.—PRINCIPAL TYPES OF BRIDGES: (A) SIMPLE GIRDER; (B) CANTILEVER; (C) ARCH; (D) SUSPENSION. ARROWS SHOW FORCES BRIDGE EXERTS ONTO OR AWAY FROM FOUNDATIONS

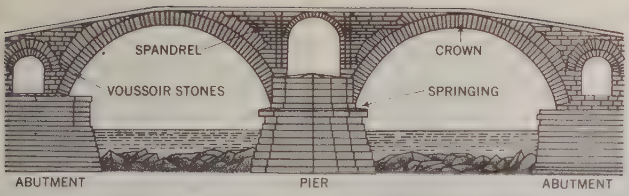

FIG. 2.—ROMAN CIRCULAR ARCH AS SEEN IN THE ORIGINAL PONS FABRICIUS, ROME; 62 B.C.

Nevertheless, the Roman underwater foundations were rarely built deep enough or given sufficient protection against scour to enable them to survive long. Most of the Roman bridges that remain were built on solid rock.

The superstructure of many Roman bridges, such as the emperor Trajan's famous bridge built by Apollodorus of Damascus over the Danube in A.D. 104–105, was of timber on stone piers; none of these bridges has survived. The fame of the Roman bridge builders rests on their majestic masonry bridges, built on the grand scale, always with circular arches, which perhaps reached the peak of achievement in the mighty bridge over the Tagus at Alcántara, Spain. Built by Caius Julius Lacer for Trajan, the tall granite piers and 98-ft.-wide arches that carry the roadway at a height of 170 ft. above the river have stood for nearly 2,000 years. The huge voussoir stones forming the arch weigh up to eight tons each and were so accurately shaped that no mortar was needed in the joints. The arches must have been built on temporary timber structures supported at the springings. The heavy arch stones were no doubt lifted by a system of pulley blocks, operated by means of a winch, probably based on the principle of the treadmill. Tools used by the Roman masons included saws, chisels, bevels, wedges, and trowels; they also used plumb bobs and levels.

Roman bridges required for a military campaign, such as that over the Danube, were built by legionnaires and financed by the treasury, but the more usual practice was to employ forced labour and to rely for finance on contributions by townships. Engineers and skilled workmen formed into semimilitary guilds were dispatched throughout the empire to supervise the work. By this means knowledge was spread abroad and interchanged and the basis laid down for schools in which professional standards were formulated. From these beginnings evolved the laws of the art of building as drawn up by Vitruvius.

BY COURTESY OF THE FRENCH GOVERNMENT TOURIST OFFICE

PONT VALENTRÉ AT CAHORS, FRANCE, IS A MEDIEVAL FORTIFIED BRIDGE

2. Bridges from the 5th to the 16th Century.—In the state of chaos that prevailed after the fall of the Roman Empire, bridge building in Europe languished, except for a brief upsurge in the reign of Charlemagne, for some eight centuries. Its revival was marked by the spread in popularity of the ogival or pointed arch westward across the continent from Egypt and the Middle East, where it originated. Medieval workmanship could not rival that of the Romans, and the pointed arch may have been preferred not only on account of its attractive shape, but also because it demanded less precision than the circular form. Any tendency to sag at the crown is less dangerous, and there is less thrust on the abutments.

Medieval bridges had other functions besides carrying traffic. Chapels, shops, tollhouses, and customhouses were built on them, and they were used for fairs and tournaments. Fortified bridges, such as the Pont Valentré at Cahors, France, the bridge over the Gave de Pau at Orthez, France, or the bridge over the River Monnow at Monmouth in Wales were defended by means of drawbridges, ramparts, and tall towers with arrow slits and machicolations. The upkeep of bridges was considered a pious work, for which money was obtained by alms, by endowment, or from tolls levied on both road and river traffic.

One of the most famous medieval bridges in France is the Pont d'Avignon over the Rhône, which was begun under the direction of St. Bénezèt in 1177 and completed ten years later. The bridge spanned the river by means of about 20 lofty, elliptical arches, each 100 ft. wide. St. Bénezèt, who is said to have been divinely inspired to build the bridge, died before its completion and was buried in a chapel on one of the piers. Because of the ravages of war and damage from ice in the river, only two or three arches at the Avignon end of the bridge, and the chapel, which has since become a place of pilgrimage, remain standing.

A year before the commencement of the Pont d'Avignon, Peter of Colechurch undertook a far more formidable task—the building of the Old London Bridge (fig. 3). This was the first stone bridge to be built with masonry foundations in a swift-flowing river having a large tidal range. The bridge was to consist of 19 pointed arches, each with about a 28-ft. span, built on piers 20 ft. wide, with a drawbridge at one end. The foundations were built inside cofferdams made by driving timber sheathing piles into the river and served to hold the pier stones in place. Obstructions encountered in pile driving resulted in variations in the span of the arches of from 15 to 34 ft. Moreover, the width of the protective "starlings," which consisted of loose-stone filling enclosed by piles at the base of each pier, was so great that the waterway was reduced to a quarter of its original width, and the tide flowed under the narrow archways like a millrace. Nevertheless, the bridge was completed in 1209 and survived together with its famous tunnel-like street of shops and houses for more than 600 years.

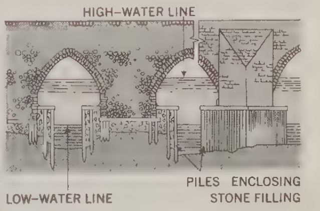

FIG. 3.—ARCHES OF OLD LONDON BRIDGE

Beyond the confines of Europe other fine medieval bridges were built, such as the Red Bridge, which consisted of four pointed arches, on the road from Tiflis (Tbilisi) to Tabriz in Persia. In the province of Fukien in China, according to H. Fugl-Meyer's *Chinese Bridges*, an extraordinary stone bridge 1,100 ft. long was built over the Dragon River at Poh Lam. The spans, up to 70 ft. in length, were comprised of three huge stones, two of which rested on top of the piers at each end, while the third spanned the gap between them. How stones of such a size, weighing up to 200 tons, were quarried and transported in those times is not known.

3. Bridges from the 16th to the 18th Century.—The confidence and unbounded enterprise of the Renaissance is typified by Leonardo da Vinci's offer in 1502 to build a masonry arch bridge with a span of 905 ft. (centre to centre of the arch rib) over the Golden Horn at Istanbul. The clear span was to be 787 ft. Moreover, his design appears to have been adequate except for the difficulty of supporting the centring (temporary wooden

ALINARI

SANTA TRINITA BRIDGE IN FLORENCE, ITALY, WAS DESIGNED BY BARTOLOMMEO AMMANATI AND COMPLETED IN 1569; REBUILT AFTER WORLD WAR II

supports) on which the arch would have had to be built. This period saw the completion of some of the most famous bridges in the world, such as the Pont Notre Dame and the Pont Neuf in Paris, the Rialto in Venice, and the Santa Trinità Bridge in Florence. Though engineers had learned much more about bridge foundations, they were still rarely able to excavate deep enough, *i.e.*, down to rock or really hard strata, but they had learned to spread the base of the pier over a wide area and to lay the foundation stones on a timber grillage supported, if necessary, on bearer piles. In the foundation of the Rialto Bridge, for example, Antonio da Ponte, the designer, had 6,000 timber piles driven under each abutment and so placed the masonry on the grillages that the bed joints of the stones were perpendicular to the thrust of the arch. So well were these foundations built that, although they have to support in soft alluvial soil a wide arch carrying a street of shops, they are still standing.

In his beautiful Santa Trinità Bridge in Florence, which was built during 1567–69 and stood until blown up during World War II, Bartolommeo Ammanati, working on scientific principles, evolved a new type of arch. He adopted the ogival shape with the angle at the crown concealed and the curves of the arches starting vertically from the springings. This shape of arch, in which the rise-to-span ratio was as low as one-seventh, became known as "basket-handled" and has been widely adopted since. After the war, the Santa Trinità Bridge was rebuilt exactly as it was and (so far as possible) with the original materials, which were dredged from the bed of the river.

In the 17th and 18th centuries, bridge building in Europe developed into a science. The Corps des Ingénieurs des Ponts et Chaussées, by whom plans of all bridges in central France had to be approved, was established in 1716. Jean Perronet, builder of some of the finest bridges of his day, including the Neuilly Bridge over the Seine, the Pont Ste. Maxence over the Oise, and the beautiful Pont de la Concorde in Paris, was appointed director of the first engineering school in the world. This was the famous École des Ponts et Chaussées, founded in 1747.

Early in this period scientists such as Galileo and Robert Hooke had investigated the theory of beams and framed structures, and before the end of the period bridge builders were required to work to detailed specifications. In 1750 or 1755, William Edwards built what many people consider the most beautiful arch bridge in the British Isles—the Pontypridd Bridge, with its lofty span of 140 ft. In London, a few years before, C. Labelye had completed the first bridge at Westminster, which, however, survived for only 100 years.

Meanwhile, in distant parts of the world construction had developed along very different lines. In China, masonry arch bridges that had to stand in the spongy, plastic silt of the river valleys were built of thin curved slabs, jointed so that they could yield to considerable deformation before failure. In Persia, bridges such as the Allah Verdi Khan and the Pul Khajoo were designed as cool, shaded retreats, where the traveler could find rooms for rest and refreshment after crossing hot desert sands. The two-storied Pul Khajoo at Isfahan (1642–67) is comprised of 24 pointed arches that carry an 85-ft.-wide roadway, with walled passageways above it, along the top of a pierced dam. Flanked by tall hexagonal pavilions and watch towers, the bridge constitutes a magnificent example of engineering and architectural harmony.

Working with another material, Johannes and Hans Ulrich Grubenmann, two Swiss carpenters, built the famous covered timber bridge having spans of 193 ft. and 171 ft. over the Rhine at Schaffhausen in 1756–58. This was followed by a similar timber bridge with a 240-ft. span at Reichenau. In North America many outstanding timber truss bridges were built, the first being Enoch Hale's framed bridge over the Connecticut River at Bellows Falls, Vt., in 1785. Louis Wernwag's "Colossus" Bridge with a 340-ft. span over the Schuylkill River at Fairmount, Pa., was constructed in 1812. The "Burr truss," developed by Theodore Burr, set a new pattern for wooden covered bridges in the United States. His McCall's Ferry Bridge (1815) had a record-breaking span of 360 ft.

III. IRON BRIDGES AND THE RAILWAY AGE

It was not until late in the 18th century that iron came to be generally employed in structures, so that bridge builders were no longer limited to the use of timber, brick, and stone. Because of the genius of such engineers as Thomas Telford, Robert Stephenson, I. K. Brunel, and John A. Roebling, the possibilities opened up by the new material were quickly exploited, and by 1860 numerous iron arches, suspension bridges, and girders had been built. This period also witnessed the first use of compressed air in the construction of bridge foundations below water.

The world's first all-iron bridge was the semicircular arch with a 100-ft. span designed by Thomas Farnolls Pritchard and built over the River Severn at Coalbrookdale in 1779, although iron had been used for many years in the cables of suspension bridges. Pritchard's bridge carried roadway traffic for more than 170 years. It was followed by a number of cast-iron arches designed by Telford, of which the first was the Buildwas Bridge, Shropshire, with a 130-ft. span, and the most ambitious was his design for a high-level 600-ft. span (which was never built) to replace Old London Bridge. John Rennie, who built London's Waterloo Bridge of masonry arches (replaced by a modern bridge in 1935–42), was also responsible for old Southwark Bridge (1814–19), which consisted of three cast iron arches with spans up to 240 ft., and the New London Bridge of multiple masonry arches completed in 1831, after his death, and subsequently widened.

In his design of the Menai suspension bridge (1820–26) of a 580-ft. span in North Wales, on which his fame as a bridge builder undoubtedly rests, Telford adopted chains of wrought iron links for which Sir Samuel Brown had taken out a patent in 1817. After all the links had been tested and pinned together, the chains were laid out full length, towed across the waterway, and hoisted up into place; then the deck was suspended beneath. The roadway was only 24 ft. wide, and, in the absence of any kind of stiffening girders or storm bracing, it was highly vulnerable to damage by wind and had to be rebuilt at least twice before the whole bridge was reconstructed in 1940. Nevertheless, in view of the fate of most of the early suspension bridges in both Europe and the United States, it was a credit to Telford that the Menai Bridge survived for 115 years. The lack of rigidity of these early examples and their inability to stand up to wind, storms, or rhythmic loads had been extreme. Nevertheless, a few survived, including the Fribourg Bridge (1834) in Switzerland, with a span of 870 ft., and, until World War II, William Tiernay Clark's fine old 666-ft.-span chain bridge over the Danube at Budapest, which was completed by his brother Adam in 1849.

The credit for designing and building the first suspension bridge that was rigid enough to withstand not only wind action but also the impact of railway traffic belongs to John A. Roebling, an immigrant from Germany to the United States. In his Grand Trunk Bridge of an 820-ft. span below Niagara Falls, there were two decks, one above the other, for rail and road traffic respectively, with stiffening trusses 18 ft. deep between them. In addition to this, the deck was braced by means of inclined wire stays overhead and others below anchored to the sides of the gorge. To span the gorge initially, Roebling hit upon the expedient of offering a prize of $10 to the first boy who could fly a kite across and fasten the string on the opposite side; the string then was used to haul across heavier cords that could support a wire. For the four main cables, instead of the separate stranded or twisted ropes that had been used for cables in Europe, Roebling used parallel wrought iron wires, spun in place, bunched together and wrapped, a process he had patented in 1841; each cable was 10 in. overall in diameter. The bridge was completed in 1855 and survived for 42 years, although not without considerable repairs and reconstruction necessitated by the wear and tear of traffic.

In 1840, W. Howe patented his timber truss, widely used on the railways in North America, in which the verticals consisted of iron ties; this was followed by numerous other trusses including the Pratt and Warren types, the last of which is frequently used today. The first major iron truss bridge, with pin connections, was built in the United States in 1851, and the earliest iron cantilever girder, which consisted of alternate cantilever and continuous spans, was built by H. Gerber over the Main River at Hassfurt, Ger., in 1867.

The Britannia railway bridge (1845–50) across the Menai Strait, North Wales, was designed by Robert Stephenson and William Fairbairn. It employed the prototype of the box girder or plate girder of the kind now used throughout the world and was originally intended to be a stiffened suspension bridge. There are four spans, each consisting of two wrought iron tubes side by side through which the trains run; the two spans over the water are each 459 ft. long, and the shore spans are 230 ft. long. In spite of the fact that C. L. M. H. Navier's lectures on the theory of elasticity and structures had been published some years earlier, so little was known of theoretical design that Stephenson had to proceed empirically by testing, modifying, and retesting a series of models. Workshops were built at the site to fabricate the wrought iron plates and sections (of the kind that had recently been produced for shipbuilding), which were handled by means of overhead gantries and riveted mostly by hand but in part by hydraulic machines designed by Fairbairn. During erection of the bridge it was found possible to dispense with the suspending chains altogether, and the tubes for the spans over the water, each weighing 1,285 tons, were floated out on pontoons and raised to their final level by means of huge hydraulic jacks located on the piers. Still in service, the Britannia Bridge carries locomotives 12 times as heavy as those in use when it was designed.

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GRAND TRUNK BRIDGE, AN IRON SUSPENSION BRIDGE FOR RAIL AND ROAD TRAFFIC, WAS COMPLETED IN 1855 BELOW NIAGARA FALLS, N.Y. IT SURVIVED 42 YEARS AND HAD AN 820-FT. SPAN

R. W. [illegible]

BRITANNIA TUBULAR RAILWAY BRIDGE OVER THE MENAI STRAIT, NORTH WALES; COMPLETED IN 1850

Up to the middle of the 19th century cofferdams were the only means by which bridge foundations could be properly constructed below water. But because of the limited length of the sheet piling and the difficulties caused by obstructions or by very hard or soft ground, cylinders or wells were employed and sunk either by dredging or under compressed air. The first use of pneumatic caissons for bridgework was on the foundations of the Rochester Bridge over the Medway at Rochester, Kent, Eng., in 1851 by Sir William Cubitt and John Wright.

Subsequently, I. K. Brunel used this method for sinking the cylinders of Chepstow Bridge, Monmouth, Wales, and on a much greater scale for the Royal Albert Bridge at Saltash, Cornwall, Eng. (1855–59). Brunel designed a wrought iron cylinder 35 ft. in diameter for the central pier, which had to be sunk through 70 ft. of water and 16 ft. of mud onto a rock bottom. It was built on the foreshore, towed out, and sunk in the position required. By means of compressed air, water was expelled from the working chamber at the bottom of the cylinder; workers entered the chamber through the air lock, excavated the mud, dressed the rock, and securely plugged the bottom of the foundation with concrete (*see* SHAFT SINKING).

Brunel was also the designer of the Maidenhead railway bridge at Berkshire, Eng., the 128-ft. spans of which are the flattest and boldest arches ever carried out in brickwork. The longest masonry arch yet built is that at Plauen, Ger. (1903), which has a span of 295 ft.

IV. EARLY STEEL BRIDGES

The last 30 years of the 19th century saw the introduction of steel plates and rectangular rolled-steel sections, which came to be mass-produced and fabricated in shops by standardized methods. This inevitably led to an enormous output of steel-truss and plate-girder bridges for use throughout the world and to spans of ever-increasing size. Arch and cantilever bridges were favoured for long spans in the railway era because they could better withstand the impact of heavy railway traffic than could suspension bridges. It is a curious fact that whereas the catastrophic effect of aerodynamic wind forces on suspension bridges had been frequently experienced, no attempt was made to investigate their character until a much later date, but the collapse of the high-level girders of the Tay Bridge, Scot., in 1879 at once prompted research by Benjamin Baker and others into aerostatic wind forces.

This period was also outstanding for the advances made in the theory of design and knowledge of the strength of materials. As a result of the work of such scientists as Karl Culmann and James Clerk Maxwell, graphic methods of structural analysis were developed, and engineers were able to draw stress diagrams and influence lines (*i.e.*, curves showing, for one component part of a beam or truss, the shearing force, bending moment, stress, deflection, or similar function for all positions of a moving load) and to calculate the deflections and bending moments in trusses and beams. Credit must be given to W. J. M. Rankine, who compiled a comprehensive series of textbooks which gave publicity to important work in Europe and the United States in subjects as varied as strut formulas, earth pressures, and shear in beams.

The change from iron to steel took place gradually. Two fine iron arches, the Maria Pia Bridge (1877) and the Dom Luís I Bridge (1885), were built over the Douro at Oporto, Port., the first being designed by A. G. Eiffel and T. Seyrig and the second by Seyrig. In southern France, two magnificent railway bridges were built—the graceful Garabit Viaduct (1885) with a central arch of 540 ft. over the Truyère River and the Viaur Viaduct at Aveyron (1898). The latter had an arch 722 ft. long, flanked by cantilever spans of 311 ft., and was the first big bridge in France to be built of steel. The Eads Bridge over the Mississippi River at St. Louis, Mo., built by James B. Eads in 1867–74, is of importance on account of the difficulties surmounted in sinking the piers in midstream to a depth never before attempted under compressed air and because it was the first major bridge to be erected by the cantilever method.

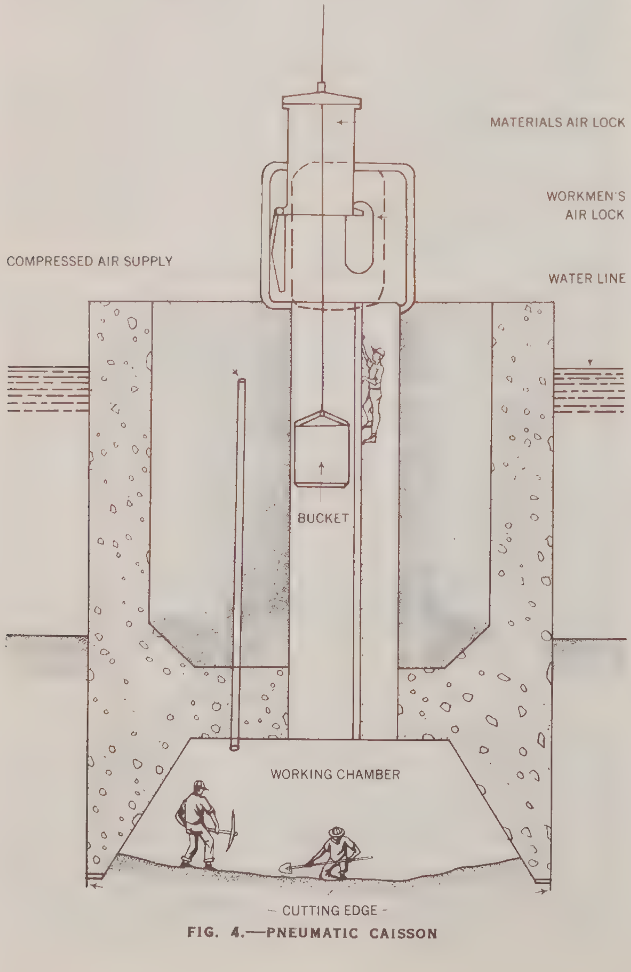
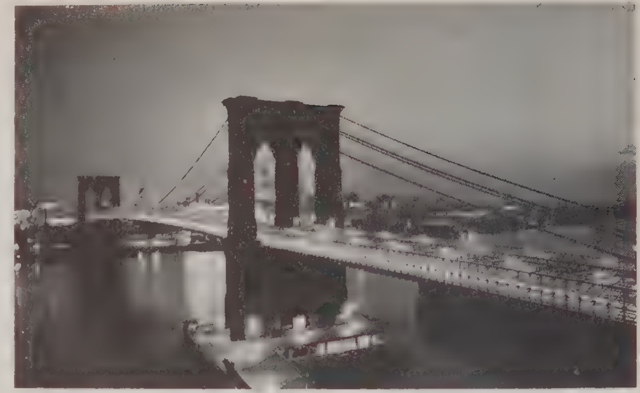


FIG. 4.—PNEUMATIC CAISSON


A DEVANEY

BROOKLYN BRIDGE, A STEEL SUSPENSION BRIDGE IN NEW YORK CITY, WAS COMPLETED IN 1883 WITH A SPAN OF 1,595 FT.

The Clifton Arch (span 840 ft.), completed in 1898 below Niagara Falls, stood for 40 years until the ends of the steel ribs were wrecked by a huge ice jam in the river. In 1905, the Victoria Falls Bridge, a flat-topped, spandrel-braced arch (span of 500 ft.) designed by Sir Ralph Freeman, was built to carry the Cape-to-Cairo railway projected by Cecil Rhodes across the 400-ft.-deep gorge of the Zambezi River.

The famous Brooklyn Bridge (1869–83; span of 1,595 ft.), designed by John A. Roebling and erected under the direction of his son, Washington Roebling, has four cables with an overall diameter of $15\frac{3}{4}$ in. built up of parallel wires of cast steel with an ultimate strength of 71.5 tons per square inch. The method of cable spinning devised by Roebling (fig. 5) was so essentially simple and effective that it has been used in principle, although now much elaborated, for all the big suspension bridges subsequently built in the United States. The wire, about 0.19 in. thick, is delivered to the site in reels from which loops are carried over the span one after another by means of grooved traveling sheaves attached to an endless hauling cable. The loops of wire are carried over the tops of the towers to the far anchorage, where each loop is pulled off the sheave and placed around a strand shoe by which it is anchored.

In one or two of the early suspension bridges, notably the Point Bridge at Pittsburgh (1877), an attempt was made to stiffen the eyebar-chain cables instead of the deck, but the latter system has proved more satisfactory. For the Manhattan Bridge (1909) over the East River in New York, the cable wire used was cold-drawn and had an ultimate strength of 93.6 tons per square inch, and the "deflection theory," by means of which substantial economy is achieved in the design of the cables, was employed for the first time.

For the design of the Forth Bridge (1882–90; two main spans of 1,710 ft. each) in Scotland, Benjamin Baker conducted an extensive series of wind pressure tests, using gauges installed at the site, over a period of two years. As a result, he was satisfied that the pressure of 56 lb. per square foot specified for the design by the committee set up after the Tay Bridge disaster was "considerably in excess of anything likely to be realized," and so it has proved.

The two main spans of the bridge each consist of two 680-ft. cantilever arms with a 350-ft. suspended span between them. About 54,000 tons of Siemens-Martin open-hearth steel, which has a substantially higher ultimate strength than modern commercial mild steel, were used. The biggest compression members were designed as tubular struts 12 ft. in diameter, and all the steelwork was fabricated in shops built for the purpose at South Queensferry. The spans were built out as balanced cantilevers from each main pier, the tubular members being erected plate by plate by means of two-ton hydraulic cranes.

The latter half of the 19th century witnessed the construction in India of a large number of multispan railway bridges more than 1,000 ft. long. Their British builders learned how to utilize

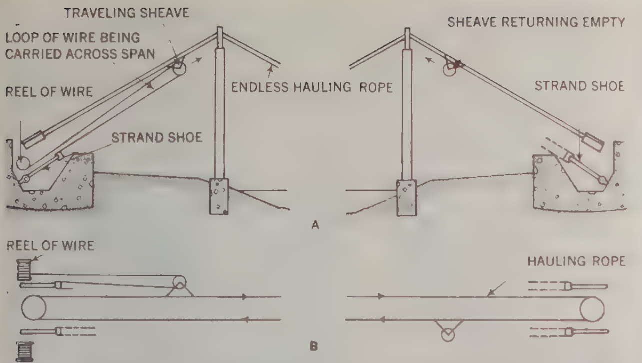


FIG. 5.—DIAGRAM ILLUSTRATING METHOD OF SPINNING PARALLEL WIRE CABLES ON A SUSPENSION BRIDGE: (A) ELEVATION; (B) PLAN

the simplest kind of equipment and unskilled labour; they had to study and develop the use of guide banks as a means of keeping the rivers under the bridges and of preventing them from meandering; and, sinking brick wells by dredging in the sand, they built the deepest foundations ever constructed, as a safeguard against undermining when the sand of the river beds was scoured away during the flood seasons.

In 1896 the first Vierendeel truss, in which the bracing consisted of a series of framed portals with rigid verticals and no diagonal members, was built for the Brussels Exhibition.

Apart from a few small cast iron swing bridges built in London early in the 19th century, the three main kinds of movable bridge, *i.e.*, bascules, swing spans, and the vertical-lift type, were evolved in the latter half of the century. The Tower Bridge in London (1886–94) is a double-leaf simple trunnion bascule which provides an opening 250 ft. wide and is operated by hydraulic power derived from steam (fig. 6). The Kincardine Bridge (1936) over the River Forth in Scotland has a balanced swing span of 364 ft. in its overall length of 2,696 ft. The world's longest vertical-lift bridge, over the Arthur Kill between Staten Island and New Jersey, was completed in 1959 (*see* Table I). The lifting span of 558 ft. weighs 2,000 tons. Transporter bridges, such as that at Middlesbrough over the Tees, on which traffic is carried on a moving platform suspended from an overhead structure, cannot cope with the demands of modern traffic and are now obsolete.

V. REINFORCED CONCRETE BRIDGES

Among the engineers to whom credit must be given for appreciating and demonstrating the possibilities of reinforced concrete as a new structural material are Robert Maillart of Switzerland and François Hennebique and Eugène Freyssinet of France. Visualizing the entirely novel forms of structure that could now be molded, with concrete resisting the compressive forces and steel bars taking the tension, Hennebique designed his bridges in sweeping curves, and Maillart showed how the basic element in reinforced concrete, which was the slab, replaced the beams, posts, and ties associated with steelwork design. From the start, Switzerland, France, and the Scandinavian countries took the lead, and the longest and most impressive reinforced spans were to be found in those nations.

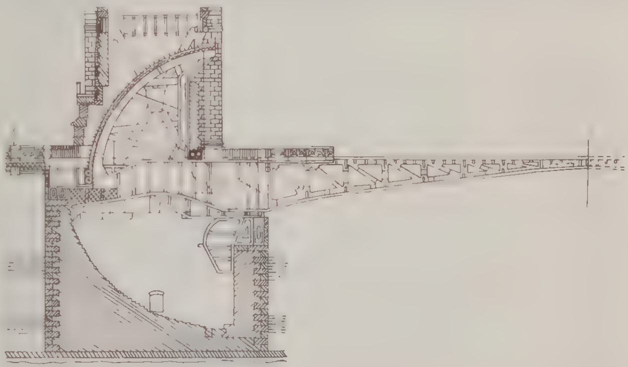
TABLE I.—*Longest-Span Movable Bridges*

Year completed	Bridge	Location	Span (in feet)
		Vertical Lift	
1959 . .	Arthur Kill*	Elizabeth, N.J.	558
1935 . .	Cape Cod Canal*	Massachusetts	544
1937 . .	Marine Parkway	New York City	540
		Swing Span	
1927 . .	Mississippi River	Fort Madison, Ia.*	525†
1908 . .	Willamette River	Portland, Ore.*	521†
1893 . .	Missouri River	East Omaha, Neb.	520†
		Bascule	
1941 . .	Sault Ste. Marie*	Michigan-Ontario	336
1940 . .	Erie Avenue	Lorain, O.	333
1917 . .	Tennessee River	Chattanooga, Tenn.	310

*Railway bridge. †Combined length including both arms.

The first notable reinforced concrete arch, the Pont de Châtellerault (1898) designed by Hennebique, had a span of 172 ft. Maillart, who was Hennebique's pupil, was the protagonist of "the structure as a whole." The first of his famous three-hinged arches, in which he combined the deck and the rib to produce closely integrated structures, was the Tavanasa Bridge, a span of 157 ft. over the Vorderrhein, Switz., which was unfortunately swept away by a landslide in 1927. In the construction of these bridges, Maillart recaptured the beauty of the fine old pointed arch of medieval times.

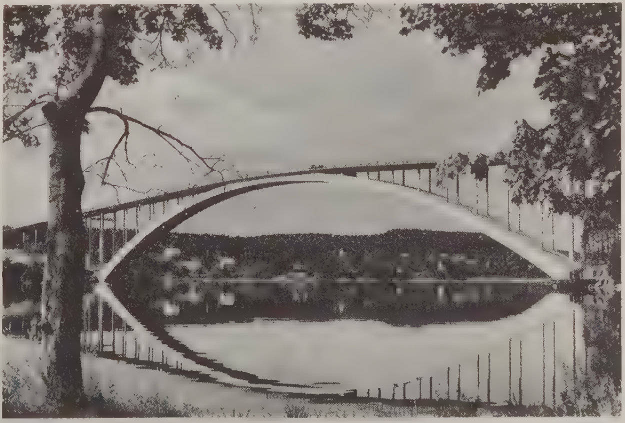
One of the biggest reinforced concrete bridges in the United States, the Tunkhannock Creek Viaduct, Pa., was completed in 1915. The overall length of the bridge, 2,375 ft., comprises ten semicircular arches of 180-ft. span which carry a double-track railway at a height of 240 ft. In Great Britain, the first major reinforced concrete structure was the Royal Tweed Bridge at Berwick, completed in 1928, which has four arch spans varying from 167 ft. to 361 ft. This was followed from 1935 to 1942 by the New Waterloo Bridge in London, designed by the firm of Rendel, Palmer, and Tritton in association with Sir Giles Gilbert Scott, which is considered by many people because of its slender simplicity and absence of decoration to be the finest bridge over the Thames.



REPRINTED WITH PERMISSION FROM O. E. HOVEY, "MOVABLE BRIDGES" (1927); JOHN WILEY & SONS, INC.

FIG. 6.—SECTIONAL ELEVATION OF BASCULE, TOWER BRIDGE, LONDON

In France, Freyssinet had built a record span of 432 ft. over the Seine at Saint-Pierre du Vauvray (1923), which he surpassed seven years later with the Albert-Louppe (or Plougastel) Bridge at Brest. The latter had three arch spans of 610 ft. The centring for this bridge consisted of a timber arch 500 ft. long and 90 ft. high, the ends of which were tied together by cables. It was built on shore, floated out on pontoons, and secured in place for con-



KLINTS FOTO, LUNDEVARV

SANDÖ BRIDGE, A REINFORCED CONCRETE ARCH BRIDGE, SPANS 866 FT. OVER THE ANGERMAN RIVER, SWEDEN; COMPLETED IN 1943

BY COURTESY OF (LEFT) CANADIAN NATIONAL RAILWAYS, (RIGHT) PORT OF NEW YORK AUTHORITY; PHOTOGRAPH, (BELOW) FRED LYON—RAPHO GUILLUMETTE

LONG-SPAN BRIDGES

(Left) Quebec Bridge across the St. Lawrence River, Canada, is a cantilever railroad bridge spanning 1,800 ft.; completed in 1918. (Right) Cable compactor working on the George Washington Bridge, New York City, during its erection over the Hudson River in 1930. (Below) Golden Gate, a suspension bridge, spans 4,200 ft. across the entrance to San Francisco Harbor; completed in 1937

creting each arch rib in turn. Freyssinet also endeavoured, by jacking the arch ribs at the crown, to eliminate internal stresses that would otherwise have been produced by shrinkage of the concrete.

In 1934 Sweden took the lead with the Traneberg Bridge in Stockholm, which has an arch of 593 ft. This was surpassed by the Esla Bridge in Spain with a 631-ft. span completed in 1942, but a year later Sweden regained the lead with the 866-ft. span of the Sandö Bridge, designed by C. R. Kolm, over the Angerman River (*see* Table II). In 1939, during the concreting of the rib, the centring—a timber-framed tied arch with a span of 810 ft.—collapsed, its failure being ascribed to persistent damp weather and the long loading period. New centring of the bridge had to be built in the form of huge timber trestles supported on 13 groups of piles 130 ft. long, and the bridge was then successfully completed in 1943.

Precast-concrete girders are sometimes used for economy and speed of construction in multiple short-span bridges. A typical example is the San Mateo Bridge across San Francisco Bay, which has 1,054 precast spans of 30 ft. and 116 spans of 35 ft. One of the main advantages claimed for reinforced concrete bridges is that, if they are well designed and the construction is thoroughly supervised, they should be maintenance-free and not require cleaning and painting every few years, as do steel bridges. To achieve this, the concrete must have a solid weather-resisting surface free from cracks and honeycombs or, alternatively, it must be stone-faced. Facing is costly, but it obviates the risk of the appearance of the concrete deteriorating with age. A most successful example is the Waterloo Bridge in London, which is faced with slabs of Portland stone.

VI. LONG-SPAN BRIDGES

For a given ratio of strength to weight of materials, there is a maximum span for each type of bridge beyond which it would have an insufficient margin of strength to support the weight of traffic in addition to its own weight and any other forces to which it might be subject. For cantilever bridges built with modern high-tensile steel, the maximum span would approach 2,500 ft., and for arch bridges, 3,000 ft. On account of the much higher strength-to-weight ratio of steel-wire cables, as compared with structural steel, suspension bridges can be built with much longer spans. In a period of 80 years, the maximum span was increased from 1,500 to 4,260 ft. (*see* Table III), thus bearing out predictions made by Roebling in 1855. There is little doubt that with modern materials engineers could build a suspension span two miles long.

1. Cantilever Bridges.—In 1904 work began on the first Quebec Bridge, which was to carry two railway tracks on a span of 1,800 ft. As the southern end of the suspended span was being erected, however, the whole of the structure on that side, some 20,000 tons of steel, collapsed. It was found that the failure was caused by buckling of the web plates of the compression chords, in which the lacing was too weak, and also by the connections being allowed to remain open and unriveted. Other grave disclosures, however, were that the specification was inadequate, the weight of the bridge was underestimated and the working stresses were unwarrantably high.

For the new design, high-tensile nickel steel was used for the main trusses and the width of the bridge was increased from 67 to 85 ft. All went well until the time came to lift the suspended span, which was 640 ft. long, weighed 5,000 tons, and had been floated out and attached to lifting links at the four corners of the cantilever arms. Suddenly one of the cross-shaped castings at the end of a lifting link failed and the span tilted, broke its back, and fell into the water. Within a year a new span had been made and successfully erected. Opened to traffic in August 1918, the bridge remains the longest cantilever span in the world. (*See* Table IV.)

Another great cantilever is the Howrah Bridge (1936–43) over the Hooghly River at Calcutta, which has a span of 1,500 ft. (fig. 7). This bridge is notable for the huge monolith foundations measuring 180 by 81 ft. in plan, the biggest ever sunk on land, required for the main piers. Each reinforced concrete monolith was divided into 21 wells 20 ft. square and was sunk by open excavating.

TABLE II.—*Longest Reinforced Concrete Arches*

Year completed	Bridge	Location	Clear span (in feet)
1964	Gladesville	Sydney, Austr.	1,000
1965	Friendship	Paraná River, Braz.	951
1963	Arrábida	Oporto, Port.	886
1943	Sandö	Angerman River, Swed.	866
1967	Shibenik	Krka River, Yugos.	808
1961	Fiumarella	Catanzaro, Italy	758
1961	Novi Sad	Danube River, Yugos.	692
1967	Lingenau	Bregenz, Aus.	689
1970	Van Stadens Gorge	South Africa	650
1942	Esla	Esla River, Spain	631
1929	Albert-Louppe	Brest, France	610
1934	Traneberg	Stockholm, Sweden	593
1953	Antas River	Brazil	590

The monolith on the Calcutta side was set at a depth of 103 ft. under compressed air. This technique was applied to each well in turn after a temporary air deck was fitted near the bottom of the well to form a working chamber—a method devised by H. J. Fereday and successfully used on a number of major bridges in India and Burma and also on the huge Lower Zambezi Bridge in Mozambique. The span of the Howrah Bridge has been surpassed by the Greater New Orleans Bridge (1958) and the Delaware River Bridge due for completion in 1971. (*See* Table IV.)

2. Arch Bridges.—The Sydney Harbour Bridge (1924–32), New South Wales, Austr., designed by Sir Ralph Freeman, may be considered the world's greatest steel arch because of its immense carrying capacity and the difficulties overcome in erecting such a huge span across a deep harbour in which no temporary supports were practicable. It has a span of 1,650 ft. and was built to carry four interurban rail or streetcar tracks, in addition to a roadway 57 ft. wide and two footpaths. Most of the 38,390 tons of riveted steelwork in the arch is of high-tensile silicon quality. The four-webbed, 11-ft.-wide chords of the arch, built up of 2-in.-thick plates and 12 by 12 in. angles, are the heaviest steelwork of this kind ever constructed. The two halves of the arch were built out as cantilevers, temporarily held back by means of wire-rope anchorages, until they met and were joined in the middle (fig. 8).

Another fine steel arch, the Bayonne Bridge over the Kill van Kull between Staten Island and Bayonne, N.J., was designed by O. H. Ammann after the commencement of Sydney Harbour Bridge and completed a few months before. It carries roadway traffic and was built over a shallow waterway which enabled the arch, which is 25 in. longer than that at Sydney, to be erected on temporary trestles. Three fine tied-arch bridges of lesser span are the Port Mann Bridge (1964), the Thatcher Ferry Bridge (1962), and the Trois-Rivières Bridge (1962), which have spans of 1,200 to 1,100 ft. (*See* Table V.)

3. Suspension Bridges.—In the series of suspension bridges of ever-increasing span built in the United States between World Wars I and II, cables of parallel wires were invariably used. Although the ultimate strength of wire increases as it is drawn thinner, it is found most economical to use wire of about 0.19 in. diameter. Moreover, the thicker the wire the less length there is to be spun to make up a cable of the necessary diameter. In Canada, cables of stranded-wire ropes have been adopted, notably on the Island of Orleans Bridge at Quebec (1935) and the 1,550-ft.-span Lions Gate Bridge at Vancouver (1938). A third variant, known as "locked-coil" cables, in which the outer wires of each strand are specially shaped so as to form a smooth circumference, was used in the Cologne-Mülheim Bridge over the Rhine.

TABLE III.—*Chronological Record of Maximum Spans Since 1820*

Year completed	Bridge	Location	Type	Span (in feet)
1826	Menai	Wales	Suspension	580
1834	Fribourg*	Switzerland	Suspension	870
1849	Wheeling	Wheeling, W. Va.	Suspension	1,010
1851	Niagara River*	Lewiston, N.Y.	Suspension	1,043
1867	Cincinnati	Cincinnati, O.	Suspension	1,057
1869	Niagara-Clifton*(1st)	Niagara Falls	Suspension	1,268
1883	Brooklyn	New York City	Suspension	1,595
1890	Forth†	Scotland	Cantilever	1,710
1918	Quebec†	Canada	Cantilever	1,800
1929	Ambassador	Detroit, Mich.	Suspension	1,850
1931	George Washington	New York City	Suspension	3,500
1937	Golden Gate	San Francisco, Calif.	Suspension	4,200
1964	Verrazano-Narrows	New York City	Suspension	4,260

*Not standing. †Railway bridge.

In the 1,750-ft. span of the Benjamin Franklin (Philadelphia-Camden) bridge (1926), cold-drawn parallel wire was used in the cables, and cellular construction (widely adopted subsequently) was employed for the first time in the design of the towers. In the endeavour to increase the allowable stress in the cables, heat-treated wires with a yield point 31% higher than that of cold-drawn wire were used in the bridge at Mount Hope, R.I., and in the 1,850-ft.-span Ambassador Bridge over the Detroit River, both completed in 1929. During erection of the cables, however, a number of broken wires were detected at the bends around the strand shoes at the anchorages. Investigation showed that the fine-grained, heat-treated wires could not withstand the alternating stresses to which they were subject; they had to be replaced by cold-drawn wire which has a tough, fibrous structure and can resist such stresses.

The next advance was O. H. Ammann's George Washington Bridge (1927–31), with a span of 3,500 ft., which was designed to carry two roadways, one above the other and sufficient for four to eight lanes of traffic respectively. Four cables 36 in. in diameter, each built up of 26,474 parallel galvanized wires with an ultimate strength of 98 tons per square inch, were used at a maximum working stress of 36½ tons per square inch. A unique feature of the bridge was that initially there were no stiffening trusses; at first, only the upper roadway was built (and that in two stages), but in 1962 the construction of the lower deck and of stiffening trusses between the two decks was completed. The great mass of wire in the cables (a total of 105,000 mi.) prompted a higher degree of mechanization in the cable erection than had ever been achieved before. Fig. 9 shows one of the cable anchorages.

TABLE IV.—*Longest-Span Cantilever Bridges*

Completion year	Bridge	Location	Clear span (in feet)
1918	Quebec*	Canada	1,800
1890	Forth*	Scotland	1,710
1971	Delaware River	Chester, Pa.	1,644
1958	Greater New Orleans	Mississippi River, La.	1,575
1943	Howrah	Calcutta, India	1,500
1936	Transbay	San Francisco, Calif.	1,400
1968	Baton Rouge	Mississippi River, La.	1,235
1955	Tappan Zee	Hudson River	1,212

*Railway bridge.

TABLE V.—*Longest-Span Steel-Arch Bridges*

Year completed	Bridge	Location	Clear span (in feet)
1931	Bayonne	New York City	1,652
1932	Sydney Harbour*	Australia	1,650
1964	Port Mann†	Fraser River, B.C.	1,200
1962	Thatcher Ferry†	Panama Canal	1,128
1962	Trois-Rivières†	St. Lawrence River, Que.	1,100
1967	Ždákov	Vltava River, Czech.	1,083
1961	Runcorn-Widnes	England	1,082
1935	Birchenough	Rhodesia	1,080
1959	Glen Canyon	Arizona	1,028
1962	Lewiston-Queenston	Niagara River	1,000
1917	Hell Gate*	New York City	977

*Railway bridge. †Tied arch.

In 1933, work began in San Francisco on two big suspension bridges, the double-decked Transbay Bridge designed by C. H. Purcell, which has an overall length of nearly 5¼ mi., and the huge Golden Gate Bridge designed by J. B. Strauss, which has a span of 4,200 ft. across the entrance to the harbour. A new method of pier construction devised for the Transbay Bridge consisted of groups of dome-capped steel cylinders, which were sunk by the controlled release of air pressure inside them. The excavation for one of the piers was carried to a depth of 242 ft. below sea level. For the Golden Gate Bridge, the south pier was built inside a huge reinforced concrete cofferdam placed on the bed of the ocean.

The Mackinac Bridge (1954–57), designed by D. B. Steinman, which has a span of 3,800 ft. across the Mackinac Straits in Michigan, is the third-longest suspension span yet built.

The Forth Road Bridge (1958–64) and the Severn Bridge (1961–66), in Great Britain, are the first major suspension bridges outside the United States to be built with parallel wire cables spun

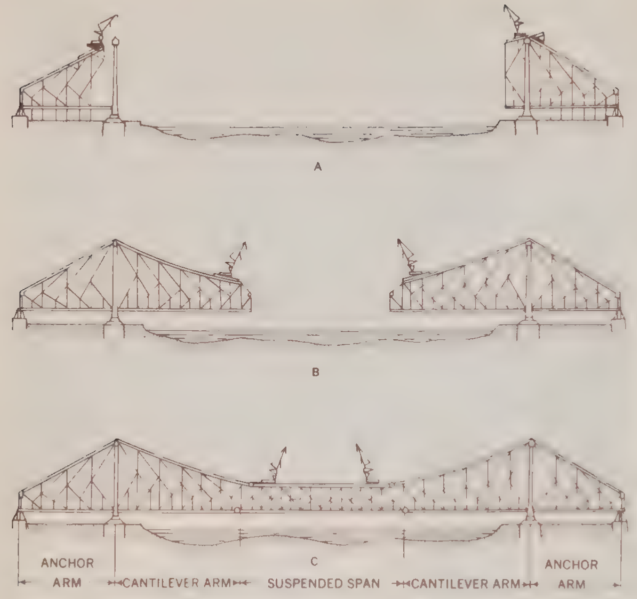


FIG. 7.—ERECTION OF HOWRAH BRIDGE, CALCUTTA, INDIA: (A) ANCHOR ARMS ERECTED ON STAGING; (B) ERECTION OF CANTILEVERS; (C) ERECTION OF SUSPENDED SPAN

in place. Although both exceed 3,000 ft. in span, they are lighter in weight, more slender, and more economical in cost than any other suspension bridges of comparable size. The design of the Severn Bridge embodies entirely new principles in that the deck consists of a shallow plated box girder, or airfoil, only 10 ft. deep, supported by suspenders which are inclined in order to damp out aerodynamic oscillation.

The Salazar Bridge, a 3,323-ft.-span suspension bridge over the Tagus River at Lisbon, Port., became Europe's longest span upon its completion in 1966. The bridge originally opened for road traffic, but its design includes plans for the addition of a lower-deck, double-track railway system. The longest single span in the world (4,260 ft.) is the Verrazano-Narrows Bridge (1959–64) at the entrance to New York Harbor. This massive bridge, containing 150,000 tons of structural steelwork, has two decks, each designed to carry six lanes of traffic.

TABLE VI.—*Longest-Span Suspension Bridges*

Year completed	Bridge	Location	Clear span (in feet)
1964 . .	Verrazano-Narrows	New York City	4,260
1937 . .	Golden Gate	San Francisco, Calif.	4,200
1957 . .	Mackinac	Mackinac Straits, Mich.	3,800
1931 . .	George Washington	New York City	3,500
1966 . .	Salazar	Lisbon, Port.	3,323
1964 . .	Forth Road	South Queensferry, Scot.	3,300
1966 . .	Severn	Beachley, Eng.	3,240
1950 . .	Tacoma Narrows II	Puget Sound, Wash.	2,800
1967 . .	Angostura	Venezuela	2,336
1936 . .	Transbay	San Francisco, Calif.	2,310
1939 . .	Bronx-Whitestone	New York City	2,300
1970 . .	Quebec Road	Quebec, Canada	2,190
1951 . .	Delaware Memorial	Wilmington, Del.	2,150
1968 . .	Second Delaware Memorial	Wilmington, Del.	2,150

Great suspension spans of the future include an accepted British design for the new Bosporus Straits Bridge, with a main span of 3,609 ft., and a new bridge over the Humber in England with a span of 4,580 ft., not expected to start construction before 1975. Both these bridges would be similar in type to the new Severn Bridge. There were also proposals for a bridge over the Messina Straits, where major difficulties are presented by the great depth of water (400 ft.) and the fact that the site is in a recently active earthquake area. Tentative schemes also have been put forward for bridges to cross the English Channel and the Gibraltar Straits.

4. Toll Bridges.—Long-span bridges are costly, and experience has shown that the most practicable manner in which they can be afforded is to build them as financially self-liquidating projects by charging tolls on the traffic using them. By this means, about 30 bridges varying in span from 1,000 to 4,200 ft. were built in the United States between 1920 and 1960, but not one was built in Britain, where it was hoped to finance them out of public funds.

The promotion of a new bridge project and its design, construction, and operation are probably best controlled by a bridge authority established by legislation. The necessary capital is raised by the issue to the public either of government-guaranteed bonds or of revenue bonds serviced by the proceeds from tolls. The toll charges for each type of vehicle are fixed by the authority and are generally less than the charges previously made on the ferries. New crossings tend not only to attract but also to generate traffic, and the majority of the toll bridges in the United States have paid their way handsomely from the start; none of them has experienced financial difficulties; on some the toll charges have been successively reduced; and a few have been freed from tolls altogether. Examples of toll bridges outside the United States include the Forth Road and Severn Bridges in Great Britain, the Salazar Bridge in Portugal, the Auckland Harbour Bridge in New Zealand, and the Tancarville Bridge in France.

VII. MODERN DEVELOPMENTS: GENERAL

Since World War II there has developed the greatest bridge-building era in history. This has no doubt partly been due to postwar reconstruction and development, but more to the unprecedented advance of the motorways.

1. Loadings and Forces.—The most important loadings and forces to which a bridge is subject are: its own weight; the weight of the traffic and its dynamic effects; natural forces set up by wind, changes in temperature, snow loads, earthquakes, etc.; and stresses arising temporarily during erection. As regards railway loadings, the bridge has to withstand not only the weight of the locomotives and rolling stock, but also the impact and effects of lurching and lateral motion of the locomotive. On the highways of several countries, vehicles weighing up to 200 tons are not uncommon, and new bridges must be designed to support them.

Considerable research has been carried out on wind forces, which can now be closely estimated, but wind-tunnel tests on a model are still advisable in assessing the effects of wind forces on a long-span suspension bridge. Although no bridge could be expected to withstand an earthquake of catastrophic force, bridges in India and New Zealand are designed to resist a horizontal force equal to

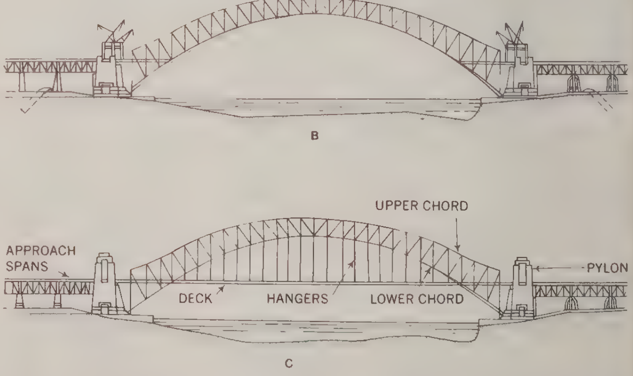


FIG. 8.—ERECTION OF SYDNEY HARBOUR BRIDGE, NEW SOUTH WALES, AUSTR.: (A) ARCH ERECTED AS TWO CANTILEVERS; (B) COMPLETION OF ARCH; (C) DECK AND PYLONS ERECTED

BY COURTESY OF THE (TOP LEFT) BRITISH STEEL CORPORATION, (BOTTOM LEFT) BRITISH TRAVEL ASSOCIATION; PHOTOGRAPH, (ABOVE) A. DEVANEY

RECENT SUSPENSION BRIDGES

(Top left) Section being raised into place on the Severn Bridge in Great Britain; completed in 1966. (Bottom left) The Forth Road Bridge at South Queensferry, Scotland, was completed in 1964. (Above) Verrazano-Narrows Bridge at the entrance to New York Harbor is the longest single span in the world (4,260 ft.); completed in 1964

one-tenth, and in Japan, Italy, and the U.S.S.R. to one-fifth, of the weight of the superstructure. Factors of safety are now considered from the point of view of "limit states," which are states in which the structure in whole or in part would cease to fulfill the function for which it was designed. The field is enormous, because the effect of numerous factors such as loading, impact, fatigue, and corrosion have to be assessed for different types of structures and materials of construction, and suitable margins of safety must be provided for various causes of failure such as deformation, buckling, fatigue, brittle fracture, or collapse of some element. While conferring greater uniformity of strength throughout all parts of the structure, this change in philosophy may also permit valuable savings to be made.

2. Aerodynamic Stability.—The collapse of the Tacoma Narrows Bridge at Puget Sound, Wash., in 1940, only four months after its completion and after more than 50 years of immunity from failure of this kind, brought the study of aerodynamic stability sharply to the fore. This bridge was by far the most flexible among its contemporaries. It had a span of 2,800 ft. with a width of only 39 ft., and the deck was stiffened throughout its length by means of plate girders 8 ft. deep. Under quite moderate winds, the deck not only swayed sideways but was subject to severe torsional vibration and ultimately, in a wind of only 42 mph, the vibrations became so violent that the deck was torn away and crashed into the water. Other fine U.S. suspension bridges have also shown undesirable aerodynamic action, and further bracing or stiffening has been incorporated.

In spite of tests in wind tunnels of models of bridges and their components, the explanation of aerodynamic instability is a matter of theory on which conflicting opinions are held; but a number of general requirements for avoiding it have now been established. One method is to open the structure to the wind wherever possible by employing latticed stiffening trusses and cross girders and leaving longitudinal slots along the deck between the dual roadways and the girders. Rigidity can also be increased by providing upper and lower lateral systems in the deck, by employing diagonal cable stays from the towers, and even by anchoring the main cables to the deck at the centre of the span. All these features, except the diagonal stays and the central anchorage of main cables to the deck, were adopted for the second Tacoma Narrows Bridge, completed in 1950, in which width and rigidity were considerably increased as compared with those of its predecessor, and for the Mackinac Bridge.

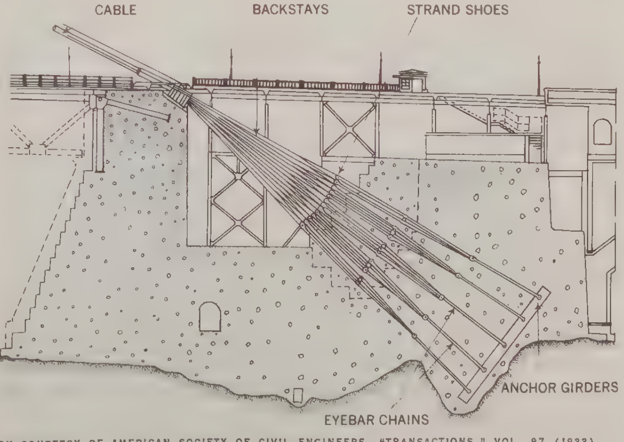
Another method is to shape the deck like a shallow airfoil, plated all round, and to employ inclined hangers as in the final design of the Severn Bridge.

3. Foundations.—The most significant trend in foundation design is the tendency to support bridge piers on groups of large-diameter piles or thin-shelled cylinders where possible in preference to using pneumatic caissons. In the foundations of the Narrows Bridge, completed in 1959 over the Swan River at Perth, Austr., 180 long piles nearly 3 ft. in diameter were used. These were driven as hollow cylinders by means of a hammer running inside the pile and striking near its foot, and they were subsequently reinforced and concreted. For the huge Wu-Han double-deck rail and road bridge started in 1955 and completed in 1957, over the Yangtze River in China, a new system of "colonnade" foundations on large-diameter piles was designed by the Soviet specialist A. I. Silin-Bekchurin.

In the Tasman Bridge, Hobart, Tas. (1965), the foundations are of bored cylinder piles some of which penetrate to a depth of 260 ft. The three cylinder piles used per pier of the 3-mi.-long Eastern Scheldt Bridge (1965) in the Netherlands are 14 ft. in diameter, with walls 14 in. thick and up to 165 ft. in length.

In the U.S.S.R., thin-shelled reinforced or prestressed concrete cylinders are used, whose diameters vary from 5 to 20 ft., and shell thickness is between 3 and 3½ in. The cylinders are sunk by vibro pile drivers rated up to 155 kw., which have an exciting force of 250 tons, and can drive 20-ft.-diameter cylinders to a depth of 130 ft. (*See* FOUNDATIONS, STRUCTURAL.)

4. Aesthetics.—Throughout the ages there have been engineers who achieved beauty in their bridges, but in spite of their example vast numbers of purely utilitarian structures have been built. Today it is accepted that economy and function are not the only criteria but that any new bridge should be a work of art, designed to harmonize with its surroundings and to give satisfaction to the



BY COURTESY OF AMERICAN SOCIETY OF CIVIL ENGINEERS, "TRANSACTIONS," VOL. 97 (1933)

FIG. 9.—CABLE ANCHORAGE ON GEORGE WASHINGTON SUSPENSION BRIDGE, NEW YORK CITY

eye of the engineer and layman alike. To this end, a number of societies are active, such as the American Institute of Steel Construction, which gives awards for the most beautiful steel bridges built each year.

In Britain, the public authorities have a considerable degree of control, and, in addition, designs for new bridges of importance have to be approved by the Royal Fine Art Commission. Highway construction entails the building of many bridges, the design of which largely determines the architectural character of these highways and the way in which they blend with the surrounding countryside.

VIII. MODERN DEVELOPMENTS: STEEL

Research in steelwork has concentrated on the commercial production of structural steel of high-tensile quality that is also suitable for electric-arc welding and for fabrication by flame cutting. Other important qualities sought include notch ductility and resistance to fatigue and corrosion. New forms of connection include welding, which reduces the weight of the structure, and the use of friction-grip bolts. Steel trusses may be built of all-welded mild or high-tensile tubular members; hollow rectangular sections up to 13 in. square and 1 in. thick, which are seamless and rolled, can now be obtained. For bearings of bridges, Meehanite, a form of cast iron, is increasingly used, and expansion joints may be built up of layers of rubber bonded between steel plates. The destruction of bridges in Europe and elsewhere during World War II gave bridge builders a great opportunity for the development of new forms. In Germany this led to the construction of many fine box-girder bridges over the Rhine and elsewhere, in which remarkable savings in material were achieved, and later to the evolution of the cable-braced girder. A new form of stiffened steel plate deck known as a "battle deck" was evolved, and composite construction in steel and concrete came into general use. Attention has also been paid to the mechanical cleaning of steelwork and methods to be used for its protection.

BY COURTESY OF SIR WILLIAM HALCROW & PARTNERS AND FREEMAN, FOX & PARTNERS

THE 805-FT. VOLTA BRIDGE IN GHANA REPRESENTS A MAJOR TECHNICAL ADVANCE. ITS SITE CONNECTIONS WERE MADE WITH LONGITUDINAL HIGH-STRENGTH FRICTION-GRIP BOLTS; COMPLETED IN 1956

1. High-Tensile Steel.—For girder bridges of span greater than 300 ft., steel should be the most economical material to use; for arches, the critical span is longer. As the length increases, low-alloy or high-tensile steel is preferable to mild steel (*see* STEELS, ALLOY). The saving in weight on long spans is shown by the fact that on the Sydney Harbour Bridge every ton of steel in the arch requires 0.7 tons to support it. With their yield point of 23 tons per square inch, low-alloy steels can be used at substantially higher working stresses than mild steel, which has a yield point of 16 tons per square inch. Among low-alloy steels suitable for welding are St 52–3 (West German), A 52 (Belgian), A 242–55 (U.S.), and steel manufactured to British standard 968. They cost little more to produce than mild steel but are not usually so readily available. Other special steels, such as the U.S. T-1, which has a yield point of over 40 tons per square inch, have been produced, but their cost is double that of mild steel. Nevertheless, about 3,000 tons of weldable quality T-1 steel were used in the second Carquinez Bridge (1958) near San Francisco, the allowable working stresses being 20 tons per square inch in tension and 16 tons per square inch in compression.

Laminations in steel plates become a much more serious defect in welded than in riveted work, and a system of ultrasonic tests has been evolved whereby laminations can be detected before fabrication. Light alloys such as aluminum may play a greater part in bridge construction when they become less costly. They have been used to make light service spans required for the erection of bridges, and also to reconstruct the decks of old bridges at reduced weight.

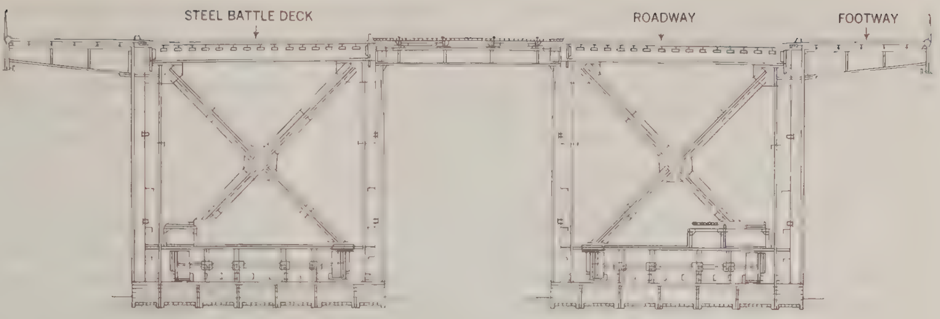
2. Shop Fabrication and Erection.—Shop fabrication now includes the use of profile burners whereby steel can be flame-cut and the edges beveled for welding, if required; rotary jigs are used for assembly of members, and automatic submerged-arc machines, which give complete penetration, are used for welding the seams of columns or girders. The quality of the welds can be determined by means of X-ray and gamma-ray photographs.

For erection on the site, welding may be used for plate girders but it is not usually suitable for trusses. Riveting has been largely superseded by the use of friction-grip bolts, which can be used in clearance holes and act as high-tension clamps. Pneumatic wrenches are used to tighten the bolts and calibrated torque wrenches to check their tension. This system is quicker, cleaner, more efficient, and more economical than riveting, and modern workmen much prefer it. It was used in the erection of the Forth Road Bridge, the Mackinac and Carquinez bridges in the United States, and the Volta Bridge in Ghana. The method in which these bolts were used in the 805-ft. steel arch of the Volta Bridge represents a major advance in bridge-building technique. At the connections between the chord members, four friction-grip bolts were used longitudinally as pretensioned ties, so arranged as to interconnect pairs of plates welded across the corners of the section. During erection of the two halves of the arch as cantilevers, therefore, the stability of the structure depended on these groups of bolts acting in tension in the connections of the upper chords.

3. Brittle Fracture.—The catastrophic failure of the all-welded Duplessis Bridge at Trois-Rivières, Can., at a temperature of −30° F (−34.4° C) on Feb. 1, 1951, followed by that of the double-deck Kings Bridge in Melbourne in July 1962, were both ascribed to brittle fracture, owing to the notch-sensitive nature of the steel used and the low temperature prevailing at the time.

The risk of brittle fracture is enhanced by welding because welding not only tends to cause changes in local stress ratings, which may initiate failures, but also increases the critical temperature at which they may occur. Moreover, it encourages the use of single, thick flange plates, which are more susceptible to fracture than the multiple thin plates used in riveted work. The fracture of a single thick plate is obviously much more serious than the failure of one of a number of thin plates; furthermore, in riveted work, cracks may be arrested by rivet holes. To obviate the risk of brittle fracture, notch-ductile steel has been evolved in a number of countries; four grades (of mild-steel quality) are now manufactured to British standard 2762, and high-tensile notch-ductile steels are rolled in Sweden and West Germany (St 52).

4. Fatigue.—Fatigue in metal is the lowering of the ultimate strength of the metal and the formation of cracks as a result of continual variations of stress. Its degree is dependent on the intensity of the stress and the number of variations. As might be expected, fatigue of steel represents a major problem to engineers responsible for the design and maintenance of railway bridges and their decks. Research has been directed to obtaining all possible data as to the number and nature of the stress cycles to which bridges are subject and to the production of types of construction and a quality of steel that can best withstand them.



FROM "CIVIL ENGINEERING"

FIG. 10.—CROSS SECTION THROUGH RIVER SPAN AT PIERS OF DÜSSELDORF-NEUSS BRIDGE, GERMANY; 1950–51

5. Protection of Steelwork.—A group of "weathering" steels is now being developed for use in bridgework. The rust coat that forms on these steels—the best known of which in Britain is "Corten"—protects the steel beneath from any further corrosion. But most structural steelwork is still best protected by grit blasting, metal spraying, and painting. It is important that protective coatings of paint or metal should be applied immediately after grit blasting, while the surface of the steel is clean and dry. If metal spraying is adopted, zinc or aluminum is generally applied, the thickness of the coat varying from 0.002 in. to 0.006 in.; although this metal coat will protect the steelwork, it is usually protected in turn by painting. Satisfactory maintenance of steelwork further depends on the care taken in designing the details so as to avoid pockets, slots, or traps of any kind in which water can lodge and in insuring that no part is inaccessible for cleaning or painting (except, of course, the interior of wholly enclosed box members).

6. Battle Decks and Composite Construction.—Battle decks, first used in ships but adapted for bridges after World War II, consist of decks made of flat steel plates welded together and stiffened by means of flats, angles, or some other section welded on the underside (fig. 10). Further economy can be achieved by making the deck act integrally with the main members of the bridge, becoming in effect the top flange of a box girder. Battle decks are economical on long spans, where their saving in weight is important. However, they require more maintenance than do reinforced concrete slabs.

In "composite" construction, the concrete roadway slab is anchored by means of shear connectors to the steel girders and made to act in conjunction with them. This form of deck was used on an all-welded steel highway bridge with a span of 334 ft. over the Moscow River in the U.S.S.R. (1956). In the 1,240-ft. Cologne-Rodenkirchen Bridge over the Rhine (1954), the concrete deck was prestressed; it not only carries the traffic but also acts as part of the upper chord of the stiffening trusses and provides lateral bracing for the main span.

On both steel and concrete decks, waterproofing and wearing surfaces have to be provided. These are frequently of asphalt with granite chips, but experiments have been made involving the application of a very thin layer of rubber compound as protection for a steel battle deck.

7. Box Girders and Trusses.—The Cologne-Deutz Bridge (1947–48), the first of the big postwar box-girder spans over the Rhine, showed what major advances in appearance, span, and economy could be made by taking full advantage of modern techniques. In the triple box girders of this bridge, stiffened web plates 25 ft. deep over the piers and only $\frac{5}{8}$ in. to $\frac{1}{2}$ in. thick were first employed. Much of the 5,760 tons of steelwork is high-tensile (St 52), and its weight is only 61% of the steelwork in the old bridge it replaces.

The longest box-girder bridge built up to 1970 was the 40-ft.-wide roadway bridge across the Sava River at Belgrade, completed in 1957, which has a span of 856 ft. and replaces the King Alexander suspension bridge. Designed by a West German firm, it consists of an inverted U-shaped girder of high-tensile steel.

A further development, in which the girders are supported by groups of prestressed cables passing over the tops of towers on the main piers, was first introduced in the Strömsund Highway Bridge in Sweden (1956). This method was adopted in the North Bridge (1957), since renamed the Theodor Heuss Bridge, over the Rhine at Düsseldorf, which has a main span of 853 ft. The two box girders, of shop-welded St 52 steel, are supported by three parallel tiers of cables that were prestressed during erection. In the Severin Bridge (1959) at Cologne, there is a cable-braced span of 991 ft. supported by three sets of cables which pass over the top of an A-shaped tower built on a pier near the east bank (fig. 11). The first monocable bridge was that over the Elbe at Hamburg (1961). The 564-ft. span was braced by cables only on the longitudinal centre line of the bridge. The towers over which they pass consist of single posts and have the dual roadways on either side.

Since then many cable-braced bridges have been built or are being built, mostly in West Germany, the longest being that of the Duisburg-Neuenkamp Bridge with a span of 1,148 ft., due for completion in 1970 (*see* Table VII). Mono cables have only about 70% of the weight of dual cables because they are less affected by unsymmetrical live load. The 675-ft. span Batman Bridge (1968) in Tasmania is the first asymmetrical cable-stayed structure in which the single A-frame pylon at one end is inclined toward the river at an angle of 20° to the vertical.

TABLE VII.—*Longest-Span Truss or Girder Bridges*

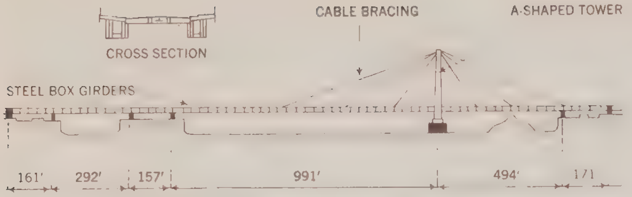
Year completed	Bridge	Location	Type	Span (in feet)
1966	Astoria	Astoria, Ore.	Truss	1,232
1970	Duisburg-Neuenkamp	Duisburg, Ger.	Cable braced	1,148
1970	Lower Yarra	Melbourne, Austr.	Cable braced	1,102
1969	Kniebrücke	Düsseldorf, Ger.	Cable braced	1,050
1970	Erskine	Glasgow, Scot.	Cable braced	1,000
1970	Bratislava	Czechoslovakia	Cable braced	994
1959	Severin	Cologne, Ger.	Cable braced	991
1966	Tenmon	Kumamoto, Jap.	Truss	984
1969	Mannheim-Nord	Mannheim, Ger.	Cable braced	951
1965	Leverkusen	Leverkusen, Ger.	Cable braced	919
1967	Bonn-Nord	Bonn, Ger.	Cable braced	919
1957	Sava River	Belgrade, Yugos.	Box girder	856
1957	Theodor Heuss	Düsseldorf, Ger.	Cable braced	853
1966	Zoobrücke	Cologne, Ger.	Box girder	850
1943	Dubuque	Dubuque, Ia.	Truss	845
1964	Somerset	Somerset, Mass.	Truss	840

In the United States and Japan, for spans in the 800 to 1,250 ft. range, continuous truss bridges are favoured, the longest span of 1,232 ft. being that of the Astoria Bridge in Oregon, completed in 1966.

IX. MODERN DEVELOPMENTS: CONCRETE

1. Prestressed Concrete Bridges.—The process of prestressing concrete, which consists of putting it into a state of compression by tensioning steel wires or bars that pass through it, was conceived at the beginning of the 20th century and undoubtedly represents the most important advance to have taken place in bridge construction since reinforced concrete came into general use. The economies in material which prestressing rendered possible led to its rapid development in the period of shortages during and after World War II.

To obtain the full benefits of the process, concrete of high quality and strength is necessary. Rapid advances in concrete technology have resulted in its strength being doubled and its surface greatly improved since World War II. The use of precast sections, often of substantial size, supported on novel systems of cantilev-



FROM "STAHLBAU-TASCHENKALENDER"

FIG. 11.—SEVERIN BRIDGE AT COLOGNE, WEST GERMANY

ered and suspended centring and thereafter prestressed, have led to a marked increase in the length of simple or continuous spans, which can be built economically up to lengths of 400 ft. or more.

Quality of Concrete.—Concrete can be made with an ultimate compression strength of 8,000 to 12,000 psi. This permits working stresses in the range of 2,000 to 3,000 psi, but the upper limit must not be exceeded because, beyond it, the rate of creep (*i.e.*, nonelastic deformation resulting from stress) of the concrete increases too quickly. This improvement in quality was achieved by making further refinements in the mix, the water-to-cement ratio, and the grading of the aggregate, by improvements in vibrating and by innovations such as steam curing. Because of the thinness of the wire used in prestressed work, it is essential that it should be completely protected against corrosion. The necessity for elimination of cracks in the concrete and the production of a dense, flawless surface therefore become of first importance. The compression induced in the concrete tends to eliminate cracks, and new materials for forms, such as hardboard, have enabled the surface of the concrete, whether flat or curved, to be of good texture, free from imperfections, easy to clean, and pleasing to the eye.

Systems of Prestressing.—The credit for developing and popularizing construction in prestressed concrete belongs to Eugène Freyssinet (*q.v.*); the worldwide use of this material and the recognition of its potentialities stems from Freyssinet's single-minded conviction of its merit.

During World War II, when shortages of timber for forms and steel for reinforcement precluded the use of conventional reinforced concrete design, Freyssinet reconstructed bridges in Tunisia by designing them to be built of precast blocks subsequently assembled on site and prestressed. This was done by threading steel wires through holes left open in the blocks, tensioning the wires and grouting them in. Various systems of prestressing have since been evolved, but the most usual procedures are those outlined below. For reinforcement, high-tensile steel reinforcing bars with an ultimate strength of 64 to 72 tons per square inch are used at a working stress of about 45 tons per square inch. The bars are usually $\frac{1}{2}$ to $1\frac{1}{4}$ in. in diameter; they have rolled threads on the ends and may be smooth or ribbed. Alternatively, cables made up of 12 parallel steel wires 0.276 in. or 0.196 in. in diameter, with an ultimate strength of 90 to 110 tons per square inch (similar to those used in the parallel wire cables of suspension bridges), may be used at a working stress of about 70 tons per square inch. Another development has been the use of stranded-wire ropes from $\frac{3}{8}$ in. to $1\frac{1}{4}$ in. in diameter. There is always a loss of about 15% in the working stresses due to shrinkage and creep of the concrete and relaxation (reduction in stress intensity) of the steel.

TABLE VIII.—*Prestressed Concrete Bridges*

Completion year	Bridge	Location	Type	Principal spans (in feet)
1970	Wadi Kuf	Libya	Cable braced	983
1961	Maracaibo	Venezuela	Cable braced	775(5)
1964	Bendorf	Koblenz, Ger.	Cantilever	232-682-232
1963	Medway	Rochester, Eng.	Cantilever	312-500-312
1966	Amakusa	Japan	Cantilever	479
1964	Alnö	Sweden	Cantilever	439(3)-416
1972	Öland	Kalmar Sound, Swed.	Cantilever	426(6)
1971	New London	London, Eng.	Cantilever	260-340-260
1965	Eastern Scheldt	Netherlands	Cantilever	300(55)
1965	Kinnaird	British Columbia	Cantilever	262(3)-238(2)
1957	Moscow River	U.S.S.R.	Continuous	144-485-144
1968	Pont du Jour	Paris, France	Continuous	302
1966	Oléron	Gironde, France	Continuous	259(26)
1966	Nötesund	Orust, Swed.	Box girder	222-360-222
1968	Semorile Gorge	Italy	Box girder	161(5)
1960	Mangfall Valley	West Germany	Latticed truss	295-354-295
1959	Luzhniki	U.S.S.R.	Tied arch	147(2)-354
1960	Mariakerke	Ghent, Belg.	Suspension	131-328-131
1957	St. Michel	Toulouse, France	Multiple portal	197-214(5)
1956	Pontchartrain I	Louisiana	Simple spans	56(2,170)

Before the concrete is cast, thin-gauge flexible sheathing is fixed permanently in position in the molds for the bars or wires to pass through; alternatively, inflated rubber ducts may be used for this purpose and withdrawn after the concrete has set. When the bars or wires have been placed in position they are tensioned; in reinforcing bars the tension is held by screwing nuts on the ends of the bar against steel anchor plates; if wires are used, the tensioning is done by means of double-acting hydraulic jacks, after which the wires are held by wedges. Colloidal cement is then forced into the sheaths under pressure to grout in the wires or bars and prevent corrosion or slip.

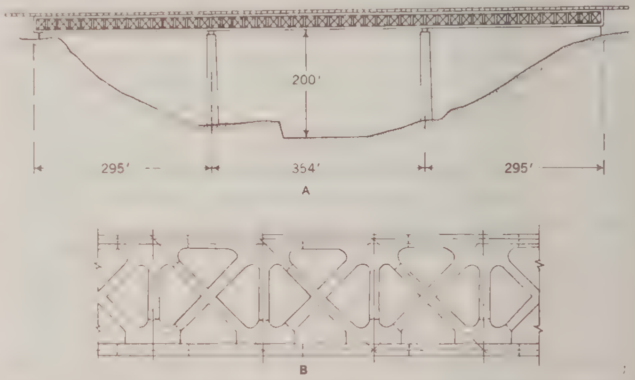


FIG. 12.—(A) FIRST PRESTRESSED CONCRETE LATTICED TRUSS, MANGFALL VALLEY BRIDGE, WEST GERMANY; (B) DETAIL OF TRUSS

The amount of prestress is usually made greater than the tension stress that would otherwise be induced under full dead and live load. The method can be applied to concrete whether it is poured *in situ* or precast. On account of the great saving in material, which amounts to at least one-third of the volume of concrete, and three-quarters of the weight of reinforcement that would otherwise be used, prestressed concrete bridges are striking in their slender proportions. They are also economical in cost, provided the necessary trained labour is available, and in favourable circumstances may be competitive with structural steel designs for spans up to about 500 ft. Because of the very high stresses employed, skilled supervision is, of course, essential throughout the work. Moreover, any fracture or accidental damage to the highly stressed concrete in a critical place may precipitate failure of the structure.

Types of Bridges.—(*See* Table VIII.) A wide variety of designs, including simple or continuous beams, cantilevers, arches, bowstring or latticed girders, and single or multiple portals, can be made with prestressed concrete. For spans up to 140 ft. simply supported beams are generally the most economical. The Vauban Highway Bridge (1956) in Strasbourg has 4 simple spans of 120, 135, 120, and 69 ft. each, consisting of 8 beams of I-section, prestressed by 17 cables, each having 12 wires 0.276 in. in diameter. The two longest causeways in the world, over Lake Pontchartrain, La., each more than 24 mi. long, are built of a series of simple spans.

As the span increases, continuous beams, as used in the Oléron Viaduct (1966) in France, with 26 spans of 259 ft., become economical. A bridge built over the Moscow River, U.S.S.R., in 1957 has three continuous prestressed concrete spans of 144, 485, and 144 ft. respectively. For still longer spans cantilever bridges may be used of which there are some fine modern examples. The 500-ft. span of the Medway Bridge (1963) at Rochester, Eng., has since been surpassed by the record 682-ft. span of the Bendorf Bridge completed in 1964 in Koblenz, W.Ger. It is interesting to note that the Bendorf Bridge, together with two other major cantilever bridges, the Eastern Scheldt Bridge (1965) in the Netherlands and the Öland Bridge, due for completion in 1972 in Sweden, are designed as twin cantilevers with no suspended spans. At the end of 1967 work began on the demolition of John Rennie's London Bridge which was due to be replaced by a prestressed concrete cantilever structure (*see* Table VIII). The masonry facades of the old arches were sold to a private developer for re-erection at Lake Havasu in Arizona.

Concrete arch bridges are rarely prestressed to any significant extent, because an arch is normally in compression by virtue of its shape. The Luzhniki Bridge (1959) in the U.S.S.R., however, is a prestressed concrete tied arch, with spans of 147, 354, and 147 ft. Portal bridges and multiple portals with either vertical or sloping legs simply represent an angular type of arch and are so shaped that prestressing can be employed to modify the line of thrust due to the external load, so that the resultant thrust is kept within allowable limits. A fine multiple portal with sloping legs is the St. Michel Bridge (1957) at Toulouse, France, which has one span of 197 ft. and five of 214 ft. each.

Bridges of latticed construction are economical in material but the unit costs are high; the saving in weight, however, makes it possible to achieve longer spans. The first prestressed concrete latticed girder bridge constructed was the Mangfall Valley Bridge (1958–60) with three spans of 295, 354, and 295 ft. over the Munich-Salzburg highway in West Germany (fig. 12).

The first self-anchored suspension bridges with continuous stiffening trusses were built by M. D. Vandepitte of Belgium. These are the Merelbeke (fig. 13) and Mariakerke bridges near Ghent, with main spans of 185 ft. and 328 ft. respectively. A novel method for prestressing the girders on the Merelbeke Bridge consisted in jacking up the towers, which were independent of the deck and stiffening girders, by 14½ in. The jacks were then replaced by permanent steel castings.

A novel form of construction was adopted by R. Morandi of Italy for the five 775-ft. navigation spans of the 5½-mi.-long multi-span bridge over the Maracaibo Lagoon in Venezuela (1958–61). These are designed as six continuous beams in prestressed concrete, supported on double-X trestles below and by tension cables above. The cables pass over the top of A-shaped towers on the piers and are connected near the ends of each beam. Another bridge of this type with a span of 983 ft. was being built over the Wadi Kuf Valley in Libya. The suspension cables that support the bridge deck pass over concrete towers and are encased throughout their length in precast concrete units which are then grouted and stressed to protect the cables from extremes of temperature.

Methods of Construction.—Prestressed concrete bridges can be built: (1) by assembly of precast units at the site; (2) by casting *in situ;* and (3) by a combination of precasting and casting *in situ.*

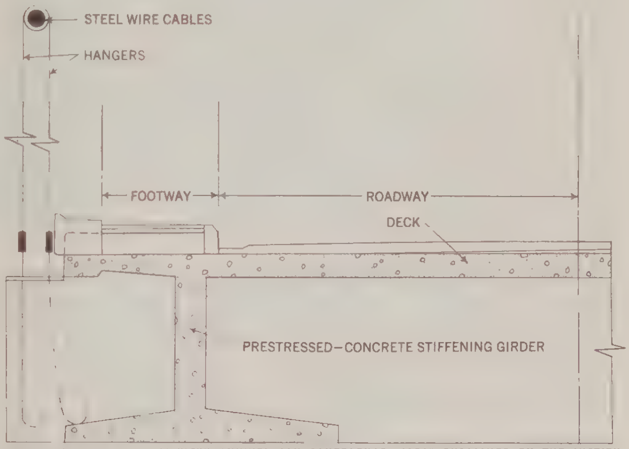
The Narrows Bridge (1959), which has five spans of 160, 230, 320, 230, and 160 ft. and carries a 76-ft.-wide roadway over the Swan River at Perth, Austr., is a fine example of a bridge built up of precast units and subsequently prestressed after assembly at the site.

The world's longest precast structure was the 24-mi. Lake Pontchartrain Causeway I (1956) in Louisiana—since surpassed by the construction of Lake Pontchartrain Causeway II (1969). The first causeway consisted of a series of spans 56 ft. long and 28 ft. wide, supported by beams resting on hollow prestressed concrete piles. Each span, made up of seven beams and the roadway slab, was precast in one piece and erected by means of a floating crane. So well was the work organized that eight spans weighing 180 tons each and comprising 448 ft. of bridge were placed each day.

Precasting has been widely adopted in the Soviet Union, an outstanding example being the huge two-level bridge (1959) over the Moscow River at Luzhniki which, with its approaches, measures 6,660 ft. and carries a six-lane roadway on the upper deck and interurban railways below. The three spans of 147, 354, and 147 ft. over the river were assembled in halves longitudinally on the foreshore from large precast units, floated out on barges, and set on the piers. In the U.S.S.R., standardization developed to such an extent that by 1958 reinforced concrete designs were automatically adopted for new railway bridges with spans less than 50 ft. and prestressed concrete designs for spans of 50 to 90 ft. Methods of heating that would enable concrete to be poured safely in freezing weather were actively investigated.

Casting *in situ* is more likely to be economical where there is little, if any, repetition work; this technique was adopted for the three magnificent arches of 498, 479, and 452 ft. respectively, designed by Freyssinet in 1953 for the new Caracas-La Guaira highway in Venezuela. In these bridges the decks were prestressed longitudinally and laterally, and prestressing cables were used temporarily to relieve the arch ribs during erection. Cantilevered centring was built out from each springing for a quarter of the span length to support the forms. To concrete the remaining half span in the middle, timber forms shaped as a tied arch having a 265-ft. span were built in the valley below and hoisted into place.

A combination of precast and *in situ* construction may be economically used for continuous and cantilever bridges, the ends of the span near the piers being concreted *in situ* and the central parts precast. In the 214-ft. spans of the Casalmaggiore Bridge over the Po River in Italy, for example, the lengths over the piers and the cantilever arms were concreted *in situ,* but the 118-ft. suspended beams, each weighing 65 tons, were precast and erected by floating cranes. In the Mancunian Way, opened in Manchester, Eng., in 1967, although a high degree of standardization of precast units was achieved, it was found preferable to cast certain lengths of the overpass *in situ.*



FROM "REPORT OF THE FIFTIETH ANNIVERSARY CONFERENCE, 1958" PUBLISHED BY THE INSTITUTION OF STRUCTURAL ENGINEERS

FIG. 13.—CROSS SECTION OF MERELBEKE SUSPENSION BRIDGE, BELGIUM

2. Modern Reinforced Concrete Bridges.—Two fine examples in Portugal are the low, slender arch over the River Tua at Abreiro (1957), which has a rise-to-span ratio of only one-tenth, and the 886-ft. fixed arch of the Arrábida Highway Bridge over the Douro River.

This span was surpassed in 1965 by that of the Friendship Bridge over the Paraná River between Brazil and Paraguay, and by the Gladesville Bridge in Australia (1964), with its span of 1,000 ft. over the Parramatta River. *See* also references under "Bridges" in the Index.

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E. Freyssinet, "Pre-Stressed Concrete," *J. Instn. Civ. Engrs.* (1950); Y. Guyon, "Long-Span Prestressed Concrete Bridges Constructed by the Freyssinet System," *J. Instn. Civ. Engrs.* (1957); J. K. Anderson *et al.*, "Forth Road Bridge," *Proc. Instn. Civ. Engrs.* (Nov. 1965); "Verrazano-Narrows Bridge," *Proc. Am. Soc. Civ. Engrs.* (March 1966); Sir Gilbert Roberts *et al.*, "Severn Bridge," *Proc. Instn. Civ. Engrs.* (Sept. 1968). (H. S.-Sm.)

BRIDGET (Birgitta, Birgit), **SAINT,** of Sweden (*c.* 1303–1373), the foundress of the Brigittine Order and a mystic whose revelations were influential in the Middle Ages, was the daughter of Birger Persson, governor of Uppland. From an early age she had remarkable spiritual favours, including a vision of Christ crucified which influenced her whole life and outlook. In 1316 she married Ulf Gudmarsson, later governor of the province of Nericia. They had eight children, one of whom was St. Catherine of Sweden.

On Ulf's death in 1344, Bridget retired to a life of penance and prayer near the Cistercian monastery of Alvastra on Lake Vetter. To the prior, Peter Olafsson, she dictated the revelations that came to her, and he translated them into Latin. One of these revelations was a command to found a new religious order. This after long waiting, she was eventually able to do (*see* Brigittines), receiving the necessary papal permission in 1370. She went to Rome for the Holy Year of 1350, and remained there for the rest of her life, save for making several pilgrimages, the last of which was to the Holy Land in 1372. In Rome she exercised a wide apostolate among rich and poor, sheltering the homeless and sinners, giving God's messages of warning in times that were full of unrest and corruption. She worked untiringly, like St. Catherine of Siena after her, for the return of the pope from Avignon to Rome. Bridget died on July 23, 1373, and was canonized Oct. 7, 1391. Her feast day is October 8.

St. Bridget's revelations were first published in 1492; some of them were edited by L. Hollman in *Den heliga Birgittas Reuelaciones extrauagantes* (1956). A 15th-century English version was edited by W. P. Cumming (1929).

See H. M. Redpath, *God's Ambassadress* (1947); J. Jorgensen, *Saint Bridget of Sweden,* Eng. trans. by I. Lund, 2 vol. (1954). (Hn. L. R.)

BRIDGETON, a city in New Jersey, U.S., 40 mi. S of Philadelphia at the head of navigation on Cohansey Creek, the seat of Cumberland County.

By 1668 a few Quaker families, augmenting a scattering of earlier settlers, moved into the vicinity and founded what was to become Bridgeton. The first name of the hamlet was Cohansey Bridge from a bridge built to span the Cohansey in 1718. From this settlement evolved Bridge Town and later Bridgeton. In 1748, Cumberland County was separated from Salem County, and in the following year Bridgeton was made the county seat. Fewer than 12 families were there in 1754 when Daniel Elmer made a survey and laid out streets. Bridgeton was incorporated in 1864, and in 1907 adopted a commission form of government.

During the American Revolution a stage route was opened to Philadelphia, and in 1799 the old bridge was replaced by a drawbridge. The river served as the important means of transportation until 1862, when the railroad reached Bridgeton from Camden. The Broad Street Presbyterian Church, built in 1792 on land donated by a Quaker with funds from a lottery established by the legislature, is a good example of Georgian architecture of that period. In the adjacent churchyard is buried, with many Revolutionary soldiers, Gen. Joseph Bloomfield, governor of New Jersey (1801–02, 1803–12). At the well-preserved Gen. Giles Manor House, built in 1792, General La Fayette was entertained during his triumphal tour of the United States in 1824–25. In the second half of the 20th century, many Bridgeton residences dated back to the Colonial period. Tumbling Dam Park (1,000 ac.) surrounds a dam built in 1814 to form a mill pond, now called Sunset Lake, which provides bathing and fishing for Bridgeton residents. Along the raceway to the dam grow lotuses said to have been seeded by a sailor returning from Egypt early in the 19th century.

Among the first local industries was a woolen mill constructed in 1811. Three concerns which later became important contributors to Bridgeton's growth and the largest employers were a nail and iron works, originating in 1815; the first glass factory, built in 1830; and the first canning establishment, opened in 1860. Glass factories grew until there were at one time 20, all of which were later merged at the time of the introduction of automatic machinery into the industry. In the 20th century, fruit and vegetable canning and freezing was the largest Bridgeton industry.

Among the relics and documents exhibited by the Cumberland County Historical Society in the county courthouse is Bridgeton's liberty bell, cast in 1763, which was rung to help celebrate the signing of the Declaration of Independence.

For comparative population figures *see* the table in New Jersey: *Population.* (H. F. Wi.; X.)

BRIDGETOWN, capital and only port of entry of the island of Barbados in the West Indies, lies mainly on the wide curve of Carlisle Bay in the south. A built-up coastal strip stretches under various names for several miles on each side of the town proper. The population of Bridgetown and St. Michael (the parish in which the town is situated) was estimated to exceed 94,000 in the late 1960s.

Founded in 1628 and originally called Indian Bridge, Bridgetown is a crowded and picturesque mixture of old and new. Two blocks of public buildings, made of coral stone and opened in 1874, face each other in an attractive square. Across the larger and busy Trafalgar Square lies the Careenage, a narrow inlet in which schooners are still sometimes careened, or hove down onto one side, so they can be cleaned underneath. Broad Street, nearby, has some excellent shops. St. Michael's Anglican Cathedral, also of coral rock, was built—largely from the proceeds of a lottery—to replace a building destroyed in the great hurricane of 1780. Government House, which stands inland in a magnificent garden, represents the beginning of the 18th century, and the large "ministerial buildings" by the shores of Carlisle Bay, the mid-20th century. The Savannah, once the garrison parade ground, is a fine open space used for race meetings and other gatherings; Queen's Park contains tropical vegetation. Ships formerly had to anchor in Carlisle Bay and load and discharge by launch and lighter, until an artificial harbour adjoining the bay, protected by a large breakwater and with berths for eight oceangoing vessels, became fully operational in 1961. (P. H.-My.)

BRIDGING, MILITARY. In the course of most military operations it is necessary to cross rivers at places where no bridges exist or where they have been demolished by the enemy. It is the duty of the engineers of an army to provide the means for such crossings. For small detachments, ferrying with boats or rafts is resorted to; but for forces of any size accompanied by artillery and tanks, bridges must be built.

Military bridges differ from civilian bridges (*see* Bridges) in being designed for speedy construction and in making use of temporary pinned or bolted connections to permit ready assembly, dismantling and reassembly. Military bridges are of two primary types: pontoon (or ponton in U.S. army usage) bridges in which a roadway is laid on floating supports; and fixed bridges, normally used over dry gaps or narrow streams, consisting of a roadway extending from one bank to the other, with or without intermediate supports. In terms of tactical use, military bridges fall into three classifications: assault bridges for use by front-line infantry troops, combat support bridges for use by supporting troops with heavy equipment, and line of communications bridges of more or less permanent construction in rear areas.

Floating or pontoon bridges may be speedily built and are most frequently employed by assault troops. Of the many types of fixed construction the most important are trestle bridges, in which the roadway is supported by a series of timber trestles; cribwork bridges, in which the supports consist of timber cribs usually filled with stone; pile bridges, suspension bridges and steel girder or truss bridges. As long as wagons and guns were drawn by animals the weight of vehicles was limited and the strength required of military bridges remained approximately constant until the beginning of the 20th century. With the introduction of motor vehicles and tanks, however, weights increased enormously and all bridging standards had to be reconsidered.

HISTORY AND DEVELOPMENT

From time immemorial floating bridges of vessels bearing a roadway of beams and planks were employed for the passage of rivers and arms of the sea. Xerxes crossed the Hellespont on a double bridge, one line supported on 360, the other on 314, vessels anchored head and stern with their keels in the direction of the current. Darius threw similar bridges across the Bosphorus and the Danube in his war against the Scythians, and the Ten Thousand employed a bridge of boats to cross the Tigris river in their retreat from Persia. Floating bridges were repeatedly constructed over rivers in Europe and Asia, not merely temporarily for the passage of an army, but permanently for the requirements of the country; and many of the great rivers in India were crossed by floating bridges, for the most part supported on boats such as those employed for ordinary traffic on the river. Alexander the Great is said to have carried his army over the Oxus by means of rafts made of the hide tents of his soldiers stuffed with straw when he found that all the river boats had been burned. Cyrus crossed the Euphrates on stuffed skins. In the 4th century the emperor Julian crossed the Tigris, Euphrates and other rivers by bridges of boats made of skins stretched over osier frames.

In later times bridges were supported on floating piers made of barrels lashed together. During World War I light footbridges for the assaulting infantry were frequently supported by floats composed of cork or empty gasoline tins held together in light crates.

Principles of Pontoon Equipments.—The devices mentioned above gradually passed out of use in military bridging, although the occasional use of light bridges and rafts buoyed up by empty oil drums and similar devices was recorded during World War II. A notable exception was the use of Rhine river barges as floating piers with a steel truss superstructure. Since these expedient bridges depended on materials to be found on the spot, no assurance could be had that suitable materials would be available, especially in sufficient quantities. Furthermore, in rapid-moving warfare, the collection of such materials took valuable time. For these reasons, special pontoon bridging was introduced, which had the added advantage of being adapted to rapid erection by a minimum number of trained troops. Transported by trucks and trailers or by trucks alone, the equipment could accompany an army and be available for use wherever required.

In the standard types of floating bridges at mid-20th century were two essential sections: the floating supports, or pontoons, and the superstructure. The pontoons, located at regular intervals along the bridge with their main axis parallel to the stream current, provide the buoyancy necessary to prevent the structure from sinking under the crossing loads. The superstructure serves as the roadway for the crossing vehicles and tanks and is designed to act as one piece when all parts are connected. By this continuity, the superstructure is stiff enough so that the weight of a 40-ton tank is actually transferred to as many as seven pontoons, the farthest of which may be 45 ft. from the centre of the tank. Thus, a floating bridge having pontoons capable of supporting only about 18 tons each can be used to support 40-ton tanks. By such means the weight of the bridge is held to a minimum.

The superstructure of military bridges may generally be divided into three types: the "balk and chess" type, the treadway type and the truss type. The first type, particularly adapted to hand erection, employs wooden or steel beams called balk spanning the intervals between pontoons and supporting the wooden transverse deck planking technically known as chess. Pre-World War II bridges were generally of this type. The second type, a product of World War II, was a bridge type suited to erection by mechanical equipment only, and had a superstructure consisting of pairs of steel treadways placed lengthwise across each pontoon to form trackways for the wheels or tracks of the crossing vehicles. The third type, generally resulting from the adaptation of equipment developed for dry-gap bridging to floating-bridge purposes, could be either a through truss or deck truss arrangement. Because of the high stiffness required, articulating connectors were placed at frequent intervals so that the trusses would not be overstressed before full displacement of the pontoons was realized.

The pontoons, in turn, are of two general types: rigid and pneumatic. The rigid pontoons are usually flat bottomed with scow-shaped bows and either with or without a deck. With the deck, the pontoon can be loaded to lesser freeboards but its interior is inaccessible for repair, is less convenient for use as a boat, and the pontoons cannot be nested to reduce transportation space. The pneumatic pontoon, or float, generally has three rubberized fabric main tubes which are inflated prior to use. A saddle placed on top of, and the full length of, the pneumatic float and tied to it by straps serves to stiffen the float and provides for the connection with the superstructure. The float has numerous bulkheads to form separate air compartments, so that effect of float damage on flotation will be minimized. The float is deflated for transport to reduce the space required, a feature that was chiefly responsible for the rise in popularity of the pneumatic pontoon.

In the design of the bridge as a whole, there are several important considerations. The parts, including pontoons, that make up the bridge must be of a size and weight that can be transported readily by standard trucks and trailers. In earlier designs they also had to be capable of being manhandled, but development and use of erection equipment during World War II virtually eliminated consideration of this requirement. In spite of light weight the parts must be strong enough to withstand rough usage.

Too close a spacing of pontoons may obstruct floating debris and result in loss of the bridge. But as the interval between pontoons increases, the strength required in the superstructure and the size of the pontoon required also increases. The final design is therefore a compromise to produce a structure requiring minimum transportation, offering maximum capacity with minimum weight, and being capable of rapid assembly with a reasonable number of troops.

Since the bridge, once in place, must remain in place, the anchorage system is an important feature in floating bridge construction. In streams with slow currents, kedge anchors mooring each pontoon in place can be used. For medium and high currents a suspended cable anchor system must be used. In this system a wire cable called the anchor cable is suspended across the stream; to the cable are connected individual rope lines, called bridle lines, from each pontoon. Good construction practice requires adequate anchorage downstream as well as upstream to maintain bridge alignment although it is not considered necessary to provide a tie to each pontoon.

History of Pontoon Equipment.—Alexander the Great occasionally carried with his army vessels divided into portions which were put together on reaching the banks of a river, as in crossing the Hydaspes (mod. Thelum river). The practice of carrying skins to be inflated when the troops had to cross a river was adopted by the Greeks, the Romans and the Mongols. In the wars of the 17th century pontoons were taken as regular components of the trains of armies, the Germans using a leather, the Dutch a tin and the French a copper skin over stout timber frames. In the middle of the 18th century the Russians introduced a collapsible pontoon consisting of a tarpaulin stretched on a wooden frame. For transport the frame was dismantled and the tarpaulin rolled up.

No armies had more experience in pontooning than the French; during the wars of the Revolution and the empire they constructed pontoon bridges over most of the principal rivers of Europe. They experimented with many types ranging from large wooden boats weighing about 2 tons to small copper ones weighing 7 cwt.; the heavy wooden type, the Gribeauval, was discarded in 1805 since it could not keep up with the movements of the armies; in 1853 they adopted a flat-bottomed open wooden boat 31 ft. long and weighing 1,450 lb., which appears to have been successful. The northern states during the American Civil War used this type extensively as heavy equipage, and used dismountable wooden frames covered with canvas as light equipage.

During the Peninsular War the British employed open pontoons, but the experience gained during that war induced them to introduce the closed form. Then Gen. Sir Charles Pasley introduced demipontoons, called sectional pontoons in the U.S., that resembled decked canoes with pointed bows and square sterns. A pair, attached sternwise, formed a single pier of support for the roadway;

they were constructed of light timber frames covered with sheet copper and decked with wood. Each demipontoon was divided into watertight compartments and provided with means for pumping out water; for transport, a pair of demipontoons and the superstructure for one bay of bridge were loaded on a single wagon. The Pasley was superseded by the Blanshard pontoon, a tin-coated cylinder with hemispherical ends for which great mobility was claimed, two pontoons and two bays of superstructure being carried on one wagon. The Blanshard pontoon was long used in the British army, but was ultimately discarded, and British engineers reverted to the open pontoon to which engineers of the continental armies had meanwhile constantly adhered.

In 1889 Lieutenant Clauson, R.E., invented a two-section pontoon coupled with easily manipulated couplings of phosphor bronze. For light bridges the sections could be used independently; for heavy bridges three sections could be coupled together end to end. Except for minor modifications this equipment was retained in the British service until 1924. During World War I it was much used in Mesopotamia and during the early and final stages in France; it was found unsuitable in the rapid current of the Piave on the Italian front.

Historically, the most important equipment was that introduced in the Austrian army by Colonel Birago in 1841; it was either adopted or copied by many other armies. The Birago pontoon was a flat-bottomed open boat constructed in sections, two or more of which could be coupled together end to end to form piers of the buoyancy required. This idea had first been proposed by Col. Pompei Floriani about the middle of the 17th century but had not previously been fully developed; it was later adopted in British Pasley equipment. The Birago pontoons were in the first instance made of wood; later they were made entirely of iron and later still of steel.

An interesting type of equipment was introduced into the U.S. army in 1846. The pontoons were made entirely of India rubber and each consisted of three parallel pointed cylinders 20 ft. long, joined together side by side by an India-rubber web. When the pontoon was required for use, these cylinders were inflated through nozzles by means of bellows; for transport the entire pontoon was folded up and packed in a box. But, after considerable experience during the American Civil War the engineers of the northern states much preferred the French equipment which was of the balk and chess superstructure type with wooden rigid pontoons. It was retained with little or no change up through World War I. Between World War I and World War II the equipment was modernized by making the pontoons of aluminum.

With the introduction of blitz warfare by the Germans in World War II, rapid construction of bridges and ready portability of equipment for rapid movement became of paramount importance. This brought about the reintroduction of a vastly improved pneumatic pontoon and the development of the steel treadway floating bridge by the U.S. army. The use of motorized air compressors solved the problem of inflating the pneumatic pontoons while the single-unit treadways placed in pairs by bridge erection trucks or singly by truck cranes speeded bridge erection and reduced personnel requirements. Meanwhile, the British, with the development of the panel truss bridge by Sir Donald Bailey for fixed bridging requirements, also adapted it for floating bridge purposes by designing special connectors and articulating members. This bridge became commonly known as a floating Bailey.

Methods of Bridge Building With Pontoon Equipment.—There are four recognized methods of building pontoon bridges; the choice depends partly upon the actual equipment in use and more upon the site of the bridge and nature of the river.

1. Successive pontoons. The pontoons are added successively to the head or far end of the bridge and the roadway added on top of them; this is perhaps the simplest method and is used primarily on narrow streams.

2. By rafts. Complete sections of the bridge are built in convenient positions by the near bank, floated into position and joined together; this method is used primarily on the wider streams and invariably results in quicker assembly than is possible by the other methods.

3. Booming out. Pontoons are added successively at the tail or shore end and the whole bridge pushed out; this saves carrying all the stores for the roadway to the far end of the bridge.

4. Swinging bridge. The entire bridge is built alongside the near bank, that is, at right angles to its final position; when complete it is allowed to swing round with the current on its near end as a pivot, anchors are dropped in their appropriate positions as it swings and the entire bridge is checked by the anchor cables as it reaches its correct alignment. On a suitable site this method is extremely rapid, but in fast streams the operation is risky and the bridge often is lost or severely damaged.

The successive-pontoons and by-rafts methods at mid-20th century were the commonest methods used. The booming-out method was generally restricted to the light bridges while the introduction of power utility boats as auxiliary bridge erection equipment virtually eliminated the need for the swinging-bridge method.

Trestle Bridges.—It is not always feasible to construct a floating bridge, as pontoons may not be available, the water may be too shallow or the gap may be entirely dry. In such cases timber trestles have frequently been used to replace pontoons as supports for the roadbearers. Such trestles consist essentially of a horizontal bottom piece, or ground sill, two or more legs which are vertical or slightly inclined inward at the top and a horizontal top piece, or transom, on which the ends of the roadbearers rest as they would on the saddle of a pontoon; the whole is stiffened by diagonal braces. The size of the timber used varies with the nature of the bridge, ranging from light army signal poles used for the trestles of infantry assault bridges during World War I to timber balks 12 in. square or even larger used for railway bridges during the American Civil War and the Boer War and for heavy road bridges during World Wars I and II. Trestles are usually constructed on shore, carried into position and upended either by manpower or mechanical equipment.

Cribwork.—Timber cribs were formerly used instead of trestles for railway and heavy road bridges when timber was plentiful and the height required small. Timber crib construction was very convenient since no skilled labour was required, but cribs are wasteful of material. When placed in water, they were usually spiked together and filled with stone. An instance occurred in 1918 in the crossing of the Selle where, under the nose of the enemy holding the opposite bank, a crib causeway for tanks, built of railway sleepers (ties), bolted together and sunk in the bed of the river, was constructed during the nights immediately preceding the attack and kept concealed from view and from aerial photography by being completed just below water level.

Pile Bridges.—Trestles or cribwork are often not feasible in rapid currents because of the scour and if pontoon equipment is not available pile driving has to be resorted to, but it is a slow method. In 1809, before the battle of Wagram, Napoleon's engineers under Gen. Henri Bertrand constructed a pile bridge 800 yd. long across the Danube at Vienna in 20 days; upstream, piles were driven to form a boom to protect the bridge from floating bodies sent down by the enemy.

The provision of truck cranes with pile-driving equipment by the U.S. army during World War II permitted fairly rapid erection of pile bridges for line-of-communication usage. A number of vital bridges in the Allied supply lines were produced by this method, including several railway bridges across the Rhine river.

Girder or Truss Bridges.—Where bridges must be built across deep ravines or where the foundation is unsuitable, it is necessary that the bridges span clear gaps of 100 ft. or more without intermediate support. In such cases, the superstructure is supported by field assembled trusses. The bridges are made in panels of interchangeable parts; and the total length of any bridge can be that of any multiple of the fixed panel. The total practicable length depends upon the material used. Metal girders, generally limited to spans of less than 100 ft., are also used for dry-gap bridges, often in combination with trestle or pile piers. The standard girders are similar to ordinary commercial girders except that bolts are used instead of rivets, so that the girders may be taken apart for transportation.

(E. W. An.; R. D. D.; W. A. M.; H. C. T.)

WORLD WAR II BRIDGING

Footbridge.—Attempts to construct any major bridging are suicidal until a foothold has been gained on the enemy-held shore so that direct small-arms fire on the proposed crossing is eliminated. It is usually necessary that the assaulting troops cross the stream in boats under cover of darkness and in secrecy to secure such a foothold. Once across these troops must be rapidly reinforced, a task that can best be done by providing a footbridge.

Since time is of the essence, a footbridge particularly adapted to fast simple erection is necessary for the purpose. The rubber plank footbridge used during World War II by the U.S. army fulfilled such requirements. This bridge is normally constructed from sections consisting of a timber duckboard or footwalk, supported by two floats each. The footwalk sections are provided with interlocking spring catches so that the mere act of pushing the end of one treadway into the end of the adjoining treadway makes the connection. The floats consist of a frame containing a number of very light expanded rubber planks and are provided with handles at each end. Spring catches also serve to attach the treadway to the float.

Footbridge sections are assembled at a convenient spot on shore and carried to the stream by men lifting the section by the handles provided on the floats. The booming-out method of construction is employed and in this case rapid erection times are achieved.

Pontoon Equipment.—While it had been generally anticipated in the interval between World Wars I and II that pontoon equipment had to be strengthened to carry heavy artillery pieces and heavier tanks, the extent and rapidity of increase in weight which occurred early in World War II were not foreseen. Therefore, the redesigned bridges soon became obsolete or were limited in use. For this reason the principal floating bridges employed during World War II were developed during the war with the exception of the 25-ton pontoon bridge of the U.S. army. This bridge was the product of refinements in basic bridge design adopted by the U.S. from the French in 1869. It exemplified the maximum that could be attained with the wooden balk and chess type of superstructure and only by the addition of reinforcing floats between pontoons was it able to carry all tanks used by the U.S. army during World War II. The bridge served its purpose well even though it appeared to be the last of its line in modern military usage.

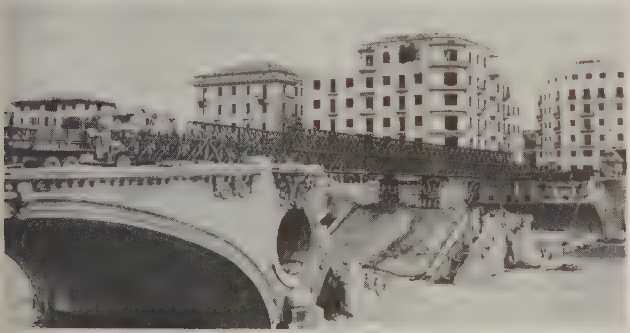

U.S. SIGNAL CORPS PHOTOGRAPH

FIG. 1.—FIXED BAILEY BRIDGE UNDER CONSTRUCTION IN ITALY DURING WORLD WAR II. THIS IS A "DOUBLE-DOUBLE" BAILEY LAUNCHED OVER A CENTRE BAILEY CRIB PIER

Steel Treadway Bridge.—Treadway bridging differs from all other types of floating bridging in that it does not have a solid decking. The vehicles it carries run on a pair of parallel steel runways or treadways, wide enough to take the tracks of a tank, or spaced close enough to take the wheels of a truck. The parallel treadways are supported by pneumatic pontoons or floats. The principal advantage of this bridge is the simplicity of its construction and the transportability of its components, and for these reasons the bridge was the one used most often and most successfully in World War II.

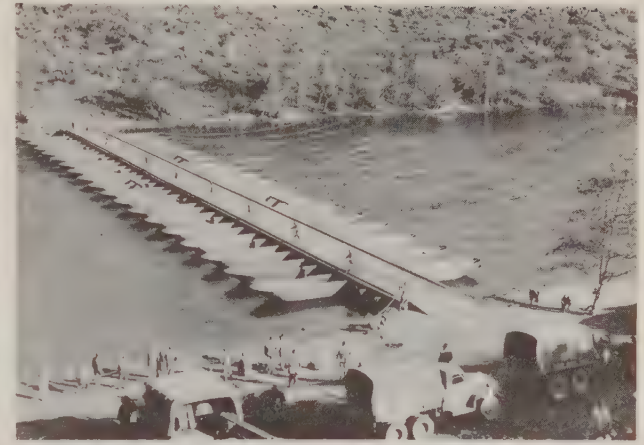

U.S. ARMY PHOTOGRAPH: BY COURTESY OF THE CORPS OF ENGINEERS

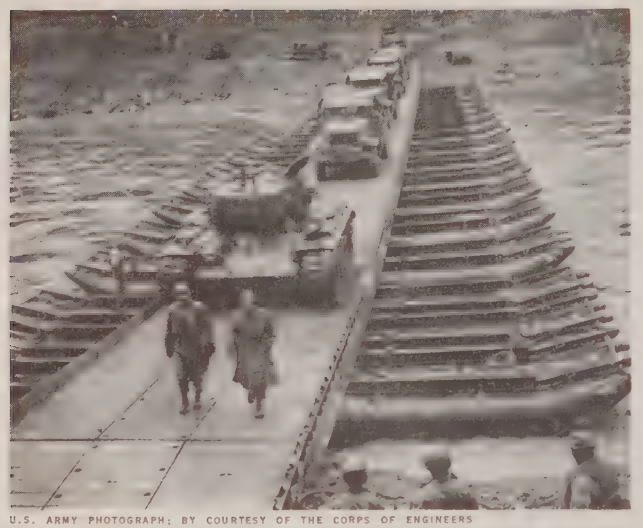
FIG. 2.—M4 FLOATING BRIDGE UNDER CONSTRUCTION. TROOPS ARE PLACING THE DOWNSTREAM ANCHOR CABLE, AFTER WHICH CONSTRUCTION WILL BE COMPLETE

The steel treadway bridge has three main components—the pneumatic float, a float saddle and the individual steel section known as the treadway. In construction, the floats are inflated and placed in the water, after which the float saddles are placed and secured. The treadway pairs to complete one bay of bridge are then placed on the saddles by a special bridge-erection truck, which is a long-bed, six-ton cargo truck fitted with a hydraulically operated boom at the rear end of the truck bed. The boom is used in unloading and loading as well as for placing the treadways. As each bay is completed, it is usually connected to another bay by interlocking the mating ends of the two pairs of treadways. Additional sections are then moved into place successively by power utility boats and connected to each other in a similar manner until the bridge is complete. The first bridge produced, the M1 treadway bridge with narrow treadways and flat-nosed 12-ton floats, was effective in slow-moving streams but suffered disastrous failures in the fast currents of the Colorado river in service tests in 1942 and in the flood-swollen Volturno river in Italy in 1943. It was replaced by the M2 bridge, with wider treadways and 18-ton floats, that was used effectively in World War II and the Korean War.

The M4 Floating Bridge.—Late in World War II the U.S. army corps of engineers unveiled an all-aluminum floating bridge with a normal capacity of 60 tons. This bridge was a slight variation of the balk and chess type of bridge in that it included a deck member that served both purposes and was therefore called a deck balk. Whereas in the 25-ton pontoon bridge previously described, the balk are spaced on about 16-in. centres leaving about an 11-in. space between balk, the balk of the M4 bridge are placed side by side so that when all balk are placed, a complete road surface is provided; therefore, no planking is required. This bridge, designed for erection by manpower, did not see combat usage in World War II but proved its value in the Korean War. At mid-20th century the M4 bridge had the widest roadway of any of the standard floating bridges and, whenever necessary, could be widened even further by the addition of lines of deck balk outside the lines normally furnished. Reinforcing pontoons could also be added between the normal pontoons for added capacity.

The Floating Bailey.—While the U.S. army engineers developed and used floating bridges designed for the purpose, the British turned to the ubiquitous Bailey bridge and adapted it to floating bridge usage. Although it served to reduce the number of bridging types used by their field armies, as well as to provide the necessary capacity, erection of the floating Bailey bridge was not so fast or so easy as was erection of the U.S. bridges. It did, however, employ long Bailey truss hinge spans from the stream bank to the floating bridge proper which allowed for considerably more rise and fall in the stream elevation than did the trestle spans of the U.S. bridges.

The flotation element of the floating Bailey is a tripartite ply-



U.S. ARMY PHOTOGRAPH; BY COURTESY OF THE CORPS OF ENGINEERS

FIG. 3.—MEDIUM TANK AND BRIDGE TRUCKS CROSSING A CLASS 60 FLOATING BRIDGE

wood pontoon composed of two 20-ft. end sections and one 20-ft. centre section. The complete pontoon is about 60 ft. long, $5\frac{3}{4}$ ft. wide and $2\frac{3}{4}$ ft. deep. The superstructure is standard dry-gap Bailey bridge equipment, except for a few additional special parts. These parts are primarily the distributing girder, which stiffens the pontoon groups at the ends of the bridge, on which the shore hinge spans rest, and the articulating connectors, which connect the various bays of bridge. These connectors prevent the occurrence of excessive stresses in the Bailey trusses before full use is made of the flotation of the pontoon.

In construction of 40-ton tank capacity bridges, 32-ft. spans of single-truss Bailey bridge are supported by pontoon piers at each end, or 52-ft. spans can be used with an additional pontoon in the centre of the span. For 70-ton tank loads a 32-ft. span of double-truss Bailey bridge supported on three pontoons, one at each end and one near the centre, form a floating bay. Bays are connected one to another by the articulated connectors.

The Bailey bridging used for the end spans is placed in the same manner as would be employed for bridging dry gaps; that is, by cantilevering the span out from shore.

Truss Bridging.—For dry-gap bridging, and also line-of-communication usage over streams for which use pontoon equipment cannot be spared, truss bridges are used. Here again, as in the case of pontoon equipment, much pre-World War II standard bridging was made obsolete by the rapid increase in weight of armoured vehicles. The British in particular were concerned over the inadequacy of their then standard box-girder and Inglis tubular-steel bridges, which reportedly could not be increased beyond 26 tons in capacity. The answer was quickly produced however by Sir Donald Bailey, whose design proved to be the most versatile military bridge of World War II. The Bailey bridge was designed essentially as a heavy, through-type fixed bridge built up of panels rather than the previously conventional box-girder sections. All components were designed to be handled and placed by manpower, and trusses could be combined in multiple to carry loads up to 100 tons over spans from 30 to 220 ft. in length. This adaptability to a wide range of lengths and loads was the greatest advantage of the Bailey bridge. The U.S. army adopted it and made extensive use of it in the European theatre of operations (1944–45).

The roadway in the Bailey bridge is supported by two main trusses composed of sections called panels pinned together to form a continuous truss. Each ten-foot section of bridge, consisting of two parallel truss sections which support cross members called transoms on which the stringers and decking chess are laid, is known as a bay.

The capacity of the bridge may be increased by adding one or two extra trusses alongside the first, by adding extra trusses on top of the first two or three to make a second story or by both means. Thus, a single-truss single-story bridge is known as a single-single, a double-truss single-story is a double-single and a double-truss double-story is a double-double and so on up to a triple-triple maximum. In the heavier constructions, the number of transoms in each bay is also doubled.

Still another bridge type appeared in World War II, the short-span assault bridge that could be erected under fire. In this category both the British and U.S. armies developed scissors-type bridges for which standard tank chassis served as transporter-launchers. These bridges could be unfolded over a gap by a mechanism powered from inside the tank. Another type, favoured more by the British than the Americans, was the so-called Ark bridge in which a tank, usually of an obsolescent type, was equipped with top-mounted treadways and attached ramps. When driven into a gap and the ramps dropped, the vehicle itself served as a bridge support.

POSTWAR DEVELOPMENTS

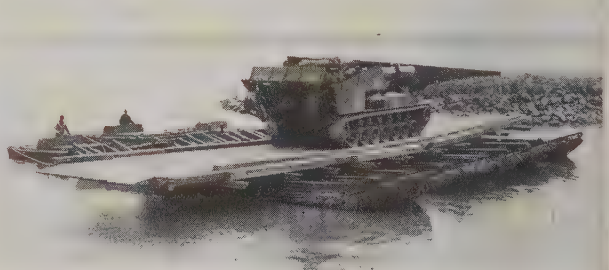
After World War II, when the performance of all equipment was reviewed, it was apparent that nothing further could be achieved with traditional balk and chess bridging. Accordingly, the U.S. 10-ton and 25-ton pontoon bridges and their variations were declared obsolete. The M2 treadway bridge, while still effective for tanks in being, was not suitable for some new designs still on the drawing board. In addition, the centre gap between treadways of the M2 had proved undesirable for supporting multi-wheeled vehicles.

The U.S. army therefore adopted, in 1953, the class 60 floating bridge with a flush deck treadway and centre filler. It consisted of a steel superstructure supported by 24-ton pneumatic floats and was capable of carrying any U.S. army vehicle. During the Korean War this bridge, designed for truck crane erection, replaced the treadway bridge although the latter was retained for divisional use.

In 1953 the deck balk of the M4 floating bridge was adapted to the 24-ton float of the class 60 bridge to produce a floating bridge particularly suited to U.S. marine corps use as it did not require a special bridge truck for transport nor a truck crane for erection. This bridge was also adopted by the U.S. army. It had high potential capacity and great flexibility. Though its normal capacity was only 60 tons, it could be strengthened by placing the aluminum pontoons closer together and adding lines of deck balk to bring its capacity up to 100 tons.

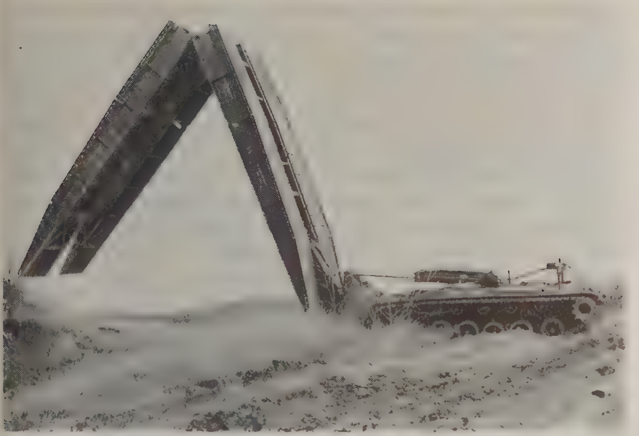
The British army, meanwhile, also recognized a need for an improved floating bridge, particularly in the 30-ton capacity range, that could be speedily erected by a small crew and would replace the standard Bailey pontoon bridge and light-folding boat equipment. The need was met by adoption of the class 30 light-assault floating bridge in the decade following World War II.

Even the successful Bailey bridge was not excepted from review and modernization. Both the British and U.S. armies attempted to develop a bridge that would retain the basic principles of the Bailey but would be more suitable for erection by mechanical equipment. The British evolved the heavy girder bridge with steel panels while the U.S. engineers brought forth an aluminum panel bridge. The



U.S. ARMY PHOTOGRAPH; BY COURTESY OF THE CORPS OF ENGINEERS

FIG. 4.—RAFT SECTION OF M4T6 FLOATING BRIDGE UTILIZED TO FERRY 63-TON MOTOR GUN CARRIAGE



U.S. ARMY PHOTOGRAPH; BY COURTESY OF THE CORPS OF ENGINEERS

FIG. 5.—SCISSORS TYPE ASSAULT BRIDGE CARRIED ON A TANK CHASSIS AND LAUNCHED HYDRAULICALLY. 60 FT. SPAN

latter gained only limited acceptance and the M2 Bailey continued as the standard U.S. bridge. The wider M3 Bailey with 13 ft. 9½ in. roadway remained standard in the British army.

Interest in mobile short-span assault bridges continued in the postwar period with the U.S. army experimenting with two types—a scissors bridge carried and launched by a tank chassis and a wheeled assault bridge that could be put in place by a fighting tank. The former had superior mobility while the latter was cheaper and required no special transporter-launcher.

Unlike the floating and fixed bridge types in which development had been aided by review of performance under combat conditions in World War II and Korea, development of short-span assault bridging was handicapped by its novelty and by lack of troop experience.

In 1953 the U.S. army adopted an aluminum footbridge to replace the M1938 rubber-plank footbridge used in World War II. It consisted of 80-lb. aluminum footwalk sections supported by 100-lb. aluminum pontoons. Each pontoon had a double bottom filled with plastic foam to make it unsinkable. The bridge could be speedily erected by the booming-out method. It was not vulnerable to small arms fire and presented a difficult target for enemy aircraft. The new bridge had greater carrying capacity than the 1938 model and was intended to provide a means for small units to cross rivers in support of the first landing parties.

BIBLIOGRAPHY.—Blanche D. Coll *et al.*, *Corps of Engineers: Troops and Equipment* (1958), and the periodical, *The Military Engineer*.

(E. W. AN.; H. C. T.)

BRIDGMAN, FREDERIC ARTHUR (1847–1928), U.S. painter, noted for his sentimental scenes of north Africa in the French academic manner, was born at Tuskegee, Ala., on Nov. 10, 1847. He began as a draftsman in New York city for the American Bank Note company in 1864–65, and studied art in the same years at the Brooklyn Art school and at the National Academy of Design, but he went to Paris in 1866 and became a pupil of J. L. Gérôme. Paris then became his headquarters.

A trip to Egypt in 1873–74 resulted in pictures of the east that attracted immediate attention, and his large and important composition, "The Funeral Procession of a Mummy on the Nile," in the Paris salon (1877), bought by James Gordon Bennett, brought him the cross of the Légion d'Honneur. Other paintings by him were "An American Circus in Normandy" and "Procession of the Bull Apis."

Bridgman was an officer of the Légion d'Honneur and of the order of St. Michael of Bavaria, and was made a member of the National academy in 1881. He was the author of *Winters in Algeria* and of *Anarchy in Art* and also composed orchestral music. He died on Jan. 13, 1928, in Rouen, France.

BRIDGMAN, LAURA DEWEY (1829–1889), the first blind deaf-mute person in whom systematic education proved successful, a pupil of Samuel Gridley Howe (*q.v.*), was born on Dec. 21, 1829, at Hanover, N.H. At the age of two she had an attack of scarlet fever that permanently destroyed her sight and hearing. Her case was brought to the attention of Howe, head of the Perkins institution for the blind at Boston, Mass., and in Oct. 1837 Laura entered the school. Howe at once set himself to teach her the alphabet by touch. He first pasted on several common articles, such as keys, spoons and knives, little paper labels with the names of the articles printed in raised letters. As soon as she had learned all the names in this fashion she was taught the individual letters, and gradually learned the alphabet and the ten digits. In Jan. 1842 Charles Dickens visited the institution, and afterward wrote enthusiastically in *American Notes* of Howe's success with Laura. Except for short visits to her home, Miss Bridgman lived at the school for the rest of her life, eventually helping with the teaching and household work. In 1887 her jubilee was celebrated at the institution, and she died there on May 24, 1889.

Miss Bridgman's importance in the history of the education of the deaf occasioned several biographies, including those by Mary S. Lamson (1878), Maud Howe and Florence Howe Hall (1903), and Laura E. Richards (1928).

BRIDGMAN, PERCY WILLIAMS (1882–1961), U.S. physicist noted especially for his research on materials at high pressures and their thermodynamic behaviour, was born in Cambridge, Mass., April 21, 1882. He received the Ph.D. degree from Harvard university in 1908, and joined its faculty the same year, becoming Hollis professor of mathematics and natural philosophy in 1926 and Higgins university professor in 1950. He was awarded the 1946 Nobel prize in physics for his extensive investigations on the properties of matter at pressures up to 100,000 atm., considerably higher than had been employed previously. The properties studied included electrical and thermal conductivity, compressibility, tensile strength and viscosity in more than 100 different compounds. Bridgman also contributed extensively to the philosophy of physics, publishing a number of volumes in this field, such as *The Logic of Modern Physics* and *Reflections of a Physicist*. In these writings Bridgman supported the operational point of view—that it is meaningless to interpret physical concepts except as they are capable of observation. He died in Randolph, N.H., on Aug. 20, 1961.

(J. H. V. V.)

BRIDGNORTH, a market town and municipal borough in the Ludlow parliamentary division of Shropshire, Eng., 21 mi. S.E. of Shrewsbury by road, on a high red sandstone rock bounded on the east by the river Severn. Pop. (1961) 7,552. The early history of Bridgnorth is connected with Aethelflaed, lady of Mercia, who rebuilt a fortress there in 912 against the Danes. William I granted the manor to Earl Roger of Shrewsbury, whose son built a castle on the rock in 1101 and in 1102 rebelled against Henry I who captured the castle after a three-month siege. The castle was also besieged in 1155 and 1321 and was all but destroyed in the Civil War; the tower (this leans 17° from the perpendicular) is the only remaining fragment. Castle and grounds were presented to the corporation in 1897. The town was incorporated in 1157; the borough returned two members to parliament from 1295 to 1867.

Bridgnorth is divided into Low Town and High Town. The former lies at the foot of the cliff beyond the Severn, there crossed by a bridge which is the successor of others dating back probably to Saxon times. Communication between Low and High Town is by several flights of steps, the best known being Stoneway steps, about 200 in number, and by the Castle Hill railway (1891), the steepest in England. The name of the town refers to the former existence of another bridge at Quatford to the south. There are many half-timbered buildings, including the birthplace of Bishop Thomas Percy (*q.v.*), dating from 1580 and now a boys' club, and the town hall; several houses have cellars cut in the rock. The chief industries are carpet weaving and the making of electrical equipment and aluminum foil. Bridgnorth lies in a productive agricultural area and holds weekly auctions and monthly sales of livestock; this market dates from 1226. The town was also a rival of Shrewsbury in the cloth and hide trades. Of the two parish churches, St. Mary Magdalene's was built by Thomas Telford in 1792–94 and St. Leonard's dates from the 12th century.

BRIDGWATER, FRANCIS EGERTON, 3RD DUKE OF (1736–1803), the founder of British inland navigation, was born May 21, 1736, the younger son of Scroop (1681–1745), 1st duke of Bridgwater. His father, who was created duke in 1720, was the great-great-grandson of Lord Chancellor Ellesmere. Francis Egerton succeeded to the dukedom on the death of his brother, the 2nd duke, in 1748. Shortly after attaining his majority he became engaged to the beautiful, widowed duchess of Hamilton, but her refusal to give up the acquaintance of her sister, Lady Coventry, led to the breaking off of the match. Thereupon the duke broke up his London establishment and, retiring to his estate at Worsley, devoted himself to its management and to the making of canals. The navigable canal from Worsley to Manchester, which he projected in 1759 for the transport of the coal obtained on his estates, was (with the exception of the Sankey canal) the first great undertaking of the kind executed in Great Britain in modern times. The construction of this work, with its famous aqueduct across the Irwell, was carried out by James Brindley, the celebrated engineer. In 1762 Bridgwater obtained parliamentary powers to provide an improved waterway between Liverpool and Manchester by means of a canal, which was completed in 1772. The difficulties were still more formidable than those of the Worsley canal, involving, as they did, the carrying of the canal over Sale Moor Moss.

Bridgwater died unmarried in London on March 8, 1803, when the ducal title became extinct, but the earldom of Bridgwater passed to a cousin, John William Egerton, who became 7th earl. By his will the duke devised his canals and estates on trust under which his nephew, the marquess of Stafford (afterward 1st duke of Sutherland), became the first beneficiary, and next his son, Lord Francis Leveson-Gower (afterward 1st earl of Ellesmere), and his issue. The trust did not expire until Oct. 19, 1903, when the whole property passed under the undivided control of the earl of Ellesmere. The canals, however, had in 1872 been transferred to the Bridgwater Navigation company, by which they were sold in 1887 to the Manchester Ship Canal company for £1,710,000.

(A. AL.)

BRIDGWATER, a seaport and municipal borough in the Bridgwater parliamentary division of Somerset, Eng., 11 mi. N.N.E. of Taunton by road. Pop. (1961) 25,582. It lies in the level country east of the Quantock hills on the right bank of the Parret, 10 mi. from its mouth in the Bristol channel; its two portions are connected by an iron bridge. Once a fortified town with a castle and a Franciscan house, there are still traces of medieval architecture. It became a free borough, having a Saturday market and an annual fair (September), by a charter of 1200; there is also an annual carnival (October–November). A number of charters were granted between 1200 and the 18th century and from 1295 until 1870 Bridgwater returned two members to parliament. Fairs for the sale of wool and wine were important in medieval times. The church of St. Mary Magdalene dates from the 14th century. The town was the birthplace of Adm. Robert Blake (1599–1657) and his house became a museum in 1924. The trade of the port revived after the construction of the new dock in 1841 and still continues, the river being navigable to the town for vessels of 300 tons though liable to a bore which sometimes attains four feet. Industries include the manufacture of Bath bricks, bricks and tiles, cellulose film, shirts and collars, preserves, heavy engineering and electrical equipment, furniture, brewing and malting.

Five miles to the southeast is Sedgemoor, a marshy tract where the Monmouth rebellion was crushed in 1685.

BRIDLINGTON, a seaside town and municipal borough (1899) in the Bridlington parliamentary division of the East Riding of Yorkshire, Eng., 17 mi. S.S.E. of Scarborough by road. Pop. (1961) 26,007. The ancient market town lies about one mile from the coast, while the modern houses of Bridlington Quay, the seaside town, fringe the sandy shore of Bridlington bay. After 1867 sea walls were built and maintained against the encroaching sea. Southward the coast becomes low, but northward it is steep and very fine, where the great spur of Flamborough head (*q.v.*), owned by the corporation since 1939, projects eastward. Bridlington seems to have been a borough before the Conquest; its medieval history is linked up with its markets and fairs, first mentioned in a grant of 1200, and with its port. The church of St. Mary and St. Nicholas consists of the fine Decorated and Perpendicular nave of the priory church of an Augustinian foundation of Walter de Gant in 1113 which flourished until 1537. There remains also the Perpendicular gateway. Bridlington was an early centre of nonconformity, and a Congregational society was founded in 1662. In the 20th century developments as a resort were extensive; they include the Spa Royal hall (1932), a promenade (1931), a pavilion (1937) and the Sewerby pleasure gardens. The town hall was opened in 1932. The town is used as a conference centre. Yachting takes place in Bridlington bay and the town is the headquarters of the Royal Yorkshire Yacht club.

Six miles from Bridlington is Burton Agnes hall (1598), a perfect example of Tudor architecture. The Old Manor house in Burton Agnes was probably built about 1170.

BRIDPORT, ALEXANDER HOOD, 1ST VISCOUNT (1726–1814), British admiral, who served with distinction in the French Revolutionary wars, was born on Dec. 2, 1726, the younger brother of Samuel (afterward 1st Viscount) Hood. He entered the navy in 1741 and served as a lieutenant under Capt. Charles Saunders in the Mediterranean and under Sir Edward Hawke at the battle of Quiberon bay in 1759, as captain of the "Minerva." In the same ship he later recaptured the "Warwick" line-of-battle ship. In 1758 he married Mary West, from whose fortune and connections with the Grenville family his career benefited. As captain of the "Robust" he was at the battle of Ushant in 1778 and gave evidence against Viscount Keppel in the court martial which followed. He became rear admiral in 1780 and served under Lord Howe in the relief of Gibraltar in 1782. On the outbreak of war with France in 1793 he was Howe's second-in-command and for the part he played at the battle of the Glorious First of June in 1794 he was made Baron Bridport. From that date until 1800 he was, in effect, in command of the Channel fleet, though only nominally so from 1797. In an attack on the French fleet off Lorient in 1795 he personally took charge of the ship when the pilot refused to sail closer in shore. In 1797 he was criticized for failure to intercept the Hoche expedition to Ireland, and later that year he was in command of the fleet which mutinied at Spithead. In 1800 he retired from active service, his conduct of the blockade of Brest having been criticized by Lord St. Vincent, and was created a viscount. In his old age he was described as "penurious and rich," though the Spithead mutineers called him their "father and friend." He died on May 2, 1814.

See D. V. Hood, *The Admirals Hood* (1942). (C. C. L.)

BRIDPORT, a market town and municipal borough in Dorset, Eng., 15 mi. W. of Dorchester by road. Pop. (1961) 6,517. It takes its name from the small river Brit and is the Port Bredy of Thomas Hardy's Wessex novels. The main part of the town is about a mile inland, but is connected by a winding street with the fishing village of West Bay. A museum and art gallery were opened in 1932. Bridport was of some importance before the Conquest but the town is first mentioned as a borough in the Pipe Roll of 1189. The earliest charter was granted in 1253 by Henry III, when it became a royal borough, and markets and fairs were granted by Elizabeth I. It was incorporated by James I in 1619. The Royal Navy procured its hawsers from Bridport in the 16th century and as early as 1213 the town was noted for the manufacture of ropes and cables. Sailcloth, cordage linen, fishing nets and lines are still made there. There is agriculture and horticulture in the district and some import trade in timber, but the harbour is accessible only to small vessels. Bridport returned two members to parliament from 1295 to 1868 and one until 1885, prior to the formation of the West Dorset parliamentary division.

BRIE, a rich farming district in northern France, east of Paris, lies between the valleys of the Seine and Marne. It includes most of the *département* of Seine-et-Marne, as well as portions of adjacent *départements*. Geologically the district consists for the most part of a platform of Tertiary limestone dissected by left-bank tributaries of the Marne and terminating southeastward in the escarpment known as the Falaise de l'Ile de France. There are some sand cappings that carry forest, and the surface layers of the limestone have commonly been decalcified to furnish damp clay areas. Fertile *limon* soil makes it generally an important area of corn and sugar-beet cultivation, and Brie cheese is well known. (Ar. E. S.)

BRIEF. In the United States, a brief is a written legal argument presented to a court to aid it in reaching a conclusion on issues of law presented by a case. It is used primarily in appellate courts and is of the utmost importance where no oral argument is made. It is less frequently used at the trial level. The usual procedure calls for the party seeking the relief asked for in the brief to present his written argument to his opponent and to file it with the court. The opponent then files and serves an answering brief. Usually, the first counsel will then have an opportunity to file a reply brief. Ordinarily the briefs are not distributed to the judges until each party has had the opportunity, specified by rules or statutes, to file his brief. Most courts have very specific rules governing the format and content of the briefs to be presented to them. The courts differ in the treatment of this written argument; some read it before the oral argument, some after, and in some courts only the judge assigned to prepare the opinion reads the briefs. Occasionally, the court may ask for further briefs after oral argument. On unusual occasions, most effectively in constitutional cases, counsel will include extensive economic and sociological data in his brief. Such a brief has become known as a "Brandeis brief," after the justice of the U.S. supreme court who is generally credited with initiating, or at least of making the most effective use of, such a document. When a court allows an outsider to file a brief in a case to which he is not a party, it is generally called a brief *amicus curiae* (*q.v.*).

In England, the word brief has a different meaning and can be understood only when it is recognized that there, unlike in the United States, the legal profession is separated into two groups: barristers and solicitors. Only the former is eligible to appear before the high court, but he cannot act on behalf of a litigant except pursuant to instructions from a solicitor. These instructions to counsel are known as a brief. In it, among other things, the solicitor will report on the evidence and proof available and will include statements and interviews, or summaries thereof, of witnesses. A barrister who receives such instructions is said to be briefed by the solicitor. The brief will carry on it a notation of the fee offered, though in fact this will have earlier been negotiated between the solicitor and the barrister's clerk. In Scotland, this form of instruction to counsel is known as memorial. A "watching brief" in England is an instruction to counsel to attend hearings on behalf of a person who is not a party to the proceedings so that he can then offer advice relating to the hearings.

A papal brief is an edict from the pope on a matter of discipline directed to an individual or community, similar to a papal bull (*see* Diplomatic: *Papal Chancery*). (P. B. K.)

BRIERLEY HILL, an urban district (1894) in the Brierley Hill parliamentary division of Staffordshire, Eng., lying 12 mi. W. of Birmingham by road. Pop. (1961) 56,075. The district includes Wallheath, Kingswinford, Pensnett and Brierley Hill.

Thirteenth-century records tell of local "sea-coal" mined in the area, and ironstone was extensively mined in Elizabethan times. Though nailing and scythe making were the chief specialized industries by the 16th century, there was considerable glassmaking, which is still a major industry; some of the well-known Stourbridge glass comes from the Brierley Hill area. Coal mining, iron- and steelworking, the making of ceramics and food products (especially hams) are the other main occupations. In the reference section of the library is a large collection of fine glasswork.

In the 1950s and 1960s Brierley Hill underwent extensive redevelopment, including the construction of a new civic centre.

BRIEUX, EUGÈNE (1858–1932), French dramatist whose plays combined dramatic skill and didactic purpose, aiming at exposing social abuses, was born in Paris on Jan. 19, 1858. Beginning as a journalist, Brieux, after several unsuccessful attempts, at last found a producer in André Antoine (1890). *La Robe rouge* (1900), dealing with professional deformation in the law, is his best play. The dramatist yields to the moralist in *Les Remplaçantes* (1901). *Les Avariés* (1902) is a lecture on the dangers of syphilis, censored in France and (as *Damaged Goods*) banned in England until World War I. In his later plays, *Simone* (1908), *La Femme seule* (1912) the balance is held more evenly. Brieux died at Nice on Dec. 6, 1932.

See *Three Plays by Brieux,* with preface by Bernard Shaw (1911); A. Benoist, *Le Théâtre d'aujourd'hui,* vol. i (1911). (D. Ks.)

BRIG (Fr. Brigue, Ital. Briga), a town in the canton of Valais, Switz., whose population (1960) of 4,647 is largely Roman Catholic and German-speaking. It is the junction of the road leading up the narrow Rhône valley to the Grimsel and Furka passes and beyond to eastern Switzerland, and of the road to Italy through the Simplon pass (*q.v.*), opened in 1807. Brig also owes its prosperity to the tourist industry in the upper Valais and to its position as frontier town and embarkation station for motor vehicles traveling to Italy on railroad flatcars through the Simplon tunnel. The tunnel was opened to traffic in 1906 and is one of the longest in the world (20 km., or 12.4 mi.). Another tunnel contributes to Brig's importance: the Lötschberg tunnel, opened in 1913. This gives direct rail communication between the Bernese Alps, Bern and Milan.

Brig's medieval name was Briga Dives. Its most prominent buildings date from the 17th century, when K. J. von Stockalper, a rich merchant, built there a graceful castle whose bulbous towers and three-storied arcades are landmarks at the entrance of the Simplon road. Also notable is the nearby Glis church, the largest in Switzerland, and the 17th-century ossuary at Naters across the Rhône. (R. M. An.)

BRIGADE, a unit in military organization commanded by a major general, brigadier (*q.v.*) or colonel, and composed of two or more subordinate units such as regiments or battalions.

In World War I the "square" division consisted of two brigades, each commanded by a brigadier general and including two infantry regiments with their components of artillery and other supporting arms (*see* Army). During the postwar period, when the "triangular" division with its three infantry regiments came into being, the infantry brigade was abolished as a standard administrative or tactical unit in the British and U.S. armed forces. The term remained in use during World War II and the Korean war to designate a task force raised for some specific mission. In the summer of 1950, for instance, the U.S. 1st provisional marine brigade in Korea included a marine infantry regiment, four aircraft squadrons and a battalion of artillery, plus smaller units of tanks, engineers and other supporting arms. This brigade was, in effect, a self-sufficient little army of about 6,500 men who were employed effectively as a mobile reserve at a time when the United Nations forces were outnumbered. The British commonwealth division in Korea was composed of four brigades, each consisting of three infantry battalions, headquarters groups and appropriate components of artillery, tanks and engineers.

In 1961 the U.S. army revived the brigade as a tactical unit consisting of a headquarters to which would be attached administrative and combat support elements and two to five combat maneuver battalions. *See* also Division, Military. (Ln. Ms.)

BRIGADIER, a military rank conferred by Louis XIV upon the commander of several regiments. The British copied it from the French very early and a royal warrant of 1699 states that "the Major General of Our Ordnance within our Kingdom for the time being shall have rank and precedency as Brigadier," evidence that the title was stabilized at that date.

In both the British and U.S. armies of World War I a brigadier general commanded a brigade (*q.v.*) composed of two infantry regiments with artillery and other supporting arms. When the brigade was abolished after the adoption of the "triangular" infantry division, the British discontinued the rank of brigadier general but revived it as plain brigadier in 1928. In the U.S. military service a brigadier general ranks just above a colonel as the lowest officer of star rank. The ADC, or assistant division commander, is customarily a brigadier general. (Ln. Ms.)

BRIGANDAGE: *see* Banditry.

BRIGANTES, a people of northern Britain, who inhabited the country from the Humber estuary on the east and that of the Mersey on the west, northward to the Antonine wall. Their chief town was Isurium (Aldborough) and later Eburacum (York), and they had forts at Cataractonium (Catterick), Olicana (Ilkley) and Vinovium (Binchester). They were first defeated by the Romans during Claudius' reign (*c.* A.D. 50). Under Vespasian they submitted to Petillius Cerealis (*c.* 71) but were not finally subdued until the time of Antoninus Pius (*c.* 155).

BRIGGS, CHARLES AUGUSTUS (1841–1913), U.S. Old Testament scholar and theologian, vigorous exponent of "higher criticism," was born in New York city on Jan. 15, 1841, and educated at the University of Virginia, the Union Theological seminary and the University of Berlin. After a pastorship in the Presbyterian church of Roselle, N.J., he went to the Union Theological seminary, where he held successively three different professorships. His inaugural address, on becoming professor of biblical theology in 1891, led to his being tried for heresy by the presbytery of New York. He was acquitted, but the general assembly, to which the case was appealed, suspended him in 1893. He was ordained a priest of the Protestant Episcopal Church in 1900. With S. R. Driver and Francis Brown, Briggs prepared a revised *Hebrew and English Lexicon* (1891–1905), and with Driver edited the *International Critical Commentary.* His publications were numerous, and he was for ten years (1880–90) editor of the *Presbyterian Review.*

Briggs died in New York on June 8, 1913.

BRIGGS, HENRY (1561–1630), English mathematician, famous for his logarithmic tables, was born at Warley Wood, near Halifax, in Yorkshire. He graduated from St. John's college, Cambridge, in 1581, and obtained a fellowship in 1588. In 1592 he was made reader of the physical lecture founded by Thomas Linacre, and in 1596 first professor of geometry in Gresham house (afterward college), London. In his lectures at Gresham house he proposed the alteration of the scale of logarithms from the hyperbolic form that John Napier had given them to that in which unity is assumed as the logarithm of the ratio of ten to one. In conferences with Napier the alteration proposed by Briggs was agreed upon; and on his return from his second visit to Edinburgh in 1617 he accordingly published the first thousand of his logarithms. (*See* NAPIER, JOHN.) In 1619 he was appointed Savilian professor of geometry at Oxford. In 1622 he published a small tract on the *North-West Passage to the South Sea, Through the Continent of Virginia and Hudson's Bay;* and in 1624 his *Arithmetica Logarithmica,* in folio, a work containing the logarithms of 30,000 natural numbers to 14 places of figures besides the index. He also completed a table of logarithmic sines and tangents for the hundredth part of every degree to 14 places of figures besides the index with a table of natural sines to 15 places, and tangents and secants for the same to ten places; all of which were printed at Gouda in 1631 and published in London in 1633 under the title of *Trigonometria Britannica* (*see* MATHEMATICAL TABLES). Briggs died on Jan. 26, 1630.

His other works include: *A Table to Find the Height of the Pole, the Magnetical Declination Being Given* (1602); "Tables for the Improvement of Navigation," printed in the second edition of Edward Wright's treatise entitled *Certain Errors in Navigation Detected and Corrected* (1610); *A Description of an Instrumental Table to Find the Part Proportional, Devised by Mr. Edward Wright* (1616 and 1618); *Euclidis Elementorum VI, libri priores* (1620); *A Treatise on the North-West Passage to the South Sea* (1622), reprinted in Purchas's *Pilgrims,* vol. iii, p. 852; *Mathematica ab Antiquis minus cognita.* Some other works, as his *Commentaries on the Geometry of Peter Ramus* were not published.

BRIGHOUSE, a municipal borough (1893, considerably enlarged 1937) in the Brighouse and Spenborough parliamentary division of the West Riding of Yorkshire, Eng., 6 mi. E.S.E. of Halifax. Pop. (1961) 30,783. Area 12.3 sq.mi. The chief industries are textile: mainly carpetmaking, also silk spinning and the manufacture of yarns and fabrics. But there is also considerable engineering of all kinds, especially the manufacture of radio and television equipment. In the grounds of Kirklees hall, 2 mi. S.E., are remains of a Cistercian priory, founded in 1155, and the traditional grave of Robin Hood.

BRIGHT, SIR CHARLES TILSTON (1832–1888), English telegraph engineer, who superintended the laying of the first Atlantic cable, was born on June 8, 1832, at Wanstead, Essex. Educated at the Merchant Taylors' school, at the age of 15 he became a clerk under the Electric Telegraph company. In 1852 he was appointed engineer to the Magnetic Telegraph company, and had charge of the laying of lines in various parts of the British Isles, including in 1853 the first cable between Great Britain and Ireland, from Portpatrick to Donaghadee. His experiments convinced him of the practicability of an electric submarine cable connection between Ireland and America; and having in 1855 already discussed the question with Cyrus Field, who with J. W. Brett controlled the Newfoundland Telegraph company on the other side of the ocean, Bright organized with them the Atlantic Telegraph company in 1856 for the purpose of carrying out the idea, himself becoming engineer in chief for the laying of the first Atlantic cable (*see* TELEGRAPH). In 1858, after two disappointments, Bright successfully accomplished what to many had seemed an impossible feat. Within a few days of landing the Irish end of the line at Valentia he was knighted in Dublin. Subsequently Bright supervised the laying of submarine cables in various regions of the world, and took a leading part as pioneer in other developments of the electrical industry. As a partner with Josiah Latimer Clark from 1861, he invented improved methods of insulating submarine cables. A paper on electrical standards read by them before the British association in the same year led to the establishment of the British Association committee on that subject, whose work formed the foundations of the system still in use. From 1865 to 1868 he was Liberal M.P. for Greenwich. He died on May 3, 1888, at Abbey Wood, near London.

See *Life Story of Sir C. T. Bright,* by his son Charles Bright, rev. ed. (1908).

BRIGHT, JOHN (1811–1889), British statesman and prototype of Victorian radicalism, the friend and associate of Richard Cobden (*q.v.*), was born at Rochdale on Nov. 16, 1811, of Quaker stock. His father, Jacob Bright, had opened a cotton mill at Rochdale in 1809; his mother, Martha Wood, Jacob's second wife, was a woman of great strength of character and refined taste. He was educated first at a boarding school near his home, then at a Friends' school at Ackworth, finally at small schools at York and Newton, near Clitheroe. Through this somewhat mixed and fragmentary education he learned, he himself said, only little Latin and Greek, but acquired a lasting love of English literature. In his 16th year he entered his father's mill, and became a partner in 1839. Rochdale, a growing hive of industry, was the centre of all his activities until the late 1830s; its political controversies and social institutions provided Bright with his first interest in public affairs. In 1833 he helped to found the Rochdale Literary and Philosophical society; for seven years, 1834–41, he was the leader of the antichurch party in a prolonged struggle concerning local church rates; his first speech against the Corn laws (*q.v.*), the issue on which his national reputation was to be founded, was made at Rochdale in 1838.

Anti-Corn Law Agitation.—As a Quaker and a millowner Bright was naturally drawn into the radical agitations of the 1830s, but he went further than most Quakers in concerning himself directly with problems of party politics and he soon stood out among his fellow millowners as a brilliant natural orator. It was almost inevitable that he should join in 1838 the Manchester provisional committee which a year later founded the Anti-Corn Law league. After the death in Sept. 1841 of his young wife (formerly Elizabeth Priestman) whom he had married 22 months before, he gave up all his energies to the league. In his famous words Richard Cobden urged him "when the first paroxysm of your grief is past, . . . come with me, and we will never rest till the Corn law is repealed." Bright accepted his invitation, and, in his own words, "from that time we never ceased to labour hard on behalf of the resolution which we had made."

Bright became the leading orator of the league just as Cobden was its leading organizer. He was soon renowned for the bitterness of his attacks on the landed aristocracy and for the appeal he made to the working classes as well as to the millowners. Although he had no sympathy with the demand of factory operatives in the north of England for a shortening of the working day and was one of the most consistent supporters of the principle of laissez faire, he knew how to appeal to the feelings of his large audiences on the cheap food question. "The iron hoof of monopoly would no longer trample on the impotent millions," he argued, if the Corn laws were repealed. "The needy shall not always be forgotten. The expectation of the poor shall not perish for ever." In 1843 he stood as a free trade candidate at a by-election at Durham. He was defeated, but his successful competitor was unseated on petition and at the second contest Bright was returned. His talents were now on display in the house of commons as well as the public platform, but he was slower in establishing his reputation there than he was in the country. It was only after 1845 that he began really to impress his fellow members. Along with Cobden, whom he encouraged to continue the national agitation in face of many difficulties, he saw the league's efforts crowned with success in the summer of 1846 when Sir Robert Peel abolished the Corn laws. At a meeting in Manchester on July 2, 1846, Cobden moved and Bright seconded a motion dissolving the league and subsequently a library of 1,200 volumes was presented to Bright as a memorial of the struggle.

Parliamentary Reform.—Bright's national political career was, in fact, only just beginning. In June 1847 he married Margaret Leatham, of Wakefield, by whom he had seven children. His happy family life provided an ordered background to his public career. A month after his marriage he was elected for Manchester, the mecca of the league, without a contest. In the new parliament, as in the previous session, he opposed legislation restricting the hours of labour and as a nonconformist spoke against clerical control of national education. But he was anxious to direct the fervour which the league had aroused in the cause of parliamentary reform. In 1848 he voted for Joseph Hume's household suffrage motion and he tried to persuade Cobden, who was more interested in financial than parliamentary reform, to join him in a campaign to extend the franchise. He had only limited success in his endeavour to win over Cobden, but never himself abandoned the battle for parliamentary reform until the last stage in the process had been realized in 1884.

Before parliamentary reform became the leading question of the day, Bright went through a period of loneliness and unpopularity which contrasted sharply with the excitement and acclamation of the early 1840s. He had joined with Cobden in attacking Lord Palmerston's foreign policy, in his view, a policy of glory and gunpowder. He maintained that traditional diplomacy was merely a form of "outdoor relief for the landed aristocracy," and resolutely supported the peaceful business ideals which lay behind the Great Exhibition of 1851. When Britain became involved in the Crimean War in 1854, Bright was Palmerston's most eloquent and persistent opponent. On Feb. 23, 1855, he delivered the greatest speech he ever made in the house of commons, with its famous image, "the angel of death has been abroad throughout the land. You may almost hear the beating of his wings." The speech moved the house as it had never been moved within living memory; his political opponent, Benjamin Disraeli, who frequently went out of his way to discuss politics with Bright, for whom he felt a curious sympathy, remarked that he would have given his all to have made the speech. Influence at Westminster, however, did not imply popularity in Manchester. The same crowds who had pressed for repeal were now prepared to identify themselves with Palmerston's policy, to brand Bright as a "Russian" and to burn his effigy in the Manchester streets. At the general election of 1857 Bright and his radical colleague lost their Manchester seats.

The next year, however, he was returned as representative for England's second city, Birmingham, which had a longstanding reputation for radicalism and which was glad to welcome him without a contest. He remained member for Birmingham for the rest of his life, finding its political atmosphere much more congenial than that of Manchester. He soon had the satisfaction of seconding a motion which led to the defeat and resignation of Palmerston in Feb. 1858. Although Bright had few sympathies with the new minority Conservative government, he warmly supported two of their measures, which he had long advocated—the admission of Jews to parliament and the transfer of the government of the East India company to the crown. He was less enthusiastic about Disraeli's projected suffrage bill which he regarded as "the product not of the friends but of the enemies of reform."

In all the many parliamentary debates on franchise reform between 1859 and 1867, Bright was a regular speaker. "I am told . . .," he said after 1867, "that I have with more labour, with greater pertinacity, with more elaborate speeches, urged the enfranchisement of my country than any other man." He had the satisfaction of seeing W. E. Gladstone, chancellor of the exchequer in a new liberal coalition formed under Palmerston in 1859, become a supporter of the cause and gave him frequent advice and encouragement. Above all he had the satisfaction of seeing public opinion swing toward reform ideas again in the middle 1860s after many earlier signs of lack of interest and excitement. Bright believed in public opinion as the key to change; his first speech in Birmingham had stressed the need for a new agitation to press for parliamentary reform, but there was relatively little enthusiasm in the country until 1864, the year when Gladstone announced his conversion.

The death of Palmerston in 1865; the growth of new political organizations of which the most important were the National Reform union (1864) founded in Manchester and backed by Bright, and the Reform league (1865) with its headquarters in London; and a trade depression in 1866 and 1867, which did as much as the diffusion of ideas to stir working class opinion, all led to a genuine revival of agitation. Bright more than any other man pulled together the threads of organization and worked for "a combined and friendly movement" in London and the provinces. In parliament Lord John Russell, who had succeeded Palmerston, was unsuccessful in carrying a reform bill in 1866, largely because of the opposition of a section of his own party led by Robert Lowe. However, Lowe and his friends, whom Bright named "the Adullamites," were unsuccessful in holding back the tide. Lord Derby and Disraeli, who formed a new Conservative minority government after Russell's defeat, introduced a reform bill of their own. It fell far short of Bright's demands, but Disraeli frequently yielded to the pressure of the opposition, and the Reform bill of 1867 as it finally passed the house was a radical measure, aptly described by the prime minister as a "leap in the dark." One Conservative critic of the government's surrender maintained that "if the adoption of the principles of Mr. Bright be a triumph, then the Conservative party, in the whole history of its previous annals, has won no triumph as signal as this."

Other Interests.—Parliamentary reform was not Bright's only interest between 1858 and 1867. In 1860 he warmly supported Cobden in the negotiations for the treaty of Commerce with France, which he regarded as a model instrument of healthy international relations. When Cobden died in April 1865, Bright told the house of commons that he dared not even attempt to express the feelings which oppressed him, and sat down overwhelmed with grief. "I little knew how much I loved him till I had lost him," he remarked, reviewing a friendship which had lasted more than 20 years.

While supporting the efforts not only of Cobden but also of Gladstone for extension of the principles of free trade, Bright was one of the most active advocates of the side of the North in the American Civil War. He had profound admiration for Abraham Lincoln, with whom he frequently corresponded; and he believed that the battle against slavery was the greatest crusade the Americans had embarked upon. He shared with Cobden a belief that American authority in world economic and political life would increase, but he went further than Cobden in acquainting himself with the immediate as well as the distant problems of U.S. politics. He was sometimes accused, unfairly, of trying to "Americanize" the British constitution. In the long run, he looked forward to the day when "from that point of land which is habitable nearest to the Pole, to the shores of the Great Gulf, the whole of that vast continent might become one great confederation of States—without a great army and without a great navy, not mixing itself up with the entanglements of European politics, without a custom-house inside, through the whole length and breadth of its territory and with freedom everywhere, equality everywhere, law everywhere, peace everywhere—such a confederation would afford at least some hope that man is not forsaken of Heaven, and the future of our race may be better than the past." This speech, delivered at Rochdale in Nov. 1861, is a good example of his extended oratory; he was, however, equally powerful in coining new pithy phrases. The slogan "a free breakfast table" was first used by him; and he also coined the sentence, "Force is not a remedy."

Until 1868 Bright had never been in office, and indeed throughout the whole of his life he preferred to remain in what he called the "common rank of simple citizenship." He was never interested in administration. The formation of a Liberal government after the general election of 1868, however, provided him with his first opportunity of office. When Gladstone urged him to accept the post of president of the board of trade, he accepted, and gave powerful support to the program of reform, particularly Irish reform of church and land, a matter which had long been among his chief interests. A severe illness compelled his retirement in Dec. 1870, but he returned to office in Aug. 1873 as chancellor of the duchy of Lancaster. Although the Conservatives gained a majority at the general election of 1874 Bright was returned unopposed for Birmingham. He gave his continued support to Gladstone when the latter came out of his retirement in 1877 to thunder against Disraeli's policy in the near east. Following the same line of argument which he had pursued during the Crimean War he now found himself backed by the united moral indignation of the whole Gladstonian party. When Gladstone returned to power after the general election of 1880, Bright once again became chancellor of the duchy of Lancaster.

His conduct between 1880 and 1886 showed that he put the claims of office far below the claims of principle. For two sessions he spoke and voted with his colleagues, supporting for example W. E. Forster's Irish Coercion bill in 1881, but after Gladstone had intervened in Egypt and the British navy had bombarded Alexandria, Bright left the ministry (July 15, 1882) and never held office again. Although he gave continued general support to Gladstone between 1880 and 1886, he disagreed with the policy of Home Rule for Ireland and played a central part in the Liberal split of March 1886, presiding over the crucial meeting in the house of commons. He had never believed in political violence and had attacked the Irish members of parliament for having "exhibited a boundless sympathy for criminals and murderers." He was therefore able to associate himself without inconsistency with his fellow radical member for Birmingham, Joseph Chamberlain, whose version of radicalism in many other ways contrasted sharply with his own. The breakup of the Liberal party, however, filled Bright with gloom. He was unhappy also in his last years about the revival of protectionist doctrines, the new interest in the expansion of the empire and the talk of imperial federation, which he dismissed as a "dream" and an absurdity. Dogged by ill-health, he died at Rochdale on March 27, 1889, and was buried in the graveyard of the meetinghouse of the Society of Friends there.

Bright and the Liberal Movement.—Bright's importance in 19th-century British history was that he helped to clarify the operative Liberal ideal of "peace, retrenchment and reform" and to popularize it among large sections of the population. The "robust, powerful and vigorous style" of his oratory, as the third marquess of Salisbury described it, was not his only weapon; in addition, he had great courage and consistency, unbounded confidence and a basic humility. As Joseph Chamberlain put it, "the foundation of his political faith was confidence in the people . . . he placed the happiness of the many before the interests of the few." His belief in the people and his attack on vested interests, particularly agricultural interests, led his opponents to brand him as an agitator who fomented class antagonisms; his unlimited confidence caused his more sophisticated critics to claim that he lacked subtlety and depth. Both these qualities, however, contributed to his influence within the Liberal movement, which he always regarded as something more than a party. If Gladstone was the official leader of that movement, Bright was for long its chief guide and inspiration. In the house of commons Bright's role was parallel to his role in the country. "The supreme eulogy which is his due," Gladstone claimed, "is that he elevated political life to a higher elevation, and to a loftier standard, and that he has thereby bequeathed to his country the character of a statesman, which can be made the subject not only of admiration and of gratitude, but of reverential contemplation." When the reverence is stripped away, Bright remains as an outstanding figure, although he has had many critics among historians just as he had in his lifetime. "The history of the last forty years of this country," he told his Birmingham constituents in 1873, "is mainly a history of the conquests of freedom. It will be a grand volume that tells the story, and your name and mine, if I mistake not, will be found in some of its pages."

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BRIGHT, RICHARD (1789–1858), English physician, the first to describe the clinical manifestations of the kidney diseases called after him Bright's disease (*q.v.*), was born on Sept. 28, 1789, at Bristol. After an expedition to Iceland and a short period of study at Guy's hospital, London, Bright took his M.D. at Edinburgh in 1812. From 1814 to 1815 he visited continental hospitals, and then became assistant physician to the London fever hospital. In 1820 he was made assistant physician at Guy's and four years later full physician. The results of his researches first appeared in *Reports of Medical Cases Selected With a View of Illustrating the Symptoms and Cure of Disease by a Reference to Morbid Anatomy* (1827), a work which described dropsical cases and showed that they involved a diseased condition of the kidney. "Bright's disease" soon became world-known, and its discoverer's reputation was ensured by subsequent papers on renal disease in the second volume of reports in 1831 (this also contained studies of the central nervous system and of diseases of the brain, meninges and cord) and in the important first volume of *Guy's Hospital Reports* of 1836. To these latter reports, from 1836 onward, Bright contributed many papers on abdominal tumours, fever, diseased arteries of the brain, etc. He resigned his post at Guy's in 1843. He died in London on Dec. 16, 1858.

See *Guy's Hospital Reports, Bright Centenary Number* (1927); Arturo Castiglioni, *History of Medicine,* ed. by E. B. Krumbhaar, pp. 703–704 (1958).

BRIGHTLINGSEA, a seaport and urban district in the Harwich parliamentary division of Essex, Eng., on a creek of the Colne, 10 mi. S.E. of Colchester by road. Pop. (1961) 4,801. Brightlingsea was a limb of the Cinque Port of Sandwich (*q.v.*) long before 1442. A 14th-century house, Jacobs, still stands. The oyster fishery is the chief industry; there are also some shipyards. It is a yachting and holiday resort.

BRIGHTON, a parliamentary and county borough and seaside resort of East Sussex, England, 51 mi. S. of London by road or rail. Pop. (1961) 163,159; area 19.6 sq.mi. The borough, which returns two members to parliament, was extended in 1923, 1928 and 1952 and includes Patcham, Rottingdean, Ovingdean and part of Falmer and Saltdean. It is bounded by the South Downs on the north, and also on the east, where the chalk cliffs rest on traces of a raised beach at Black Rock beyond Kemp Town, and by Hove which continues the urban development without interruption along the flat shore line to the west. In 1930 big sea defense schemes were undertaken between Black Rock and Saltdean, including an undercliff promenade and sea wall.

The first mention of Brighton is in Domesday where it appears as Bristelmestune (Bryghneston in 1324, Brighthempston in 1514, Brighthelmston in 1816) and comprised three holdings, from one of which a rent of 4,000 herrings was due to Earl Godwin. Its early history is one of the vicissitudes of its fishing community, living largely at the foot of the cliff amid the hazards of sea storms, cliff erosion and marauding Frenchmen. In the time of Elizabeth I, disputes between fishermen and neighbouring landsmen led the queen to order the establishment of the "Society of Twelve"—eight fishermen and four landsmen—to assist the constable, and this body was for long the local government. From the 17th century the community declined until in 1750 Richard Russell published his work on the medical uses of sea water and settled in Brighton (1754) to carry his theories into practice, thereby initiating the era of sea bathing. Its popularity received a new impetus from the arrival, in 1783, of the prince of Wales, afterward the prince regent and King George IV. His powerful patronage, extending almost continuously to 1827, gave Brighton its most splendid period and one which stamped the town with the distinguished character imparted by its regency squares and terraces. Mrs. Fitzherbert, recognized as his wife, is buried in St. John's Roman Catholic church. His palace, the Royal pavilion, designed in Indian style with fantastic Chinese interior decorations, was built on the Old Steine (where fishing nets were dried) at a cost of more than £376,000 for land and buildings alone. It was sold to the town by Queen Victoria in 1850 and now, furnished in the style of that period, including some of the original furnishings, is open to the public during the summer. The Dome, originally the royal stables, accommodates 2,000 and is used for concerts, conferences and social functions, and the Royal pavilion estate houses the museum and art gallery. With the opening of the London to Brighton railway in 1841, the future popularity of the resort was assured. It was granted a charter of incorporation in 1854.

The heart of Brighton—the old town of narrow "lanes"—lies west of the Old Steine, and its seaward side is the main promenade, between the Palace and West piers. The Chain pier (1,134 ft.), built in 1823 in the form of four suspension bridges, was destroyed in a storm in 1896. The oldest church, St. Nicholas, originally dated from Norman times. Brighton has more than 7 mi. of sea front above the pebbly beach where there is sand at low tide. There in 1887 Magnus Volk established the first electric railway in Great Britain (1½ mi. in length), which still carries holidaymakers in open coaches.

The town has several theatres; the Booth museum of birds; Preston manor, a Queen Anne house bequeathed for a museum and public park; a racecourse of 122 ac. on a crest of the downs overlooking the sea near Whitehawk hill, where are Neolithic earthworks; two open-air swimming pools; an aquarium; five golf courses; an ice stadium; a sports arena of 14 ac.; and about 28 sq.mi. of land within and without the borough, a large part of which, including the Devil's dike, was bought to form a green belt. The municipal airport is at Shoreham-by-the-Sea. The University of Sussex was founded at Brighton in 1961, with its headquarters in the 18th-century Stanmer House. Of many schools the biggest are Brighton college (1845) and Roedean girls' school; there are also a technical college, a college of arts and crafts and a teachers' training college. Sussex county hospital is the largest of numerous hospitals and sanatoria.

The town has industrial estates covering 45 ac., and the making of office machinery, jigs and machine tools, time recording equipment, electrical apparatus, vacuum cleaners, shoes, paint, medicinal preparations, street name plates, brushes and beer are among its varied industries.

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(W. O. D.)

BRIGHT'S DISEASE is named after Richard Bright, an English physician, who described the clinical manifestations of certain kidney diseases now known as glomerulonephritis and hypertensive contracted kidney. Subsequently others enlarged Bright's conception to include essentially all forms of kidney disorders of the glomeruli, the vascular tree and those of a degenerative type. *See* Bright, Richard; Edema; Urinary System.

(F. L. A.)

BRIGIT (Bridget, Brigida, Bride), **SAINT,** of Ireland (d. *c.* 524–528), abbess of Kildare, is one of the patron saints of Ireland. Little is known of her life but legend, myth and folklore. According to these, she was born at Fochart, in the present County Louth, of a noble father and a slave mother. As a child she was sold with her mother to a druid, whom she later converted to Christianity. On being set free she returned to her father, who tried to marry her to the king of Ulster, but the latter, impressed by her piety, removed her from parental control. She gathered other virgins around her, and obtained ecclesiastical recognition of their privileged status. They lived as a community at Kildare, which became a double abbey, for monks and nuns, under an abbess who ranked above the abbot. St. Conlaed, bishop, was honoured there with Brigit from the earliest times. She seems to have been active in founding other communities of nuns. Brigit died on Feb. 1, which is kept as her feast day.

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(Pl. Gn.)

BRIGITTINES (*Ordo Sanctissimi Salvatoris*), a religious order founded by St. Bridget (*q.v.*) of Sweden about 1346, though the mother house at Vadstena, Swed., was not begun until 1371. Among the 79 pre-Reformation houses of the order (mostly in northern Europe) was that of Syon at Isleworth, Eng., dating from 1415. On Aug. 5, 1370, Pope Urban V approved the Brigittine rule but required the use also of the rule of St. Augustine. The modern Sisters of the Most Holy Saviour of St. Bridget, founded at Rome in 1911 by Mother Elisabeth Hesselblad, were recognized by the Holy See on Sept. 12, 1942, as an offshoot of the ancient order. (H. G. J. B.)

BRIHASPATI (Brhaspati or "Lord of Prayer," equated with the planet Jupiter), a deity in the Vedic Hindu mythology, an ally of Indra in his conquest of the cloud demon. In the Rigveda he is identified with Agni (*q.v.*). Offspring of heaven and earth, he inspires prayer and protects the pious. Depicted as having 7 mouths, 100 wings and sharp horns, he is armed with bow and ax, and his chariot is drawn by red horses. In the epics he is merely a priest or sage.

BRIL (Brill), **PAUL** (1554–1626), Flemish artist, was the most popular landscape painter in Rome in the late 16th and early 17th centuries, a time when the Flemings were still considered the leading specialists in this field. His early forest landscapes have a twisted, exaggerated appearance; their style derives partly from the Mannerist painters of his native Antwerp. After 1600 he disciplined and simplified his compositions under the influence of Adam Elsheimer (*q.v.*). His latest work is classical in character and forms part of the background which helps to account for Claude Lorrain. He died in Rome on Oct. 7, 1626.

Several fresco cycles by Bril survive (Vatican, Palazzo Rospigliosi, etc.) and numerous individual works on panel and canvas.

See A. Mayer, *Das Leben und die Werke der Brüder Mattheus und Paul Brill* (1910); R. Baer, *Paul Bril* (1930). (M. W. L. K.)

BRILLAT-SAVARIN, ANTHELME (1755–1826), French lawyer, politician and writer, who was the author of the celebrated work on gastronomy, *Physiologie du goût.* Born at Belley on April 1, 1755, he followed the family profession of lawyer. A deputy of the third estate at the states-general of 1789, he was forced to flee the country during the Terror and went to Switzerland and the United States. He returned to France in 1796 and became a judge of the court of cassation during the consulate. He published several works on law and political economy before his work on gastronomy appeared in 1825 (Eng. trans., *The Physiology of Taste,* 1925). He died at Paris on Feb. 2, 1826.

See M. des Ombiaux, *La Physiologie du goût de Brillat-Savarin* (1937).

BRINDISI, a city of southeast Italy, Puglia region, and capital of Brindisi province, is a major Adriatic port situated on the Italian "heel," 113 km. (70 mi.) S.E. of Bari by road. Pop. (1961) 76,272 (commune). It lies between the arms of a

Y-shaped sea inlet which admits ocean-going ships. Much of the city is modern, with wide streets and spacious buildings. Two columns are the chief Roman relics, but other remains include vestiges of a water-supply system and public baths. The church of S. Benedetto (1080) has a cloister and a carved portal, that of Sta. Lucia, a crypt with Byzantine frescoes. The 11th-century circular baptismal church of S. Giovanni al Sepolcro is now a museum. The 12th-century cathedral was almost entirely rebuilt in 1749. The Church of Christ has a 13th-century façade and 14th-century frescoes by Rinaldo da Taranto. The castle of Frederick II overlooks the western arm of the inner harbour. Brindisi is on the main coastal railway from Ancona to Lecce, with a branch to Taranto, and from its port ships ply to the near and far east. There is an airport 3 mi. N., at Casale. The chief industry is the import and export of merchandise, but wine and preserved fruit are produced.

Legend attributes the city's foundation to Diomedes, the companion of Ulysses, and its original Greek name, *Brentesion,* changed by the Romans to Brundisium (meaning "Stag's head" from the antler-shaped inner harbour), shows its Illyrian origin. It was made a Roman town in 266 B.C. and with Tarentum (Taranto) formed a base of resistance to Hannibal half a century later. In the 2nd century B.C. it was joined to Rome by the Appian way and after the Social wars became a municipium. Octavian (Augustus) and Antony were reconciled there in 40 B.C. and in 19 B.C. Virgil died there. Brindisi had various rulers during the early middle ages. It regained importance after conquest by the Normans (1071) and was the embarkation port for many crusaders. Its prosperity continued under the first Angevin, but the town was damaged in the struggles over the succession at the end of the 14th century, and by an earthquake in 1456. In common with the rest of the kingdom of Naples, Brindisi changed hands several times in the 18th and early 19th centuries, but from 1815 the restored Bourbons began to make it an important commercial centre. The opening of the Suez canal in 1869 increased its prosperity. In World War I it was the centre of naval operations in the Adriatic and in World War II was captured by the Allies on Sept. 10, 1943.

The province of Brindisi, formed in 1927 with Brindisi as capital, is shaped roughly like a flat triangle, with its base on the Adriatic 47 mi. long. Its greatest width is 28 mi. and its chief river the Canale Reale. Pop. (1961) 342,741; area 709 sq.mi. The province is mainly flat or undulating, rising to the westward. Chief towns are Fasano, Ostuni and Francavilla Fontana. The emphasis in agriculture is on cereals, olives, vines and vegetables.

(M. T. A. N.)

BRINDISI, a term used for drinking songs in 19th-century Italian opera, from *brindisi,* "a toast." Typical examples are the aria "Libiamo" ("let's drink") in Verdi's *La Traviata* and "Viva il vino" in Mascagni's *Cavalleria Rusticana.* The genre reached its height in the dramatic drinking song by Iago, accompanied by Cassio, Roderigo and a choir, in act i of Verdi's *Otello.*

BRINDLEY, JAMES (1716–1772), co-founder with John Smeaton of the civil engineering profession, was born at Thornsett near Buxton, Derbyshire, in 1716. Of humble origin, he became a millwright. In 1752 he designed and set up an engine for draining coalpits at Clifton, Lancashire. In 1759 his genius and skill led to his being called by the duke of Bridgwater to advise on his project of a canal from Worsley to Manchester. His solution of the problems, including the Barton aqueduct carrying the canal over the river Irwell and the many miles of underground communications in the Worsley coal mines, established him as the foremost canal engineer of his day. The success of this canal encouraged similar projects; the Grand Trunk canal, penetrating the central ridge of England by the Harecastle tunnel, the Staffordshire and Worcestershire, the Coventry, the Oxford, the old Birmingham and the Chesterfield canals were all designed and, with one exception, executed by Brindley. By his labours a network totaling 360 mi. of canals was laid out and constructed. The communications of the country were so improved that the way was paved for the industrial revolution of the 19th century. Brindley left no record of his works, which he undertook without written calculations or drawings. He died on Sept. 30, 1772, at Turnhurst, Staffordshire.

See S. Smiles, *The Lives of the Engineers,* vol. i (1864).

(A. McD.)

BRINELL, JOHAN AUGUST (1849–1925), Swedish metallurgist, devised the Brinell hardness test (*see* HARDNESS TESTING). Born in Bringetofta in the district of Jönköping, on Nov. 21, 1849, he attended the technical school at Borås. He rose to a leading position in the iron and steel industry. In 1875 he became the engineer for the Lesjöfers ironworks and in 1882 was appointed chief engineer of the Fagersta ironworks, a position he held until 1903. From 1903 to 1914 at the Jarnkontoret works he carried on research in steel handling and the crystallization of steel. He retired in 1914.

About 1900 he developed the rapid test for steel that bears his name, by which the hardness and other properties are determined by the imprint made by a hardened ball under a given pressure. He won many awards including the Bessemer medal of the Iron and Steel institute of London. Brinell died at Stockholm on Nov. 17, 1925.

(S. C. HR.)

BRINK, BERNHARD TEN (1841–1892), German philologist, of Dutch origin, best known for his studies of early English literature, was born at Amsterdam on Jan. 12, 1841, and educated at Düsseldorf, Münster and Bonn. In 1870 he became professor of modern languages at Marburg, and in 1873 professor of English at Strasbourg university. In 1874 he began to edit, in conjunction with W. Scherer, E. Martin and E. Schmidt, *Quellen und Forschungen zur Sprache und Kulturgeschichte der germanischen Völker.* In 1877 he published *Chaucer: Studien zur Geschichte seiner Entwicklung und zur Chronologie seiner Schriften;* in 1884, *Chaucers Sprache und Verskunst.* He also published critical editions of the *Prologue* and the *Compleynte to Pité.*

Brink's work stimulated a revival of Chaucer study in the United Kingdom as well as in Germany, and to him was indirectly due the foundation of the English Chaucer society. His *Beowulf-Untersuchungen* (1888) proved a hardly less valuable contribution. His best known work is his *Geschichte der englischen Literatur* (1889–93; English trans. by H. Kennedy in Bohn's *Standard Library*), which was never completed, and broke off just before the Elizabethan period.

Brink died at Strasbourg Jan. 29, 1892.

BRINON, FERNAND DE (1887–1947), a leading French supporter of Naziism and collaborator under the Vichy regime, was born at Libourne, Gironde, on Aug. 16, 1887, and graduated at the École Libre des Sciences Politiques in Paris. A journalist, he became a vigorous supporter of Franco-German reconciliation and founded the Comité France-Allemagne and the Cercle du Grand Pavois, which exercised great influence in political and business circles. Heavily financed by Germany through his friend Otto Abetz, J. von Ribbentrop's chief agent in France, he played an important part in the final demoralization of the third republic and in the establishment of the Vichy regime.

In Nov. 1940, by agreement with the Germans, the Vichy government appointed Brinon its ambassador in Paris and then its delegate general for German-occupied France also; in April 1942 he became a junior minister. In Sept. 1944, after the Allied invasion had caused the collapse of the Vichy regime, he, Marcel Déat and other collaborators formed in Marshal Pétain's name a pseudo government which was, however, devoid of effective authority. Eventually captured by the Allies, Brinon was tried by the high court and sentenced to death for treason. He was executed on April 15, 1947. His services to Germany had been so great that his Jewish wife was recognized by the *Reich* as an "honorary Aryan."

(P. W. C.)

BRINVILLIERS, MARIE MADELEINE MARGUERITE D'AUBRAY, MARQUISE DE (*c.* 1630–1676), French poisoner, was the eldest daughter of Antoine Dreux d'Aubray, civil lieutenant of Paris. In 1651 she married a young army officer, Antoine Gobelin de Brinvilliers. Vivacious, attractive and pleasure-loving, she became the mistress of a friend of her husband's, J. B. Godin, called de Sainte-Croix. On her father's intervention, Sainte-Croix was arrested and sent to the Bastille on March 19,

1663. Released two months later, he plotted with his mistress to take revenge on her father by poisoning him. With the assistance of Glaser, one of the king's apothecaries, he obtained poisons which she tested on patients in hospitals. Eventually she was thus enabled to procure the death of her father (Sept. 10, 1666) and then of her two brothers (1670), but an attempt on her husband failed. Then Sainte-Croix died suddenly (July 31, 1672) and among his belongings documents were found incriminating Madame de Brinvilliers and her valet, as well as some phials of poison. The valet was condemned to death and was broken on the wheel in the Place de Grève (Feb. 23, 1673). The marquise, having escaped and taken refuge in England and later in the Low Countries, was condemned to death in her absence.

Arrested at Liège (March 25, 1676) and taken to France, she was tried by the *parlement* of Paris and condemned to be beheaded. Having admitted her crimes under torture and expressed her repentance, she was executed in the Place de Grève on July 16, 1676. Her body was burned and the ashes scattered. *See* also POISONS, AFFAIR OF THE.

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BRISBANE, ARTHUR (1864–1936), U.S. newspaper editor and writer, was best known for his work on the Hearst newspapers. He was the son of Albert Brisbane (1809–1890), U.S. social reformer, whose European study and travels led him to adopt the principles of François Marie Charles Fourier (*q.v.*), and after his return to the U.S., to organize, write and lecture for their implementation. Arthur was born in Buffalo, N.Y., Dec. 12, 1864. Educated in the U.S. until the age of 13, he then, like his father, studied in France and Germany. Returning to the U.S. in 1883, he worked first on Charles A. Dana's *New York Sun* and then on Joseph Pulitzer's *New York World*. In 1897 William Randolph Hearst (*q.v.*) made him managing editor of the *New York Journal*, and, with his salary tied to circulation rises, Brisbane became the highest paid U.S. newspaper editor of his day. Master of the big, blaring headline and of the atrocity story, he played a large part in the *Journal's* promotion of the Spanish-American War (*see* NEWSPAPER: *Yellow Journalism*). His editorial column, "Today," written from 1917 to the day of his death in New York city, Dec. 25, 1936, was widely syndicated, often as a front page feature.

See Oliver Carlson, *Brisbane: a Candid Biography* (1937).

BRISBANE, SIR THOMAS MAKDOUGALL (1773–1860), Scottish soldier and astronomical observer who is mainly remembered as a patron of science, was born on July 23, 1773, at Brisbane house, near Largs, Ayrshire. He entered the army in 1789 and served in Flanders, the West Indies, Canada and Spain. He developed an interest in astronomy and built an observatory at Brisbane house. In 1821 he was appointed governor of New South Wales and, although generally a poor administrator, he introduced grapevines, sugar cane and tobacco plants into the colony. He established an observatory at Paramatta in 1822 and after his return to Scotland constructed a combined observatory and magnetic station at Makerstoun in Roxburghshire. He was awarded the gold medal of the Royal Astronomical society in 1828, and the results of magnetic observations at Makerstoun gained him the Keith prize of the Royal Society of Edinburgh in 1848. He was elected president of that society in 1833 in succession to Sir Walter Scott. Brisbane was made a baronet in 1836 and a general in 1841. He died at Brisbane house on Jan. 28, 1860.

See *Mon. Not. R. Astr. Soc.*, vol. 21 (1860). (O. J. E.)

BRISBANE, city, port, and capital of Queensland, Austr., is situated in the southeastern corner of the state on the Brisbane River; the central city area is 14 mi. (24 km.) from the river mouth in Moreton Bay. The population of the municipal area in 1966 was 656,222 and of Brisbane statistical division 777,674, exclusive of full-blood Aboriginals, making Brisbane the third largest city of Australia. The municipal area of the city is 375 sq.mi. (971 sq.km.). The Brisbane statistical division, an area of 957 sq.mi. (2,479 sq.km.), includes and surrounds the Brisbane municipal area. This division comprises an area in close economic and social contact with Brisbane in which urbanization is expected to spread outward from the capital during the remaining decades of the 20th century. It includes the nearby cities of Ipswich and Redcliffe and parts of six surrounding shires. Brisbane lies astride a river that winds through wooded, hilly country and is crossed by five bridges and several ferries, including a large vehicular ferry in the lower reaches of the river. The climate is subtropical with temperatures varying from a mean minimum of 60° F (15.6° C) to a mean maximum of 77.8° F (25.3° C), an average daily sunshine of 7.5 hours, and an average annual rainfall of 44.76 in. (1,137 mm.) falling mainly from December to March.

BY COURTESY OF BRISBANE CITY COUNCIL

VIEW OF BRISBANE FROM WICKHAM TERRACE. THE CITY HALL (WITH CLOCK TOWER) STANDS IN THE CENTRE

One of the city's most splendid buildings is the city hall, erected in Renaissance style in 1929 at a cost of nearly $A2,000,000 covering 2½ ac. on the site of Brisbane's original water hole. The University of Queensland at St. Lucia has excellent modern buildings, and there are a fine Parliament House (1869), the Queensland Museum (1855), the Queensland National Art Gallery (1895), and an Anglican and a Roman Catholic cathedral. The main thoroughfares are Queen Street and Adelaide Street. There are three racetracks and many public recreation grounds, besides beautiful parks and gardens, such as the Botanic Gardens (51 ac. [21 ha.]).

Brisbane is the outlet for a vast and rich agricultural and pastoral hinterland stretching west to the Eastern Highlands, the Darling Downs, and beyond. It is also becoming increasingly important as an industrial centre, its industries including heavy and light manufacturing, shipbuilding, oil refining, fertilizer processing, food processing, sawmilling, tanning, and the manufacture of cement, clothing, and motor cars. The city is supplied with water from Lake Manchester and the Somerset Dam and, via direct pipelines from Roma, with oil and natural gas. Brisbane is Australia's first capital city to use natural gas in homes and industry.

Railways link Brisbane with Sydney and the southern states, one via Toowoomba and Warwick and the other via Kyogle and the coast. There are also rail links with the northern sugar and mining areas and with the vast pastoral plains to the west. Coal from the west Moreton coalfield centring on Ipswich is transported by river to the port of Brisbane. This has a 400-ft. (121 m.)-wide dredged channel, a maximum tidal rise of 7 ft., and berths for ships up to 750 ft. in length and with a draft of 28 ft.

right up to the heart of the city. There are 52 wharves which serve passenger vessels of up to 25,000 tons and other vessels ranging to tankers of 34,000 tons. There are two graving docks. Most of the state's exports of wool, meat, sugar, minerals, butter, and general dairy products pass through the port. Brisbane has two civil airports: Eagle Farm, 6 mi. (9 km.) NE, provides services to the main cities of Australia and also to London and other major cities overseas; and Archerfield, 8 mi. (13 km.) S, is an auxiliary airport.

The site of the city was discovered by Lieut. John Oxley in 1824 when he "landed to look for water" and it was first used for the penal settlement of Moreton Bay. Land was thrown open for sale in 1842, after transportation to New South Wales had been abolished. The city has been known as Brisbane since an early visit to the settlement by Sir Thomas Brisbane, then governor of New South Wales. On Sept. 7, 1859, Brisbane was proclaimed a municipality and on Dec. 10, 1859, Queensland was constituted a separate colony, with Brisbane as its capital and seat of government. At that time Brisbane had a population of about 5,000.

See Gordon Greenwood and John Laverty, *Brisbane, 1859–1959* (1959). (T. V. M.)

BRISSON, (EUGÈNE) HENRI (1835–1912), French statesman of strong anticlerical views, twice premier, was born at Bourges on July 31, 1835. He studied law and practised as a barrister in Paris. He contributed articles to *Le Temps* in the days of the second empire. One of the deputy mayors of Paris after Sept. 4, 1870, he was elected on Feb. 8, 1871, to the national assembly, as a deputy of the extreme left. He was the first to propose a general political amnesty—to include the condemned Communards—but this was rejected. Brisson sat as a deputy for Paris from 1876 to 1902 and for the Bouches-du-Rhône from 1902 until his death. He was president of the chamber from Nov. 1881 to March 1885. He succeeded Jules Ferry as premier on April 6, 1885, but resigned on Dec. 29 on obtaining a bare majority for the vote of credit required for the Tongking expedition. He was president of the committee of inquiry into the Panamá scandal. He stood unsuccessfully as a candidate for the presidency of the republic in June 1894 and again in Jan. 1895. Having been president of the chamber again from Dec. 1894, he formed his second cabinet on June 28, 1898. The two main problems with which he had to deal were the Dreyfus affair and the Fashoda incident. He was forced to resign on Oct. 25, when his war minister, Gen. Jules Chanoine, contrary to the cabinet's agreed policy, declared in the chamber that he believed in Dreyfus' guilt and so provoked a vote of no confidence in the government.

Brisson actively supported René Waldeck-Rosseau and Émile Combes (*qq.v.*), particularly in regard to the separation of church and state. In 1906 and in 1912 he was re-elected president of the chamber. He died in Paris on April 13, 1912.

BRISSOT, JACQUES PIERRE (BRISSOT DE WARVILLE), (1754–1793), a leader of the Girondins (Brissotins) during the French Revolution, notable particularly for his war policy, was born at Chartres on Jan. 15, 1754, the 13th son of an eating-house keeper. He began to work as a clerk in lawyers' offices, first at Chartres, then in Paris. His pamphlet *Testament politique de l'Angleterre* (1780) brought him to the notice of the English editor of *Le Courrier de l'Europe,* and Brissot worked for this journal for a year. He then tried to resume his former career, but the legal profession's resentment at his *Théorie des lois criminelles* (1781) made this impossible. Taking an interest in science, he went to London (Feb.–Nov. 1783) and not only sent literary articles to *Le Courrier* but also founded two scientific periodicals, which failed. Returning to France, he was imprisoned in the Bastille for pamphlets against the queen and the government, but was released in Sept. 1784.

Inspired by the English antislavery movement, Brissot founded the Société des Amis des Noirs in Feb. 1788. He left for the United States in May, but returned when the states-general were convened in France and launched a newspaper, *Le Patriote français* (May 1789). Elected to the first municipality of Paris, he took delivery of the keys of the Bastille when it had been stormed.

At first Brissot concentrated on the struggle for the emancipation of slaves, demanding from the Jacobins (May 11, 1791) that Negroes should enjoy all the rights of ordinary citizens. After Louis XVI's flight to Varennes, however, he attacked the king's inviolability in a long speech to the Jacobins (July 10, 1791), which contained all the essentials of his future foreign policy. Elected 12th deputy for Paris to the legislative assembly, he at once concerned himself with foreign affairs, joining the diplomatic committee. He argued that action must be taken against the king's *émigré* brothers (Oct. 20, 1791) and that war could only consolidate the Revolution by unmasking its enemies and inaugurating a crusade for universal liberty (speeches of July 10, Dec. 11 and 30, 1791, and Jan. 20, 1792). Only Robespierre dared to oppose him, and war was declared (April 1792). The early defeats suffered by the French, however, gave fresh impulse to the revolutionary movement, which Brissot and his friends meant to check. Having tried in vain to prevent the suspension of the monarchy, Brissot was denounced by Robespierre in the Paris commune as a "liberticide" on Sept. 1.

No longer acceptable to Paris, Brissot represented Eure-et-Loir in the Convention. Expelled from the Jacobins (Oct. 12, 1792) and attacked by the Mountain (extreme revolutionary faction), he was still influential in the diplomatic committee: his report led to war being declared on Great Britain and the Dutch (Feb. 1, 1793). Having voted for suspension of the death sentence on Louis XVI, he later maintained in a pamphlet that the execution had halted the course of French victories. On April 3, 1793, Robespierre accused him of being the friend of the traitor Gen. C. F. Dumouriez and of being chiefly responsible for the war. Brissot replied denouncing the Jacobins and calling for the dissolution of the municipality of Paris. He was not conspicuous in the struggle between the Girondins and the Mountain (April–May), but on June 2, 1793, his arrest was decreed with that of his Girondin friends. He fled, but was captured at Moulins and taken to Paris. Sentenced by the revolutionary tribunal on the evening of Oct. 30, he was guillotined the next day. His *Mémoires,* written in prison, were edited by C. Perroud, two volumes (1912).

See E. Ellery, *Brissot de Warville* (1915) ; also H. A. Goetz-Bernstein, *La Diplomatie de la Gironde* (1912). (A. So.)

BRISTLE, the supple, resilient hair of the wild or semiwild boar or hog, one species of which is found in Europe, Siberia and China; three other distinct types are native to India, Tibet and Japan respectively. Bristle has a broad base and a tapered tip split into several filaments or "flags." Its surface is slightly rough or ridged. Because of its form, bristle has been a brush material of prime importance for centuries.

The chemical basis of bristle is keratin, a protein-type substance, the molecular structure of which is a chain formation. Nylon bristles are produced by the chemical construction of similar molecular chains. *See* BRUSH. (E. L. Y.)

BRISTOL, EARLS AND MARQUESSES OF. The English title earl of Bristol was first held, between 1622 and 1698, by members of the Digby family (*see* BRISTOL, GEORGE DIGBY, 2nd earl of; BRISTOL, JOHN DIGBY, 1st earl of). It was revived in 1714 in favour of John Hervey and has been held continuously by members of his family since that date. From 1826 the earls of Bristol have also borne the titles marquess of Bristol and Earl Jermyn.

JOHN HERVEY (1665–1751), 1st earl of Bristol (in the Hervey line), was born on Aug. 27, 1665, the son of Sir Thomas Hervey (d. 1694) and the nephew of John Hervey (1616–79), treasurer to Catherine of Braganza, queen consort of Charles II. He was educated at Clare hall, Cambridge, and became member of parliament for Bury St. Edmunds (March 1694). He was created Baron Hervey of Ickworth in March 1703 and earl of Bristol in Oct. 1714, through the influence of the duchess of Marlborough. By his first marriage he had only one son, Carr, who died unmarried on Nov. 14, 1723, and is thought by some to have been the father of Horace Walpole (1717–97). The 1st earl died on Jan. 20, 1751. His eldest son by his second marriage, John (1696–1743), gained some renown as a writer and politician (*see* HERVEY OF ICKWORTH, JOHN HERVEY, Baron).

The 1st earl was succeeded by his grandson GEORGE WILLIAM

Hervey (1721–75), 2nd earl, who was born on Aug. 31, 1721. He became Baron Hervey of Ickworth in 1743 and succeeded to the earldom in 1751. He served in the army (1739–42), was sent to Turin as envoy extraordinary in 1755, and was ambassador at Madrid from 1758 to 1761. Appointed lord lieutenant of Ireland in 1766, he never visited that country during his short tenure of office. After having served for a short time as keeper of the privy seal, he became groom of the stole to George III in Jan. 1770. He died unmarried on March 18, 1775, and was succeeded by his brother Augustus John Hervey (1724–79), 3rd earl.

Augustus John was born on May 19, 1724. He entered the navy in 1736, served under Adm. John Byng in the Mediterranean and gave evidence at his trial in 1757. He was of great assistance to Adm. Edward Hawke in 1759. Having served with distinction in the West Indies under George Rodney, his active life at sea ceased with the peace of Paris (Feb. 1763). Hervey was, with one short interval, member of parliament for Bury St. Edmunds from 1757 until he succeeded his brother in the peerage (1775). Having served as a lord of the admiralty (1771–75) he won some notoriety as an opponent of the Rockingham ministry and a defender of Admiral Keppel. He had married in 1744 Elizabeth Chudleigh (1720–88), later well known in many European courts. The marriage was kept secret as she wanted to retain her position as maid of honour to the princess of Wales. In 1769 she denied having been married and married the duke of Kingston. On his death she was prosecuted for bigamy, and convicted, and spent the rest of her life on the continent. The earl died in London on Dec. 24, 1779, leaving no legitimate issue and having, as far as possible, alienated his property from the title.

He was succeeded by his brother Frederick Augustus Hervey (1730–1803), 4th earl, who was born on Aug. 1, 1730, and educated at Westminster school and Corpus Christi college, Cambridge. He became a royal chaplain and was made bishop of Cloyne in 1767, and of Derry in 1768. He did much to improve agriculture and communications within his diocese, often at his own expense, and he opposed the penal laws, the tithe system and Roman Catholic disabilities. He became earl of Bristol in 1779. In 1782 he threw himself ardently into the Irish volunteer movement. He was a member of the volunteer convention at Dublin in 1783 and probably wanted to be elected chairman. But his ideas, which included votes for Catholics, were too radical and republican for loyal Protestants, and more moderate parliamentarians like Henry Grattan gained control of the movement. Discouraged, the bishop retired abroad and died at Albano, Italy, on July 8, 1803.

Frederick Augustus was succeeded by his younger son, Frederick William Hervey (1769–1859), 5th earl and 1st marquess, born on June 2, 1769. He was created marquess of Bristol and Earl Jermyn in 1826, and died on Feb. 15, 1859. He was succeeded by his son, Frederick William (1800–64), M.P. for Bury St. Edmunds, 1826–59, as 2nd marquess, by the latter's son Frederick William John (1834–1907), M.P. for West Suffolk, 1859–64, as 3rd marquess. Frederick William Fane Hervey (1863–1951), 4th marquess, nephew of the 3rd marquess, served in the Royal Navy and was M.P. for Bury St. Edmunds in 1906–07. His brother Herbert Arthur Robert Hervey (1870–1960), 5th marquess, succeeded to the title after a career in diplomacy. The son of the 5th marquess, Victor Frederick Cochrane Hervey, became the 6th marquess of Bristol in 1960.

BRISTOL, GEORGE DIGBY, 2nd Earl of (1612–1677), English royalist, who was an ambitious and impetuous minister of Charles I and for a short time, in exile, of the future Charles II, was born in Madrid in Oct. 1612, the eldest son of John Digby, 1st earl of Bristol. He was educated at Magdalen college, Oxford. In 1638–39 he attacked Roman Catholicism in a series of letters to Sir Kenelm Digby. He bore resentment to the court for his imprisonment for dueling in Whitehall palace in 1634, and so when he was elected member of parliament for Dorset in 1640 he supported John Pym and John Hampden, and was one of the committee for the impeachment of the earl of Strafford. But in 1641 he voted against the earl's attainder and opposed the bill whereby the Puritans unsuccessfully tried to abolish the episcopacy and the hierarchy of the church "root and branch." To save him from the attacks of the house of commons, the king raised him to the peerage in his father's barony of Digby (June 1641), and he became one of Charles's advisers. He urged the arrest of the five members in Jan. 1642, and was soon after forced to escape impeachment by fleeing abroad. He returned to fight for the king at Edgehill, the first battle of the English Civil War (1642), but threw down his commission after a quarrel with Prince Rupert. He was made secretary of state in 1643, and lieutenant general of the king's forces north of the Trent in 1645. On Oct. 15, 1645, he was defeated at Sherburn in Durham, his correspondence, disclosing royal intrigues with Ireland, Scotland and foreign powers, was captured, and he was forced to escape to Ireland, where he worked with the marquess of Ormonde, and was unjustly blamed for the intrigues of the earl of Glamorgan. Finally he fled to France where he served Louis XIV in the Fronde. He was reappointed secretary of state by the future Charles II in 1657, but he became a Roman Catholic in 1658 and, to his surprise, was forced to resign office. His estrangement from Edward Hyde, afterward earl of Clarendon, also occurred at this time.

Digby, who had inherited the earldom of Bristol in 1653, returned to England after the Restoration but was excluded from office because of his religion. He adopted an attitude of violent hostility toward Clarendon and on July 10, 1663, brought a charge of high treason against him. The charge was dismissed and Bristol expelled from court. On the fall of Clarendon, however, Bristol was again welcomed at court and resumed his seat in the house of lords (July 1667). In March 1673, though still a Roman Catholic, he spoke in favour of the Test act, describing himself as a "Catholic of the Church of Rome, not a Catholic of the court of Rome." He died at Chelsea on March 20, 1677.

The 2nd earl had two sons, Francis, who was killed in a naval engagement on May 28, 1672, and John, the elder, who died without legitimate issue in 1698, when the barony of Digby and the earldom of Bristol became extinct.

See D. Townshend, *George Digby, Second Earl of Bristol* (1924).

BRISTOL, JOHN DIGBY, 1st Earl of (1580–1653), English diplomat and statesman, who as a moderate royalist advocated conciliation and reform in the struggle with parliament, was born in Feb. 1580 and educated at Magdalen college, Oxford. Between 1611 and 1624 he was constantly employed as ambassador of James I, notably in the negotiations with Spain, and he was created Baron Digby in 1618, and earl of Bristol in 1622. During 1621 he was sent to Brussels and Vienna to advocate the cause of the king's son-in-law, Frederick V, elector palatine. In 1623 when the negotiations for a marriage between Prince Charles (afterward Charles I) and a Spanish princess were wrecked by the behaviour of Charles and the duke of Buckingham in Madrid, Bristol incurred Buckingham's resentment by sending to England an account of the true state of affairs. On his arrival at Dover in March 1624 he was ordered to be confined to his home at Sherborne in Dorset. After the death of James he was removed by Charles I from the privy council and ordered to absent himself from Charles's first parliament (March 1626). Bristol applied to the lords, who supported his right either to take his seat in parliament or to be given a fair trial, and Charles sent him his writ, accompanied by a letter desiring him not to use it. Bristol, however, took his seat and demanded justice against Buckingham. The king endeavoured to obstruct his attack by causing Bristol, on May 1, to be himself brought to the bar, on an accusation of high treason by the attorney general. The lords, however, ordered that the charges against Bristol should be investigated simultaneously with the charges against Buckingham. Charles could only prevent further proceedings by the dissolution of parliament on June 15, and he ordered that Bristol should be prosecuted in the Star Chamber. Bristol was sent to the Tower of London, where he remained until March 17, 1628, when the peers, on the assembling of Charles's third parliament, insisted on his liberation and restoration to his seat in the house of lords.

In the discussions on the Petition of Right, Bristol supported the use of the king's prerogative in emergencies, but, when the compromise based on this principle was rejected by the commons, he joined in the demand for a full acceptance of the petition by the king. He was now restored to favour, but took no part in politics until the outbreak of the Scottish rebellion (1639) when he warned Charles of the danger of attacking with inadequate forces. He was a leader in the great council held at York and a commissioner to negotiate with the Scots at Ripon in 1640, and he strongly advised the summoning of a parliament. In Feb. 1641 he advocated reforms in the administration and received a seat in the council. Though no friend to the earl of Strafford, he endeavoured to save his life, desiring only to see him excluded from office. Bristol was declared an evil counselor by the house of commons on Dec. 27, 1641, and Oliver Cromwell moved an address to the king to dismiss him from his councils, on the plea that he had advocated the bringing up of the northern army to overawe parliament in the preceding spring. There is no evidence to support the charge but Bristol was regarded by the parliamentary party with unreasonable hatred and distrust. He was sent to the Tower on March 28, 1642, for having failed to disclose to parliament the Kentish petition. Liberated in April, he joined Charles at York, and became his councilor at Oxford. He was named in the propositions for peace of Feb. 1643 for removal from the court and public office forever, and in those of Nov. 1644 was excepted from pardon. In January he had endeavoured to instigate a breach of the Independents with the Scots. Bristol, however, was not in favour of continuing the war, and withdrew to Sherborne, moving in the spring of 1644 to Exeter and, after the surrender of the city, retiring abroad (July 11) by order of parliament. He published in 1647 *An Apology* defending his conduct during the English Civil War. He spent the rest of his life in exile, dying in Paris on Jan. 16, 1653, when he was succeeded by his eldest son (*see* Bristol, George Digby, 2nd earl of). (G. Ds.; X.)

BRISTOL, a city, parliamentary and county borough and seaport of England, geographically within Gloucestershire but administratively a separate county of itself, 114 mi. W. of London by road, with its own sheriff, court of quarter sessions, civil court (the Tolzey court) and assizes, returning six members to parliament. Pop. (1961) 437,048; area 41.2 sq.mi. The nucleus of the city is at the confluence of the Avon and Frome rivers, whence the Avon flows through a limestone gorge, crossed by the Clifton suspension bridge, to join the Severn estuary at Avonmouth, the western extremity of the city. Main lines of the Western and Midland regions of British railways connect the city with London, with south Wales via the Severn tunnel, with Birmingham and the midlands via Gloucester and with Exeter and Plymouth via Taunton. The municipal airport at Lulsgate, 6½ mi. S. of Temple Meads railway station, provides flights to Ireland, the Channel Islands and the European mainland.

History.—The ancient city of Bristol (Bricgstowe, Bristou, Bristoll) was situated on a 20-ac. mound of land at the junction of the Avon and the Frome, thus providing a sheltered tidal harbour capable of defense.

It differs from other large English cities in that it was from the beginning a strictly commercial place and has remained such to this day. The early history of Bristol is shrouded in obscurity. At Clifton, on the heights commanding the portion of the Avon gorge close to the suspension bridge, are three camps of British origin, but there is no evidence of a settlement at the confluence of the Avon and Frome until the 10th century, when Saxon coins of the reign of Aethelred the Unready (978–1016) minted in Bristol prove that the place had become sufficiently important to have a mint. At the time of the Norman Conquest, Bristol was part of the royal manor of Barton, paying to the king 110 marks of silver and 33 marks of silver to Geoffrey, bishop of Coutances, France, who built the first castle. This was enlarged and completed by Robert of Gloucester in 1122 and was wholly destroyed in the 17th century.

The growth of trade which followed the Conquest put Bristol in the forefront of ports outside London. The first of the city's long series of charters, granted by Henry II in 1155, freed the burgesses from all tolls and customs throughout England, Normandy and Wales. Another, dated 1171, granted the town of Dublin to the men of Bristol as a trading colony. In the early 13th century a better harbour and quays were provided by diverting the Frome and by building a stone bridge over the Avon, and this led to the expansion of the town and the inclusion of the parishes of Temple and Redcliffe within its walls. During the reign of Edward III the manufacture of woolen cloth developed in Bristol, being marketed in Ireland, Spain and Portugal, and Bristol was made one of the staple towns.

THE TIMES

GOTHIC TOWER OF MAIN BUILDING OF UNIVERSITY OF BRISTOL, DESIGNED BY SIR GEORGE OATLEY, 1925, SITUATED ON THE UPPER SLOPES OF ST. MICHAEL'S HILL, OVERLOOKING CENTRE OF CITY

Until 1216, when Adam le Page was elected the first mayor of Bristol, the constitution of the town was manorial rather than municipal. In 1373 Bristol was made a county and separated from Gloucestershire and Somerset, being the first provincial town to receive this honour. The boundaries were extended to include a large water area of the Avon and Severn to Steep Holme and Flatholm Islands. The town had its own sheriff, controlled its own legal affairs and elected a common council.

In the 15th and 16th centuries, Bristol, port and manufacturing town, was a great collecting and distributing centre not only for overseas, but also for inland trade. The city also played a notable part in maritime history. From its quays sailed such famous men as John and Sebastian Cabot, Martin Pring and Capt. Thomas James. It was the age of the merchant princes and in 1552 the Society of Merchant Venturers was incorporated. Bristol was a royalist stronghold during the Civil War until it was captured by parliamentarians under Lord Fairfax in 1645.

During the 17th and 18th centuries, trade with the new colonies, based on tobacco and sugar, stimulated the growth of new industries, such as pottery, glass, textiles, leather goods, sugar refining and tobacco manufacture. Bristol was a famous centre for glass manufacture; no fewer than 14 glassworks were active in the 18th century. In 1768 Richard Champion set up a pottery making the finest porcelain. The manufacture of chocolate was first developed in the city. Bristol also played a large part in the prosperous African slave trade, which was, however, vigorously opposed by the Quakers, who were an influential body in Bristol, and John Wesley, of whose activities Bristol was the centre.

It was in the 18th century that Bristol became a spa as a result of the opening up of springs (70° F.) at Hotwells, which led to the development of Clifton, to the west, where fine terraces and crescents were laid out.

Toward the end of the 18th century Bristol began to lose its importance, and the decline continued into the 19th century. For this there were a number of reasons: (1) the rise of Liverpool and loss of the West Indies trade; (2) failure to improve the port facilities; (3) the abolition of the slave trade; and (4) heavy rates levied by the Bristol Dock company, formed in 1803, to pay for the floating harbour built in 1809. Nevertheless, it was from the Bristol area that J. L. McAdams's idea of road construction spread throughout the country, and the "Great Western," one of the first steamships to cross the Atlantic, and the "Great Britain," the first iron ship, were both built in Bristol. In an attempt to restore the trade of the city, a chamber of commerce was established in 1823, and in 1848 the corporation took over the control of the docks, making many improvements and reducing the dock rates. By mid-20th century Bristol was again a flourishing seaport and the great distributive centre of the southwest of England.

But while its greatness has always been based on industry and commerce, Bristol has made notable contributions to practical progress in other ways: one of the first free libraries was established there in 1613, the first newspaper outside of London (1704) and the first savings bank in England (1812).

Great names connected with Bristol are those of the poets Thomas Chatterton and Robert Southey, who were born there, and S. T. Coleridge, who met Southey there in 1794 after which the Bristol bookseller, Joseph Cottle, published poems of both Coleridge and W. Wordsworth. Sir Thomas Lawrence, the artist, was the son of a Bristol innkeeper, and W. G. Grace, the cricketer, was born at Downend, 3 mi. N.E. of the town.

In 1899, the mayor of Bristol received the title of lord mayor.

Architecture.—Although the city suffered badly from air attack in World War II and a number of buildings of architectural or historic interest were destroyed or seriously damaged, the city still retains a large number of interesting and picturesque buildings. The Cathedral Church of the Holy and Undivided Trinity, seat of the Anglican bishop and situated in College green, was once the abbey of St. Augustine, founded by Robert Fitzhardinge in 1142. The Norman gateway of the abbey and the rectangular chapter house remain. The see was founded by Henry VIII in 1542 and in 1836 was united with that of Gloucester until 1897 when it was again separated. On the north side of College green is St. Mark's or the Lord Mayor's chapel, probably the only municipally owned church in the world. Formerly part of the Gaunt's hospital, it was founded in 1220 by Sir Maurice de Gaunt. The chantry of Sir Robert Poyntz, with its fan-tracery roof, is a beautiful example of late Perpendicular architecture; the hospital was purchased by the corporation from Henry VIII and the chapel has since been maintained by the corporation for worship and is unique in this respect in England.

Other conventual remains are the Dominican priory which has associations with William Penn and the early history of the Friends (the priory with the adjoining Regency Friends' meetinghouse was restored for use as the central register office); the Benedictines' church of St. James (*c.* 1130) and the gateway of St. Bartholomew's hospital. The church of St. Mary Redcliffe is the most striking ecclesiastical building in Bristol for grandeur of proportion and elaboration of design and is one of the most celebrated parish churches in England. Rebuilt in the 14th century by William Canynges the elder, whose grandson completed the work a century later, it is planned like a cathedral with aisled choir, ambulatory and transepts. Of St. Thomas' in the vicinity only the tower (15th century) remains of the old structure.

All Saints' church, rebuilt in the 15th century, retains much Norman work. The New Room in Broadmead, the first Methodist chapel in the world, was the headquarters of John Wesley after 1739. There is an equestrian statue of Wesley in front of the building. Broadmead Baptist church has associations with the early days of nonconformity in Bristol. The Roman Catholic pro-cathedral is at Clifton.

Notable examples of secular architecture are the Red lodge, which was built in 1590 and contains fine carved woodwork; the Llandoger Trow, a 17th-century inn; the Georgian house, now used as a museum for the display of Georgian furniture; the Theatre Royal, the oldest theatre in the country still in use, which was built in 1766 by James Paty and received a royal licence in 1778; and the Exchange, built by John Wood of Bath in 1743. A new council house on College green, opened by Queen Elizabeth II in 1956, holds most branches of the city administration and the city archives and insignia. The museum and art gallery contains china, pictures and other works of art.

Among the buildings destroyed during World War II were St. Peter's hospital, a gabled building mainly Jacobean, with a fine courtroom and carved timber front; the Dutch house, an early 17th-century timbered building; and the Hall of the Merchant Venturers. Of the churches of St. Mary-le-Port (Perpendicular), St. Peter (15th century) and the Temple (Decorated and Perpendicular) only the towers remain. The 11th-century crypt of St. Nicholas (18th century) remains intact.

The destruction of a large part of the city centre in World War II by air raids provided an opportunity for replanning. Postwar reconstruction resulted in the building of a new shopping centre in Broadmead.

Education.—The University of Bristol was founded as University college, Bristol, in 1876 and its charter was granted in 1909. Its growth has been rapid as a result of much generosity, notably from the Wills family, and by the mid-20th century it had more than 3,000 full-time students. The main building, designed by Sir George Oatley and opened in 1925, is situated on the upper slopes of St. Michael's hill, overlooking the centre of the city.

There are flourishing colleges of advanced science and technology, art and commerce provided by the corporation, which serve the many and various industries of the city and its neighbourhood. Among the schools of the city may be mentioned the grammar school, Queen Elizabeth's hospital (a bluecoat school for boys) and the Cathedral school, all founded in the 16th century; Colston's school (1708); and the Red Maids school (1627). The Baptist college was founded in 1679 and the Western college (Congregational), founded in Plymouth (1752), was transferred to Bristol in 1901. Other colleges include Didsbury (Methodist; 1842), Tyndale Hall (1925) and Clifton (1862).

Open Spaces.—Bristol possesses about 3,000 ac. of parks and open spaces. The most extensive is the Ashton Court estate, acquired by the corporation in 1960; the best known are the Durdham and Clifton downs, which adjoin the Avon gorge near the point at which the gorge is spanned by Isambard Kingdom Brunel's suspension bridge (1831–64); and Blaise Castle estate with a folk museum and a park. Close to Clifton down are the zoological gardens. Brandon hill, near the centre of the city, commands a fine view of Bristol and the surrounding countryside, and on the summit of the hill is the Cabot tower erected to commemorate the 4th centenary of the voyage to North America made by John Cabot.

The Port.—The port of Bristol comprises three dock systems: the City docks, Avonmouth docks and Portishead dock, administered as one undertaking (The Port of Bristol authority) by the corporation.

Until the early years of the 19th century the Avon and Frome rivers were tidal, but in 1809 three miles of tidal river were converted into a floating harbour with a constant depth of water. In 1884 the docks at Avonmouth and Portishead, which had been constructed by private interests, were acquired by the corporation. In 1908 the Avonmouth docks were considerably extended by the construction of the Royal Edward dock, and subsequently they were again enlarged.

The entrance lock of the Royal Edward dock measures 875 ft. by 100 ft. with 46 ft. of water on the outer sill (high-water ordinary spring tides) and is capable of admitting, with few exceptions, the largest type of vessel. There are good facilities for the repair and reconditioning of vessels, including a graving dock 875 ft. over-all in length.

Well-equipped modern transit sheds are available both at the Avonmouth and City docks, and there is extensive warehouse accommodation, including a cold store, silo granaries, tobacco warehouses and a bonded warehouse for wine. All general cargo berths are amply furnished with cranes, and specialized equipment such as floating and shore elevators is available. In general the port is highly mechanized and most of the equipment was installed after World War II.

The City docks are mainly concerned with coastwise and European traffic, whereas the Avonmouth docks enjoy a world-wide trade and provide accommodation for the largest cargo vessels. The principal imported commodities are grain, petroleum, animal feeding stuffs, zinc concentrates, meat, dairy produce, fruit, timber, phosphates, metals, tobacco, wines and cocoa. Export commodities include cars, tractors, machinery, clay and chemicals. About 7,000,000 tons of cargo are handled in the port annually and on the sterling value of its imports it occupies fifth place among the ports of Great Britain and is the largest municipally owned port.

Liner services link the port with most European countries trading with the United Kingdom and with Canada, the United States, Africa, Australia, New Zealand, India and Pakistan, Japan and far eastern countries, including Malaya and Burma. The Avonmouth docks are connected with the centre of the city by a magnificent roadway, known as the Portway, 5½ mi. long and for the most part 100 ft. wide. Just below New Passage pier (11½ mi. N.W.), the railway crosses the Severn estuary via the Severn tunnel (4.33 mi. long).

Industries.—Bristol has a large variety of industries, of which aircraft design and construction at Filton is the most important. Other significant industries are tobacco, papermaking, printing and flour milling and their allied trades, pottery and metallurgical and chemical processes of various kinds, shipbuilding and engineering. Bristol is also a market centre for a rich agricultural area.

See also references under "Bristol" in the Index volume.

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(A. Pd.; X.)

BRISTOL, a city of Hartford county, Conn., U.S., 19 mi. S.W. of Hartford on the Pequabuck river. The area was first settled in 1727 as part of Farmington and a Congregational parish (called New Cambridge) was organized in 1744. Bristol was organized as a town in 1785, incorporated as a borough in 1893 and chartered as a city in 1911. During the American Revolution it was the centre of considerable Tory activity, and Chippens hill with its cave known as the "Tories' den" was a meeting place for Connecticut Loyalists. The Rev. James Nichols, the Anglican rector, was tarred and feathered by the Patriot party; Moses Dunbar, also an Anglican, was hanged by the Connecticut authorities for recruiting soldiers for the British army.

Bristol has always been a manufacturing centre. During the colonial period there were gristmills and sawmills, tanneries, tinware shops and woodworking establishments. In the late 17th and early 18th centuries Bristol supplied the "Yankee peddlers" with the tinware which was sold throughout the Atlantic seaboard. The presence of workers in both metal and wood led to Bristol's pre-eminence in the manufacture of clocks. With the introduction of metal wheels and interchangeable parts Bristol clockworkers turned to the production of low-priced clocks and pocket watches and later to such other metal products as bicycle and automobile parts, springs, machinery, tools, cutlery and sporting goods. For comparative population figures *see* table in CONNECTICUT: *Population*. (Gl. W.)

BRISTOL, a town of Rhode Island, U.S., and the shire town or seat of Bristol county, is 12 mi. S.E. of Providence on a peninsula between Narragansett bay and Mt. Hope bay. On the south it is connected to Aquidneck Island by Mt. Hope bridge. Capacious Bristol harbour was an active centre of privateering and the triangular trade in rum and slaves in the 18th century but is now used largely by pleasure craft. Until its closing in 1945 the Herreshoff Manufacturing company, builders of the America's cup defenders, made Bristol a renowned yacht building centre. It is an important suburban residential area for Providence (*q.v.*) and has large manufactures of rubber goods. The Rhode Island soldiers' home, established in 1890, is located in Bristol.

The town was created in 1680 by Plymouth colony out of land acquired in 1676 at the close of King Philip's War, and named after Bristol, Eng., in anticipation of a commercial future. It came under the jurisdiction of Massachusetts in 1692 and in 1747 was annexed to Rhode Island. During the American Revolution it was twice attacked by the British and partially destroyed, Oct. 7, 1775, and May 25, 1778. It is governed by a town meeting and a mayor. It has many fine homes of historic interest, is the site of Brown university's Haffenreffer Museum of the American Indian and is noted for its scenic location.

For comparative population figures *see* table in RHODE ISLAND: *Population*. (W. D. Mz.)

BRISTOL, an urban unit on the Virginia-Tennessee (U.S.) state line. Physically and culturally unified, it consists of two politically separate bodies, each with its own government, public schools, utilities and post offices. In 1903, to equalize maintenance, Tennessee legislatively re-established the state line, previously slightly off centre of the main business street. Bristol is between the Cumberland and Holston ranges at 1,800 ft. elevation but in a valley, the extension of the Shenandoah. The site was originally an Indian village. In mid-18th century a trading post was built there to serve the frontiersmen moving west over the Wilderness trail blazed by Daniel Boone. Eight miles east stands the centuries-old Pemberton oak, where assembled the mountaineers who defeated the Loyalists in the battle of King's mountain during the American Revolution. On a Scotch-Irish pioneer stock have been grafted many cultural branches, but emphasis on education and religion, characteristic of the first settlers, continues to be a vital force. More than 50 churches and 3 colleges, dating from the 19th century, attest this fact. King college (1867), offering a four-year course, is Presbyterian and coeducational. Sullins college (1870), originally Methodist but now nondenominational, and Virginia Intermont college (1884), a Baptist institution, are both junior colleges for women. The trading centre of a rich agricultural valley and home of numerous and diversified manufacturing concerns, the city has a well-balanced and stable economy. The climate and natural beauty of a mountainous region, enhanced by national forests and game preserves and proximity to four Tennessee Valley authority lakes, provide Bristol with uncommercialized facilities for recreation. Bristol, Va., which was known as Goodson before it was chartered as a city in 1890, has a council-manager form of government which became effective in 1919; the city is administratively independent of Washington county. Bristol (Sullivan county) Tenn., has a mayor-commission form of government. For comparative population figures *see* tables in TENNESSEE: *Population* and VIRGINIA: *Population*. (D. L. Me.)

BRISTOW, BENJAMIN HELM (1832–1896), U.S. lawyer and statesman, was born in Elkton, Ky., on June 20, 1832. He studied law in his father's office and was admitted to the bar in 1853. He was an ardent antislavery unionist, and at the outbreak of the Civil War, helped recruit the 25th Kentucky infantry. He was wounded at Shiloh and upon his recovery helped raise another regiment, the 8th Kentucky cavalry, and became its colonel. Elected to the state senate in 1863 without his knowledge, he reluctantly took his legislative seat, realizing the need for Union men in the government of Kentucky. He worked actively for President Lincoln's re-election in 1864, for ratification of the 13th amendment to the federal constitution and for other Unionist measures.

After the war he served as U.S. attorney for the Kentucky district, 1866–70. By working for the protection of the Negro against the violence of Ku Klux Klan, as well as by prosecuting distillers of illicit whisky, he attracted national attention. Pres. Ulysses S. Grant appointed him as the first solicitor general of the United States and later as secretary of the treasury (1874–76). His greatest service in the latter post was to direct the prosecution of the so-called "whisky ring," a group of western distillers, revenue officers and others who had evaded payment of the federal whisky tax. An alleged accomplice of the ring was Orville E. Babcock, private secretary to President Grant. Bristow resigned from the treasury under presidential pressure. He was a prominent candidate for the Republican presidential nomination in 1876 with the backing of party moderates, but when it became apparent that he could not win, he gave his support to Rutherford B. Hayes. He took up the practice of law in New York city in 1878 and a year later was elected the second president of the American Bar association. He died in New York on June 22, 1896. (C. F. McI.)

BRITAIN (Gr. PRETANIKAI NESOI, BRETTANIA; Lat. BRITANNIA, rarely BRITTANIA), the anglicized form of the classical name of England, Wales and Scotland, sometimes extended to the British Isles as a whole. The Greek and Roman forms are doubtless versions of a Celtic original, which gives modern Welsh *Prydain*. Brittany (Fr. *Bretagne*) in western France acquired its name because of migrations thither from Britain in the 5th and 6th centuries A.D.

The first written evidence of the island came indirectly from Pytheas (*q.v.*), the Greek navigator who explored its coast *c.* 325 B.C.

In this article the archaeological interest of early Britain is dealt with in connection with the history of Britain in pre-Roman and Roman times; this account being supplementary to the articles CALEDONIA; ENGLAND; ENGLISH HISTORY; SCOTLAND, etc.

It is arranged as follows:

- I. Pre-Roman Britain
- II. Roman Britain
  - A. The Military System
    - 1. Walls of Hadrian and Antoninus
    - 2. Military Areas
    - 3. Roman Army and Fortifications
    - 4. Roman Roads
  - B. The Civil Pattern
    - 1. Administration
    - 2. Urban Development
    - 3. Rural Life
    - 4. Religion
    - 5. Art
  - C. End of Roman Britain

I. PRE-ROMAN BRITAIN

Britain appears to have been first inhabited by sporadic Paleolithic hunters in the latest phases of the Pleistocene, or Glacial, epoch (*see* PLEISTOCENE EPOCH). Much more definitive evidence of settlement is forthcoming for the presence of Mesolithic settlers, who ranged over much of Britain, in nomadic groups. The Scottish coasts, the Pennines, Star Carr in Yorkshire, East Riding, the caves in the Mendip hills, the Peak district and Devonshire or the pit dwelling at Abinger, Surrey, provide useful evidence of active communities of hunters and fishers. Neolithic people, arriving from northwestern Europe about 3000 B.C., introduced not only systematic stock raising, associated with enclosures, but also agriculture, pottery and improved tools of stone and flint, the latter mined on a large scale. Communal burial mounds (long and circular barrows) were introduced in different styles from different regions. Circular religious enclosures, in wood (Woodhenge) and stone (Stonehenge, *q.v.*), were another new feature, partly connected with the dead. About 1800 B.C. Rhineland folk, styled Beaker folk from their distinctive pottery, introduced gold and copper and exploited the metals of western Britain and Ireland, evolving bronze and trading widely with the continent: amber, tin, gold and Egyptian faïence are found, particularly in Wessex. Individual wealth is reflected in individual hamlets and fields and individual or family burials in round barrows. Imposed upon this vigorous and primitive civilization the Iron Age invaders, moving in from about 400 B.C., made little impression at first, but their improved tools increased agricultural and technical possibilities, encouraged family land settlement and, as population increased, led to the organization of the tribe for aggression or defense and of the first hill forts of the 3rd century B.C. This organization of society for self-defense was intensified by the Belgic invasion during the first half of the 1st century B.C. which embraced southeastern Britain, bringing with it developments in pottery and chariot warfare, and in the extensive fortified chieftain's capital (*oppidum*), with multiple defenses against chariots and sling fire. In this changing world the tribes known to Roman Britain (*see* map for names and location) began to emerge and were completed by the influx following the conquest of Gaul by Julius Caesar. The growing complexity of society and the growth of trade was illustrated by the emergence of coinage by 100 B.C., at first in gold and later in silver and bronze. It replaced gradually a currency of iron bars or ingots, attested by Caesar and by surviving examples in the form of sword blanks of standard weights. In religion, the chief feature was the priesthood of Druids, who there, as in Gaul, practised magical arts and barbarous rites of human sacrifice, taught a secret lore and wielded great influence in society (*see* DRUIDISM). In art, these tribes possessed a native late-Celtic fashion, descended from far-off Mediterranean antecedents and more directly connected with the La Tène culture of the continental Celts (*see* LA TÈNE). Its characteristics were a flamboyant and fantastic treatment of plant, animal and, more rarely, human forms, a brilliant use of curved geometrical forms, and much skill in enameling. Its finest products were in bronze, but the same patterns spread to woodwork and pottery. The Roman conquest of northern Gaul (58–50 B.C.) brought Britain into definite relationship with the Mediterranean. It was already closely connected with Gaul, and when Roman civilization and its products invaded Gallia Belgica they passed on easily to Britain. The British coinage then began to bear Latin legends, and after Julius Caesar's two raids (55, 54 B.C.) the southern tribes were regarded at Rome, though they do not seem to have regarded themselves, as vassals. Actual conquest was, however, delayed. The emperor Augustus planned it. But both he and his successor Tiberius realized that the greater need was to consolidate the existing empire and absorb the vast additions recently made to it by Pompey, Caesar and Augustus.

II. ROMAN BRITAIN

Preparations for the Roman conquest of Britain had been started and then canceled by the emperor Caligula (Gaius Caesar): the invasion was finally undertaken by Claudius in A.D. 43. Two causes coincided to produce the step. Claudius desired for political prestige an outstanding conquest. Cunobelin, probably a philo-Roman prince (known to literature as Cymbeline), had just been succeeded by two sons, Caractacus (*q.v.*) and Togodumnus, who were hostile to Rome. Two immediate reasons for action were the expulsion of Verica, a Roman partisan, by Cunobelin's sons and the raids upon Gaul which were then taking place from across the English channel. So Aulus Plautius, with a well-equipped army of about 40,000 men, landed in Kent and advanced on the Thames, crossing at the site of London (Londinium). Claudius himself appeared there—the one emperor of the 1st century who crossed the ocean—and the army moved through Essex to capture the native capital, Camulodunum (now Colchester). From the bases of London and Colchester three legions and their auxiliaries continued the conquest. The left wing, the 2nd legion (under Vespasian, afterward emperor), subdued the south; the centre, the 14th and 20th legions, subdued the midlands, while the right wing, the 9th legion, advanced through the eastern part of the island. This strategy was at first triumphant. The lowlands of Britain, with a population partly romanized and scanty in parts and with easy physical features, presented no obstacle. Within three or four years everything south of the Humber estuary and east of the river Severn had been either directly annexed or entrusted, as protectorates, to native client princes. Farther north, even the Brigantes (*q.v.*) in the area of the Pennine range came into the sphere of client realms.

The wild hills and wilder tribes of Wales, notably the Silures, offered fiercer resistance, and there followed more than 30 years of intermittent hill fighting (A.D. 47–79). The precise details of the struggle are not known. Legionary fortresses were established at Gloucester, Wroxeter (until A.D. 66 at least) and Lincoln, Caerleon replacing Gloucester, Chester Wroxeter, and York Lincoln at the close of the period. The method of conquest was the erection and maintenance of small detached forts in strategic positions, each garrisoned by 500 or 1,000 Roman legionaries

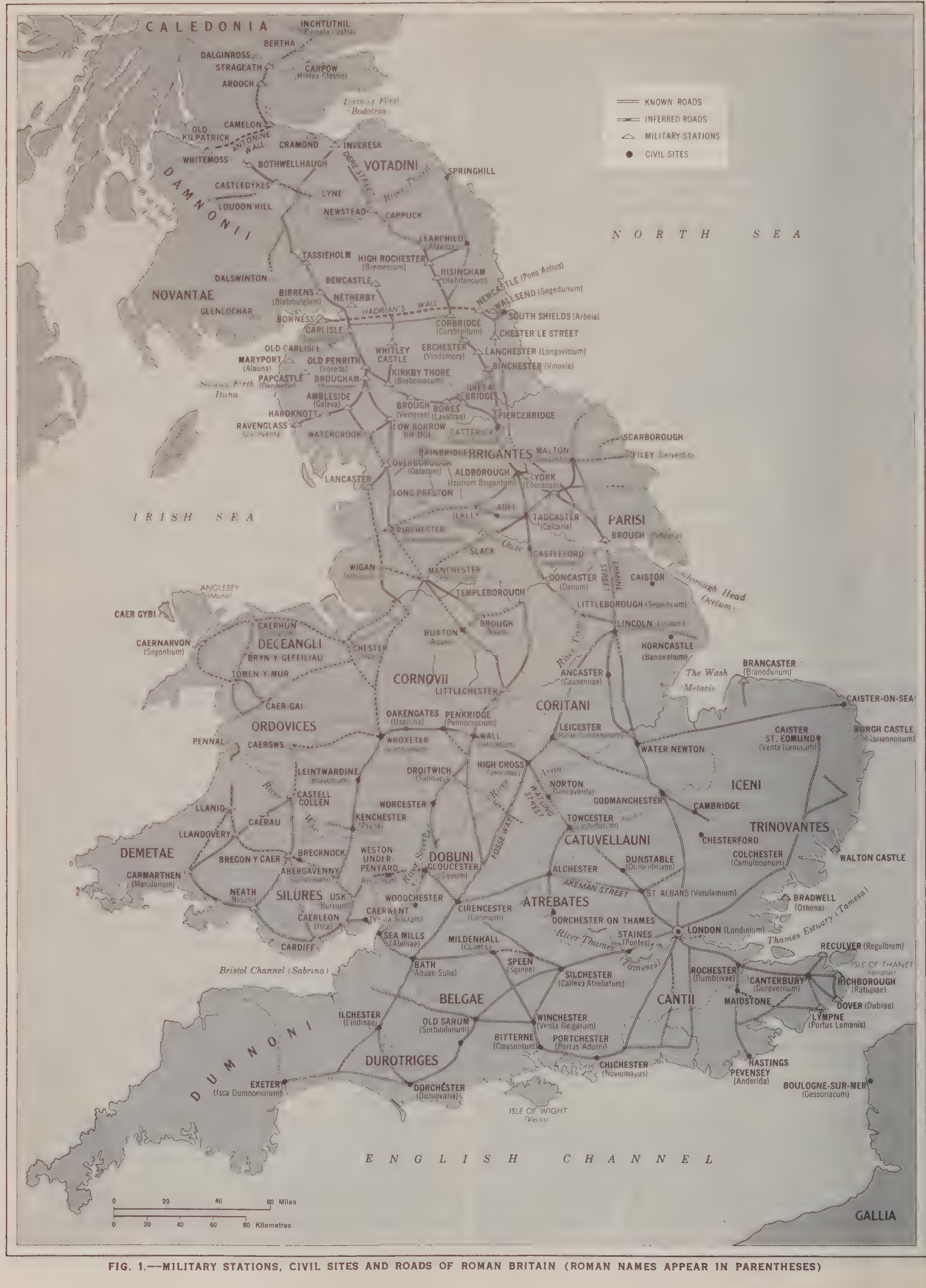
KNOWN ROADS
INFERRED ROADS
MILITARY STATIONS
CIVIL SITES
CALEDONIA
INCHTUTHIL (Pinnata castra)
BERTHA
DALGINROSS
STRAGEATH
CARPOW (Horrea Classis)
ARDOCH
Firth of Forth Bodotria
CAMELON
OLD KILPATRICK
ANTONINE WALL
CRAMOND
INVERESK
WHITEMOSS
BOTHWELLHAUGH
VOTADINI
DERE STREET
SPRINGHILL
DAMNONII
CASTLEDYKES
LYNE
River Tweed
LOUDON HILL
NEWSTEAD
CAPPUCK
LEARCHILD (Alauna)
NORTH SEA
TASSIEHOLM
HIGH ROCHESTER (Bremenium)
RISINGHAM (Habitancum)
DALSWINTON
BEWCASTLE
NEWCASTLE (Pons Aelius)
WALLSEND (Segedunum)
NOVANTAE
BIRRENS (Blatobulgium)
NETHERBY
HADRIAN'S WALL
GLENLOCHAR
BOWNESS
SOUTH SHIELDS (Arbeia)
CORBRIDGE (Corstopitum)
CARLISLE
CHESTER LE STREET
OLD CARLISLE
EBCHESTER (Vindomora)
LANCHESTER (Longovicium)
MARYPORT (Alauna)
OLD PENRITH (Voreda)
WHITLEY CASTLE
BINCHESTER (Vinovia)
PAPCASTLE (Derventio)
BROUGHAM
KIRKBY THORE (Braboniacum)
Solway Firth Ituna
GRETA BRIDGE
AMBLESIDE (Galava)
HARDKNOTT
BROUGH (Verterae)
BOWES (Lavatrae)
PIERCEBRIDGE
RAVENGLASS
WATERCROOK
LOW BORROW BRIDGE
CATTERICK
SCARBOROUGH
BAINBRIDGE
BRIGANTES
MALTON
FILEY
OVERBOROUGH (Galacum)
ALDBOROUGH (Isurium Brigantum)
YORK (Eburacum)
LANCASTER
LONG PRESTON
IRISH SEA
ILKLEY
ADEL
TADCASTER (Calcaria)
PARISI
RIBCHESTER
BROUGH (Petuaria)
River Ouse
SLACK
CASTLEFORD
WIGAN
MANCHESTER
DONCASTER (Danum)
ERMINE STREET
CAISTOR
Flamborough Head Ocelum
ANGLESEY (Mona)
TEMPLEBOROUGH
LITTLEBOROUGH
CAER GYBI
CAERHUN
BUXTON
BROUGH
LINCOLN
CAERNARVON (Segontium)
DECEANGLI
CHESTER
HORNCASTLE (Banovalium)
BRYN Y GEFEILIAU
River Trent
TOMEN Y-MUR
CORNOVII
ANCASTER (Causennae)
BRANCASTER (Branodunum)
The Wash Metaris
LITTLECHESTER
CAER-GAI
CORITANI
CAISTER-ON-SEA
OAKENGATES (Uxacona)
PENKRIDGE (Pennocrucium)
ORDOVICES
LEICESTER
CAISTER ST. EDMUND (Venta Icenorum)
BURGH CASTLE
PENNAL
CAERSWS
WROXETER
WALL
WATER NEWTON
LEINTWARDINE
DROITWICH (Salinae)
HIGH CROSS
River Avon
ICENI
CASTELL COLLEN
NORTON
WATLING STREET
GODMANCHESTER
LLANIO
WORCESTER
CAMBRIDGE
CAERAU
KENCHESTER
FOSSE WAY
TOWCESTER
LLANDOVERY
River Wye
River Severn
CATUVELLAUNI
CHESTERFORD
TRINOVANTES
DEMETAE
BRECKNOCK
WESTON-UNDER-PENYARD
DOBUNI
DUNSTABLE
COLCHESTER (Camulodunum)
BRECON Y CAER
GLOUCESTER (Glevum)
WALTON CASTLE
CARMARTHEN (Maridunum)
ABERGAVENNY
ALCHESTER
AKEMAN STREET
ST ALBANS (Verulamium)
NEATH
SILURES
USK (Burrium)
WOODCHESTER
ATREBATES
BRADWELL (Othona)
CAERWENT (Venta Silurum)
CIRENCESTER (Corinium)
DORCHESTER ON THAMES
Thames Estuary (Tamesa)
CAERLEON (Isca)
SEA MILLS (Abonae)
LONDON (Londinium)
CARDIFF
MILDENHALL (Cunetio)
STAINES (Pontes)
River Thames
RECULVER (Regulbium)
Bristol Channel (Sabrina)
BATH (Aquae Sulis)
SPEEN (Spinae)
SILCHESTER (Calleva Atrebatum)
ROCHESTER (Durobrivae)
ISLE OF THANET
CANTERBURY (Durovernum)
RICHBOROUGH (Rutupiae)
BELGAE
CANTII
MAIDSTONE
DOVER (Dubrae)
ILCHESTER (Lindinae)
OLD SARUM (Sorbiodunum)
WINCHESTER (Venta Belgarum)
LYMPNE (Portus Lemanis)
DUMNONII
BITTERNE (Clausentum)
PORTCHESTER (Portus Adurni)
DUROTRIGES
CHICHESTER (Noviomagus)
HASTINGS
PEVENSEY (Anderida)
EXETER (Isca Dumnoniorum)
DORCHESTER (Durnovaria)
BOULOGNE-SUR-MER (Gessoriacum)
ISLE OF WIGHT (Vectis)
ENGLISH CHANNEL
0 20 40 60 Miles
0 20 40 60 80 Kilometres
GALLIA

FIG. 1.—MILITARY STATIONS, CIVIL SITES AND ROADS OF ROMAN BRITAIN (ROMAN NAMES APPEAR IN PARENTHESES)

and auxiliaries, and it was accompanied by a full share of those disasters which vigorous barbarians always inflict on civilized invaders. Progress was delayed in A.D. 60–61 by the revolt of Queen Boadicea (*q.v.*) and a large part of the nominally conquered lowlands. Her rising was soon crushed, but the government was obviously afraid for a while to move its garrisons forward. Indeed, other needs of the empire caused the withdrawal of the 14th legion in A.D. 69. But the decade A.D. 70–80 was decisive. A succession of three able generals commanded an army which was restored to full strength by the addition of the 2nd legion (Legio II Adiutrix) and achieved the final subjugation of Wales and the first conquest of Yorkshire.

The third and best known, and probably the ablest, of these generals, Gnaeus Julius Agricola (*q.v.*), moved on in A.D. 79 to the conquest of the farther north. He built forts in Cumberland and County Durham, began the network of roads, held down the north, and pushed on into Scotland, where he established between the rivers Clyde and Forth, a temporary frontier that was guarded by a line of posts, the most certainly identifiable of which is that at Bar Hill in Dunbartonshire. Presently he advanced into Caledonia and won a notorious victory at Mons Graupius (incorrectly spelled Grampius), the site of which is unidentified, but was not south of the approaches to the county of Banff. He dreamed even of invading Ireland, and thought it an easy task, preparing for it by the conquest of southwestern Scotland with forts at Loudon hill, Ayrshire; Dalswinton, Dumfriesshire; and Glenlochar and Gatehouse-of-Fleet, Kirkcudbrightshire. His permanent occupation of Scotland enveloped Strathmore, the large valley in central Scotland stretching from southwest to northeast through the counties of Perth, Angus and Kincardineshire.

A. The Military System

1. Walls of Hadrian and Antoninus.—Before A.D. 90 the Roman garrison in Britain was reduced by the transfer of Legio II Adiutrix to Pannonia, a country south and west of the Danube. About this time Strathmore was evacuated and the whole of Scotland was abandoned early in the 2nd century, probably in connexion with Trajan's conquest of Dacia in central Europe. Early in Hadrian's reign the Britons were in revolt, and the 9th legion faded from history. In 122 Hadrian came to Britain, brought the 6th legion to replace the 9th, and introduced the frontier policy of his age. For more than 70 mi., from the Tyne estuary to the Solway firth, more exactly from Wallsend to Bowness, he built a continuous rampart known as Hadrian's Wall. There were outposts in the west to the north of it, and some detached forts, mile-castles and towers guarding the Cumberland coast beyond its west end. His title as builder of the wall is proved alike by literature and by inscriptions. The meaning of the scheme is equally certain. It was to be a wall (comparable with the Great Wall of China) marking the definite limit of the Roman world. The actual works were twofold. First, the stone wall, 10 ft. thick in the east, 6–8 ft. thick elsewhere, and originally 15 ft. high to rampart walk, with a deep ditch in front (*i.e.,* on the northward side) and regularly spaced mile-castles and towers (two to a mile) attached to it for patrols, together with 16 forts for the fighting garrison, was connected by a road behind it. On the high moors between Chollerford, Northumberland, and Gilsland, Cumberland, its traces are still plain, as it climbs from hill to hill and winds along precipices. In the west, the wall was at first of turf, but was gradually replaced in stone, on the same line except for two miles at Birdoswald near Gilsland. Second, to the south of the wall the so-called Vallum (rampart) was in reality no vallum at all, but a broad flat-bottomed ditch out of which the earth was cast up on either side into regular and continuous mounds, 100 ft. apart from crest to crest. The meaning of this ditch has been much discussed. It is now clear that it is a Roman work of Hadrianic date, but an addition to the Wall, intended as a rearward obstacle delimiting the military zone. When the reoccupation of Scotland led to the temporary dismantling of mile-castles the ditch was breached by having a series of causeways laid across it, at 15-yd. intervals. It is further clear that before the Vallum existed the earliest forts associated with the Wall lay behind it (*i.e.,* to the south of it), on the Stanegate road, at such points as Corbridge, Chesterholm (Vindolanda), Haltwhistle Burn, Throp, Nether Denton, Boothby Castle Hill, Old Church Brampton, and Carlisle. The forts on the Wall itself belong to a rapid strengthening of the frontier, and only after they were built was it possible to devise the rearward obstacle represented by the Vallum. The Hadrianic scheme thus reached final form only after numerous changes of plan. Under Lucius Septimius Severus many elements in the tower system were given up and the outpost forts, hitherto existing only in the west at Bewcastle, Netherby and Birrens, were extended to the east at Risingham (Habitancum) and High Rochester, both on Dere Street.

Whether the land beyond Hadrian's Wall became temptingly peaceful or remained in vexing disorder, in 139 Hadrian's successor, Antoninus Pius, acting through his general Lollius Urbicus, made a change and was preparing to advance to the narrower isthmus between the Forth and Clyde rivers 36 mi. across, which Agricola had fortified before him. There in 142 he erected a turf wall (the so-called Antonine Wall) fronted by a large ditch, with 19 forts, normally attached to it, and a rearward connecting road. In the central sector the work still survives, in varying preservation, and occasionally, as on Croy hill (near Kilsyth) or at Bonnybridge (about 3 mi. W. of Falkirk), wall, ditch and road can be distinctly traced, while the sites of many forts (some revealed by aerial photography) can be plainly seen by practised eyes. Eight forts have been excavated. In each case the barrack rooms were of wood, and the headquarters buildings, granaries, commandant's house and the baths of stone. In size the forts range from just over one acre to just under seven. The defenses differ. Balmuildy, Dunbartonshire, and Castlecary, Stirlingshire, were walled with stone, whereas the ramparts of Old Kilpatrick and Bar Hill, Dunbartonshire, and of Rough Castle, Stirlingshire, were of sods, and those of Mumrills, Stirlingshire, of clay. Besides the 19 forts on the wall, there were outposts at Camelon, Ardoch, Strageath, Carpow and Bertha, along the natural route which runs by Stirling and Perth to Strathmore. On the Firth of Forth, Cramond and Inveresk forts guarded the flank, while the Clyde was watched by a fort at Bishopton near Paisley and by minor posts. The new frontier was reached from the south by two roads. One, known in medieval times as Dere Street, ran northwest from Corbridge on Tyne (Corstopitum) through forts at Risingham, High Rochester, Cappuck, Newstead near Melrose, Inveresk and Cramond, to the eastern end of the Wall. The second, starting from Carlisle, ran to Birrens near Ecclefechan, Dumfriesshire, and thence by Tassiesholm and Crawford in Lanarkshire to Inveresk in Midlothian, with branches to Carzield in the valley of Nithsdale, Dumfriesshire, and to Carstairs in Clydesdale, Lanarkshire, and so to the west end of the Wall. A fort at Lyne near Peebles suggests the existence of an intermediate link between them. There is nothing to suggest that the erection of the Wall of Antoninus Pius meant the complete abandonment of the Wall of Hadrian. At first the latter was held by a garrison in forts only, but later both barriers were fully held together, and the district between them was regarded as a military area.

The Antonine Wall brought no long peace. Less than 20 years after its construction (155–158) disorder broke out in the district between the Cheviot and Derbyshire hills, and was repressed with difficulty. About 180–185 the "northern" Wall according to Dio Cassius, presumably the Antonine Wall, was broken; and civil war which soon raged in Europe (193–197) for the imperial succession gave the Caledonians the opportunity to ravage the north when its garrison was withdrawn to fight on the continent. The lost land was recovered as far as Hadrian's Wall in 197, and in 209 the emperor Lucius Septimius Severus with his son Caracalla conducted a punitive expedition into Caledonia and consolidated the position once more. Then, in 211, the third year of operations, Severus died at York. Amid much that is uncertain and even legendary about his work in Britain, this is plain, that Hadrian's Wall was chosen as the substantive frontier. His successors, Caracalla (sole emperor 212–217) and Alexander Severus (emperor 222–235), accepted the position, and many inscriptions refer to building or rebuilding executed by them for the greater efficiency of the frontier defenses. There was no further advance. The Wall of Hadrian remained for nearly 200 years more the nothern limit of Roman power. (*See* also HADRIAN'S WALL; ANTONINE WALL.)

2. Military Areas.—Geographically, Britain consists of two parts: (1) the comparatively flat lowlands of the south, east and midlands, suitable for agriculture and open to the continent; *i.e.*, to the rest of the Roman empire; and (2) the district comprising Devon and Cornwall, Wales and northern England, regions lying more, and often very much more, than 600 ft. above the sea, scarred with gorges and deep valleys, mountainous in character and difficult for armies to traverse. The lowlands were conquered easily and quickly, though the midlands were garrisoned until about A.D. 79. The uplands were hardly subdued completely until the end of the 2nd century. They differ, moreover, in the character of their Roman occupation. The lowlands were the scene of civil life. Towns, villages and country houses were their prominent features; troops were hardly seen in them save in some fortresses on the edge of the hills and in a chain of forts built in the 4th century to defend the south and southeast coast, the so-called Saxon shore. The uplands of Wales and the north presented another spectacle. There civil life straggled into Glamorgan and Pembrokeshire and even touched Brecknockshire, while in the north it penetrated as far as County Durham. But the hills were one extensive military frontier, covered with forts and strategic roads connecting them, and only the trading settlements outside the forts afford any hint of organized Roman communities. This geographical division was not reproduced by Rome in any administrative partition of the province. At first the whole was governed by one imperial legate (*legatus Augusti*) of consular standing. Caracalla made it two provinces, *superior* and *inferior*, the former including Caerleon, Monmouthshire and Chester, the latter Lincoln, York and Hadrian's Wall. In the 4th century there were four provinces, Britannia Prima, Britannia Secunda and Flavia Caesariensis, ruled by governors with the title of *praesides,* Maxima Caesariensis and, after 369, a fifth named Valentia, ruled by *consulares* (governors of consular rank), all under the *vicarius Britanniarum* (vice-governor of the Britains). Politically, it is known that Britannia Prima included Cirencester. Within the army organization the command was divided between the *dux Britanniarum*, or "duke of the Britains," responsible for York and Hadrian's Wall, while the *comes litoris Saxonici,* or "count of the Saxon shore," was responsible for the fleet and for coastal defense; in the later stages of Roman rule the *comes Britanniarum,* or "count of the Britains" commanded the field army.

3. Roman Army and Fortifications.—The army of the province consisted, from the time of Hadrian onward, of (1) three legions, the 2nd at Caerleon (*q.v.;* Isca), the 6th at York (*q.v.;* Eburacum), the 20th at Chester (*q.v.;* Deva), a total of approximately 15,000 heavy infantry; and (2) a large but uncertain number of auxiliaries, troops of the second grade, organized in infantry (*cohortes*) or cavalry (*alae*), each 500 or 1,000 strong, and posted in *castella* (or small forts) nearer the frontiers than the legions. The legionary fortresses were large rectangular enclosures of 50 or 60 ac., surrounded by strong walls of which traces can still be seen in the north and east town walls of Chester, at the eastern and western angles of York and on the south side of Caerleon. The auxiliary *castella* were likewise square or oblong in shape but varied from three to six acres according to the size of the regiment and the need for stabling. Of these about 100 are known. The internal arrangements follow one general plan, but while in later forts the buildings are all of stone, in Claudian and Flavian forts wood is used throughout, and in many forts as late as 160 only the principal buildings seem to have been constructed of stone. In the centre of the fort was the headquarters (*principia*), a rectangular structure with a front entrance which gave access first to a small cloistered court, then to a covered hall, bordered by a row of three, five or even seven rooms containing the shrine for official worship, the pay and record offices. Close by was the commandant's house (*praetorium*), generally built around a cloistered court, granaries (*horrea*) with buttresses and ventilated basements. These filled the middle third of the fort. In the other two thirds were barracks for the soldiers. No space was allotted to private religion or domestic life. The shrines which individual private worshipers might visit, the bathhouse, and the dwellings or shops of camp followers, etc., lay outside the walls. Such were nearly all Roman forts in Britain, differing little from those in other provinces.

4. Roman Roads.—The road system was laid out to meet the strategy of Roman conquest, which was in stages.

Roads in Wales and Northern Britain.—Forts were dotted all along the military roads of Wales and of northern Britain. From Chester a road ran through north Wales past Canovium fort at Caerhun near Conway to a fort at Caernarvon (Segontium), and a similar road ran westward along the south coast from Caerleon past a fort at Cardiff to Neath (Nidum) and Carmarthen (Maridunum). A third, roughly parallel to the shore of Cardigan bay, with forts at Llanio, Trawscoed, Pennal, Tomen-y-Mur near Ffestiniog, Llystyn and Caer Llugwy, connected the northern and southern roads, while the interior was held by roads and forts discernible at Caer-gai on Bala lake in Merionethshire, Caersws in Montgomeryshire, Forden Gaer near Montgomery, Leintwardine (Bravonium) in Herefordshire, Castell Collen near Llandrindod Wells in Radnorshire, Cae Gaer near Llangammarch in Brecknockshire, Y Gaer (Bannium) (caer, or gaer, is the Welsh for fort, or encampment) near Brecon, and Merthyr Tydfil and Gellygaer in Glamorgan.

In the north of Britain there were three principal roads. One led due north from York past forts at Catterick (anc. Cataractonium), Piercebridge, Binchester (Vinovium), Lanchester (Longovicium), Ebchester (Vindomora) in Durham and Corbridge in Northumberland to Hadrian's Wall and to Scotland, while branches through Chester-le-Street in Durham reached the Tyne mouth at South Shields. A second road, turning northwest from Catterick, crossed the Pennines with forts at Greta Bridge and Bowes (Lavatrae) in Yorkshire and at Brough-under-Stainmore (Verterae) in Westmorland, descended the Eden valley with forts at Kirkby Thore, northwest of Appleby, and Broughham in Westmorland, where it joined the third route, reaching Hadrian's Wall near Carlisle by way of Old Penrith (Voreda) in Cumberland, and running on to Birrens (Blatobulgium). The third route, starting from Chester and passing up the western coast, was more complex and existed in duplicate, the result perhaps of two different schemes of road making. Forts in plenty can be detected along it, notably Manchester (Mamucium), Ribchester (Bremetennacum) and Overborough (Galacum) on a western branch, Lancaster, Watercrook near Kendal, Ambleside (Borrans Field), Hardknott (a peak in Eskdale with remains of a Roman camp known as Hardknott Castle) and, on the Cumberland coast, Ravenglass (Glanoventa), Moresby, Maryport (Alauna), and Old Carlisle. In addition, crossroads from Manchester, Ribchester and Overborough maintained communication with Yorkshire.

Roads in Southern Britain.—There were four main groups of roads radiating from London, and a fifth which ran obliquely. One road ran southeastward to Canterbury (Durovernum) and the Kentish ports, of which Richborough (Rutupiae or Portus Ritupis) was the most frequented. A second ran westward to Silchester (Calleva Atrebatum), and thence by various branches to Winchester (Venta Belgarum), Exeter, Bath, Gloucester (Glevum), and south Wales. A third, known afterward to the English as Watling street (*q.v.*), ran by St. Albans and Wall (Letocetum) near Lichfield to Wroxeter (Viroconium) and Chester (Deva). A fourth served Colchester (Camulodunum), the eastern counties, Lincoln and York. The fifth, known to the English as the Fosse Way (*q.v.*), joined Lincoln and Leicester with Cirencester (Corinium), Bath and Exeter. Besides these five groups, a useful road, called by the Saxons Akeman Street, gave alternative access from St. Albans, through Alchester north of Oxford, to Bath; while another road ran south from near Sheffield, past Derby and Birmingham, to Gloucester (Glevum), linking the lower Severn river with the Humber estuary. Ermine Street (*q.v.*) connected London with the north and ran to the Humber via Godmanchester, Ancaster (Causennae) and Lincoln. These roads and their various branches provided adequate communication throughout lowland Britain. Besides these detached forts and their connecting roads, the north of Britain was defended by Hadrian's Wall (*see* above).

B. The Civil Pattern

Behind this formidable garrison, sheltered from barbarians and in easy contact with the Roman empire, stretched the lowlands of southern and eastern Britain. There a civilized life grew up, and Roman culture spread. In the lands looking on to the Thames estuary (Kent, Essex, Middlesex) the process had perhaps begun before the Roman conquest. It was continued after that event, and in two ways. To some extent it was encouraged by the Roman government, which founded towns settled with Roman citizens—generally discharged legionaries—and endowed them with franchise and constitution like those of Italian municipalities. It developed still more by its own volition. The coherent civilization of the Romans was accepted by the British tribal notables, as it was by the Gauls, with something like enthusiasm. Encouraged perhaps by sympathetic Romans, spurred on still more by their own instincts, they began to speak Latin, to use the material resources of Roman civilized life, and presently to consider themselves not as unwilling subjects of a foreign empire but as British members of the Roman state. The steps by which these results were reached can to some extent be dated. In A.D. 49 a *colonia*, or municipality of time-expired soldiers, had been planted in the old native capital of Colchester, and, though it served at first mainly as a fortress and thus provoked British hatred, it soon came to exercise a civilizing influence. At the same time the British town of St. Albans (Verulamium) was thought sufficiently romanized to receive the status of a *municipium* (*q.v.*), which at this period differed little from that of a *colonia*. London became important. Romanized Britons were numerous; in the great revolt of Boadicea (60–61) the rebels seem to have massacred many thousands of them along with actual Romans. Fifteen or 20 years later, the movement increased. Tribal capitals sprang up, such as Silchester, laid out in Roman fashion, furnished with public buildings of Roman type, and filled with houses which are Roman in fittings if not in plan. The hot springs of Bath (Aquae Sulis) were exploited. Another *colonia* was planted under Domitian (emperor A.D. 81–96) at Lincoln (Lindum), and a third at Gloucester in 96. The fourth, established on the west bank of the Ouse at York, belongs to the early 3rd century and marked the upgrading of an existing town. A series of judicial legates was appointed to attend to the increasing civil business.

After the 2nd century Hadrian and his successors consolidated the achievement, despite the repeated risings in the north, and country houses and farms became common in most parts of the civilized area. By the beginning of the 4th century the skilled artisans and builders and the cloth and corn of Britain were famous on the continent: this probably was the age when the prosperity and romanization of the province reached its height. The town populations and the educated landowning class spoke Latin, and the people of Britain regarded it as a Roman land, inhabited by Romans.

The civilization which had thus spread over half the island was identical in kind with that of the other western provinces of the empire, and in particular with that of northern Gaul. But the elements which composed it were smaller, less wealthy and less splendid. It was also uneven in distribution. Large tracts, in particular Warwickshire and the adjoining midlands, were very thinly inhabited. Even densely populated areas like north Kent, the Sussex coast, west Gloucestershire and east Somerset immediately adjoin areas, like the Weald of Kent and Sussex, where Romano-British remains hardly occur.

1. Administration.—The administration of the civilized part of the province, where subject to the governor of all Britain, was practically entrusted to local authorities. Each Roman municipality ruled itself and a territory, perhaps as large as a small county, which belonged to it. Some districts formed part of the imperial domains and were administered by agents of the emperor. By far the larger portion of the country was divided up among the old native tribes or cantons, about 10 or 12 in number, each grouped around a country town where its council (*ordo*) met for cantonal business. This system closely resembles that of Gaul. It is a native element recast in Roman form and well illustrates the Roman principle of local government by devolution.

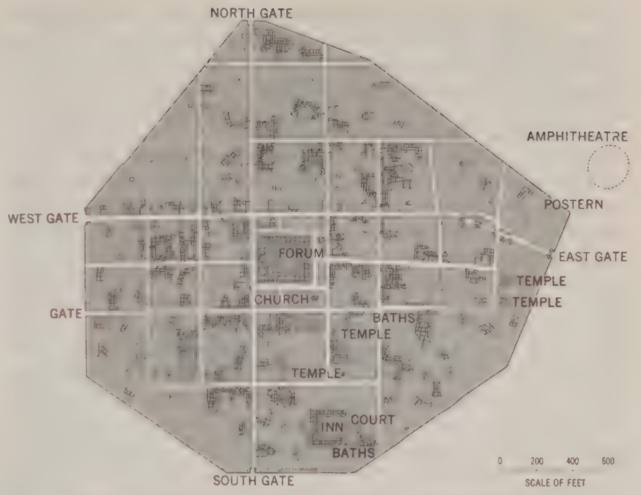

FIG. 2.—ROMAN PLAN OF SILCHESTER: 2ND CENTURY A.D.

2. Urban Development.—In the general framework of Romano-British life the two chief features were the town and the villa. Apart from Carlisle (Luguvallium) and Corbridge on Tyne, which lay within the military area and became market towns for the soldiers of the frontier garrison, the towns of the province fall into two classes. Five modern cities, Colchester, Lincoln, York, Gloucester and St. Albans, stand on the sites, and four in some fragmentary fashion bear the names of Roman municipalities founded by the Roman government with special charters and constitutions. All of these reached a considerable measure of prosperity. Besides them cantonal capitals developed as market centres or capitals of the Celtic tribes. Such are Aldborough (Isurium Brigantum), capital of the Brigantes, 12 mi. N.W. of York and the most northerly Romano-British town; Leicester (Ratae Coritanorum), capital of the Coritani; Wroxeter near Shrewsbury, capital of the Cornovii; Caerwent (Venta Silurum) near Chepstow; Cirencester (Corinium), capital of the Dobuni; Exeter (Isca Dumnoniorum), the most westerly of these towns; Dorchester (Durnovaria) in Dorset, capital of the Durotriges; Winchester; Silchester, south of Reading; Canterbury; and Caister St. Edmund (Venta Icenorum). Besides these country towns, London was a rich and important trading town, centre of the road system and of the finance officials of the province, while Bath was a spa provided with splendid baths and a richly adorned temple of Sulis, goddess of the hot springs, whom the Romans called Minerva. Many smaller places within the cantons, for example Kenchester (Magna) near Hereford, Rochester (Durobrivae) in Kent, Chesterton near Peterborough, Great Chesterford near Cambridge, or Alchester near Oxford, exhibited some measure of town life and served as markets or centres of tax collection.

A good general idea of life in the cantonal capitals has been depicted through excavations carried out at Silchester, Caerwent, St. Albans, Canterbury and Wroxeter. Public life centred in the *forum* (market place) and the adjoining *basilica* (public hall of exchange). There the local authorities had their offices, justice was administered, traders trafficked, citizens and idlers gathered. In the plan of Silchester (*see* fig. 2), the area of the *forum* contained the *basilica*, or great hall for meetings and business, into which opened a row of administrative offices; while many of the rooms on the other three sides of the quadrangle were probably shops. The temples might have been of classical or native type, and at Silchester a small Christian church has been postulated. A suite of public baths was always a prominent feature, and there was usually an amphitheatre and sometimes a theatre as well. The private houses consisted either of a row of rooms, with a corridor along them, and perhaps one or two additional rooms at one or both ends, or of three such units, ranged around three sides of a large square open court or garden. Except in the chartered towns, they were detached houses, standing each in its own garden, and not forming terraces or rows. They differed widely from the town houses of Italy; their real parallels occurred in Gaul, and they may have been Celtic types modified to Roman use—rather as Indian bungalows were adapted to European use. Their internal fittings—hypocausts, frescoes, mosaics—were everywhere Roman.

The streets varied in width. They intersected regularly at right angles, dividing the town into rectangular blocks, a system usual in both Italy and the provinces, and derived ultimately from Babylon and the east through the Hellenistic cities founded by Alexander the Great and his successors. The walls were often built later than the streets, having been erected when the peace of the province began to be seriously threatened by barbarian inroads. The material romanization suggested by the town planning was confirmed by numerous small objects recovered in the course of the excavations—coins, pottery, window and table glass, bronze ornaments, iron tools, etc. Few were individually notable; traces of late Celtic art were singularly absent; Roman fashions ruled supreme, and inscriptions showed that even the lower classes there spoke and wrote Latin. These towns were thoroughly romanized, peopled with Latin-speaking citizens, furnished with Roman appurtenances and adapted to Roman ways, but were not very large and not very rich, a humble witness to the assimilating power of the Roman civilization.

3. Rural Life.—The country, as opposed to the towns, of Roman Britain seems to have been divided into estates commonly (though perhaps incorrectly) known as villas. These represented the landowning upper classes of the cantons. Many examples survive, some large and luxurious, some simple farms, constructed usually on one of the two patterns described in the account of the towns above. The inhabitants were clearly as various—at the top the tribal notables who were wealthy landowners, lower down small farmers or possibly bailiffs. Some of these estates were worked on the true villa system, by which the lord occupied the "great house," and cultivated the land close around it by slaves, while he let the rest to half-free *coloni*, or tenant farmers. But other systems inherited from the Celtic world must have prevailed as well. Among the most important country houses of which remains exist are those of Bignor in west Sussex, Woodchester and Chedworth in Gloucestershire. At the other extreme were the hut dwellings, whose remains can be detected in the Thames valley and elsewhere, and which housed the peasant population.

The wealth of the country was indeed principally agrarian, and the needs of the army of occupation must have helped to stimulate production. Wheat and wool were exported in the 4th century when, as we have said, Britain was especially prosperous. But the details of the trade are unrecorded. More is known of the lead and iron mines which, at least in the first two centuries, were worked in many districts—lead (from which silver was extracted) in Somerset, Shropshire, Flintshire, Derbyshire and Yorkshire; iron in the Weald of west Sussex, the Forest of Dean and to a slight extent elsewhere. Other minerals were less notable. The gold mentioned by Tacitus proved scanty, although there was one large-scale gold mine at Dolau Cothi, Carmarthenshire. Cornish tin, according to present evidence, was worked comparatively little until the 4th century, when Somerset was also producing silver in quantity.

4. Religion.—The religious life of the province was divided into official, imported and native cults. Official worship was represented in the civilian world by the calendared festivals of Roman officials and troops, and by the provincial cult of the emperor. Relics of the worship accorded by Roman government officials have hardly survived, but those of the troops and their officers are abundant, including the rich series of annual parade-ground dedications (from Maryport, Cumberland) to Iuppiter Optimus Maximus and other purely Roman deities, the dedications to the standards by legionary or auxiliary officers and to the imperial discipline, a series which Roman Britain shared with Roman Africa, or to local deities of importance such as Mars Cocidius in Cumberland and Apollo Maponus or Hadrian's Wall. Brigantia, the patron goddess of northern England, appears to be an official creation of the early 3rd century and her personified statue is now in the National Museum of Antiquities, Edinburgh. The official provincial cult was centred under Claudius at Colchester and is mentioned by Tacitus and, bitingly, in the *Apocolocyntosis* of Seneca. There in the worship of a living emperor as *divus* (divine) Claudius, provincial zeal, however inspired, had outrun normal convention. The vaulted foundations of the temple, in existence below Colchester castle, attest its large size and underline the burden of the cult on a relatively small number of tribal communities, about a dozen as compared with 64 in Gaul. A comparable early dedication was for the welfare of the *Domus Divina*, or imperial household, by a guild at Chichester set up by the authority of Tiberius Claudius Cogidumnus, *rex et legatus Augusti*, who is also mentioned by Tacitus as a faithful ally and client king. This led on to the religious corporations of cities represented by the *seviri Augustales* at York and Lincoln, whose business was the maintenance of a local imperial cult, and to the innumerable dedications to the *numina Augustorum* ("the imperial spirits") by officials, military officers and private individuals.

Imported cults were represented by many deities brought by auxiliary units, such as Mars Thincsus, worshiped by Frisii at Housesteads, Northumberland; Matres Ollolotae of the Vettones at Binchester, County Durham; Vagdavercustis and Harimella, brought by Tungrians to Birrens, Dumfriesshire; or the Dea Hammia of the Syrian archers at Carvoran, Northumberland. The eastern religions were exemplified by numerous dedications to Iuppiter Dolichenus, and the dedications and shrines of Mithras. Mithraism (*q.v.*) was not only favoured by the soldiery, as demonstrated by the shrines on Hadrian's Wall at Housesteads, Rudchester and Carrawburgh (this last on public view) but also by traders, as shown by the rich shrine at Walbrook, London: for Mithras was a god not only of valour but also of honest dealing and truth. It should, however, be emphasized that Mithraic communities were never large and that this religion, though widespread, counted relatively few adherents. Individual importations were not uncommon, such as the dedication to Oceanus and Tethys by Demetrius of Tarsus (copying Alexander the Great) at York, that to Sarapis by a legionary legate at York or to Apollo Grannus by a procurator at Inveresk, Midlothian. Dedications in Greek, like that of Demetrius, were rare and principally confined to doctors, with whom it was a professional fashion, or to such exotic figures as the priestess of Tyrian Hercules at Corbridge, Northumberland.

The native cults were numerous and striking, and it is interesting that the dedications in many of them were coupled with the *numen Augusti*, associating loyalty with worship. The most striking was perhaps that of Sulis-Minerva at Bath (in Somerset), where Sulis, the native goddess of the springs, was equated with Minerva. This *interpretatio Romana*, which gave to a native deity perhaps never expressed in human form a classical equivalent whose human guise and attributes were well known, was exemplified at Bath by the statues of Minerva and by the classic form given to the temple, whose architectural order and front pediment still survive. But it led to strange results, as when Mars became a healing deity (an attribute from the Treveri of the Moselle region in Gaul) at Caerwent (in Monmouthshire) where he was *Mars Lenus sive Ocelus*, or where an auxiliary unit must speak of *Mars Militaris* (Maryport in Cumberland). Maponus on Hadrian's Wall is equated with Apollo, Belatucadrus in Cumberland with Mars, as is also Cocidius in north Cumberland. Nodens, the hunter-god at Lydney (in Gloucestershire), is equated with Silvanus, as is also Vinotonus, a local deity of the high Pennines, near Bowes (in Yorkshire). Many shrines remain nameless, for want of inscribed dedications surviving. The striking feature is their ubiquity and their survival to the latest period of Roman Britain, particularly in the southwest.

Christianity.—By mid-20th century archaeological evidence of Christianity had been found, notably the wall-paintings discovered at Lullingstone, Kent, to supplement the isolated literary references of early date (*i.e.*, those of Tertullian and Origen, writing at the beginning and middle of the 3rd century respectively). These point to the beginnings of Christianity in Britain, but the evidence, especially for the period before Constantine I (sole emperor 323–337), remains comparatively meagre and is often difficult to interpret. The traditions reflected in later writers such as Bede (*q.v.*), ascribing the earliest British martyrs, including St.

Alban (*q.v.*), to the late 3rd or early 4th century may rest on historical fact but it is not clear, for instance, to which persecution St. Alban's martyrdom belongs. For the 4th century, there are written references to the presence of British bishops at the Councils of Arles (314) and of Nicaea (325). For the British heresy of Pelagianism *see* PELAGIUS.

5. Art.—The term Romano-British art embraces objects of varied character and provenance since it includes not only works which were purely British, *i.e.*, made in Britain by British craftsmen, but also works made in Britain by immigrant craftsmen from Gaul, the Mediterranean and even the orient. Imported provincial (*e.g.*, Gaulish and Rhineland) work shows in varying degrees the influence of Greek and Greco-Roman art, as well as a large number of imported objects of actual Greco-Roman workmanship. Art in Roman Britain includes sculpture in the round and relief sculpture (particularly on tombstones, sarcophagi and the like) in marble and stone; sculpture in bronze; fresco painting, mosaics, carved objects in bone, ivory and native shale and jet; ceremonial armour (such as the 1st-century bronze parade masks from Ribchester in the British museum and from Newstead in the National Museum of Antiquities, Edinburgh); vessels of metal and glass for domestic and ceremonial use and pottery; as well as a host of small objects (such as brooches, rings and toilet articles) for personal adornment and other uses.

The best tradition of Greco-Roman sculpture is exemplified in the heads of Mithras and Sarapis probably of the 2nd century A.D. in Italian marble and of Italian manufacture from the Mithraeum excavated at Walbrook, London, in 1954 (now in the Guildhall museum, London). Of approximately the same period are the examples of Roman portrait sculpture from Lullingstone. The naturalism which, having its origins in classical Greek sculpture, animated such works as these often prevailed over the native tendency toward the abstract and the formalized to produce in Britain works showing a high degree of naturalism and classical restraint; at other times it combined with these tendencies to produce works of singular novelty and vitality. The dignified 2nd-century bronze head of Sulis-Minerva at Bath is among the best provincial work showing strong classical influence; other works, such as the fragmentary stone relief depicting figures with stylized drapery from Wellow, Somerset, show the persistence of the native tendency to geometric simplification of forms. The stone head from Towcester, Northamptonshire (in the British museum), with its formalized rendering of the hair and flat, almost linear, treatment of the features, has an expressionistic quality alien to classical art.

Excavation of the sites of Roman villas in Britain has revealed examples of mosaic pavements, many of them depicting figure subjects chosen from classical mythology, such as the 4th-century pavements from Aldborough representing the nine muses and that from Lullingstone, showing the abduction of Europa; a villa at Horkstow, Lincolnshire, yielded notable mosaics including genre scenes of horse racing and chariot racing. In another type of mosaic, often associated with baths, marine deities are surrounded by sea creatures and plants formally rendered: examples of this type are the pavement from Withington, Gloucestershire, representing Oceanus encircled by dolphins, sea monsters and plants, and the damaged pavement from Hemsworth, Dorset, of Venus surrounded by a border of dolphins and mullet. As well as these figurative mosaics derived from Mediterranean models (by whatever processes of copying that can be inferred from the recurrence of classical motives) there were numerous nonfigurative mosaics in which conventional abstract pattern, already a strong element in Celtic art, was developed and enriched by new classical motives. In the decorative arts, although classical influence generally prevailed, the persistence of late Celtic tendencies is to be noted in some Romano-British objects: the predilection for curvilinear design, for foliation and for palmette, pelta and scroll ornament appears in such objects as the enameled altar-shaped plaque (2nd–3rd century) from the river Thames with its colours of the pleasantly low key characteristic of Romano-British decorative colour schemes, and the "dragonesque" enameled brooch from Norton, Yorkshire (both in the British museum). As in other parts of the Roman empire, fresco painting was employed in the decoration of Romano-British villas although because of the climate it has hardly survived. A notable 2nd-century painted plaster frieze was found at St. Albans in 1956 with a remarkable use of the "populated" scroll design familiar from the wall plasters of Pompeii: in this Romano-British version of the motif the spirals terminate in the masks of animals.

The so-called Samian red-glazed ware (with its relief decoration molded and applied) which was common throughout the Roman empire was imported to Britain (mainly from central and southern Gaul) and to a small extent imitated by British potters. As well as a large number and variety of coarse wares from many centres in Britain, notable wares were produced at certain centres such as Castor, Northamptonshire, where pottery decorated in barbotine with foliated designs and animal and human forms was made from the late 2nd century A.D. until the end of the Roman occupation. Other centres which produced their own characteristic wares were New Forest, Hampshire, and Crambeck, Yorkshire.

Bronze objects for furnishings and domestic and other uses were imported in large quantities from Gallia Belgica. The costly silver vessels which were used both for table and for cult use in Roman Britain were for the most part imported from the Mediterranean. Perhaps the most spectacular is the group of tableware discovered near Mildenhall, Suffolk (now in the British museum), of which the great dish, with its embossed decoration depicting a Bacchanalian scene with Hercules, and the two platters showing Pan and a satyr with maenads, are undoubtedly of Mediterranean and probably of Roman origin; while other pieces, such as a bowl with fluted decoration, may have been made in Britain.

C. END OF ROMAN BRITAIN

About 286 Marcus Aurelius Carausius (*q.v.*), admiral of the Classis Britannica (a well-equipped fleet that secured him command of the English channel and neighbouring seas), quarreled with the central government and proclaimed himself emperor. He remained in control of the island until 293, when he was murdered by one of his own officers, Allectus, who succeeded him for three years. In 296, an expedition under the *Caesar* and future emperor, Constantius I, successfully recaptured the province. Extensive changes in the distribution of the garrison seem to have followed. Danger threatened, not only from the Picts beyond Hadrian's wall but also from the sea. A special coast defense, reaching from the Wash to Spithead, was established against Saxon pirates: there were forts at Brancaster (Branodunum) in Norfolk; Burgh Castle; and Walton, near Felixstowe, Suffolk; Bradwell, at the mouth of the Blackwater estuary in Essex; Reculver (Regulbium), Richborough, Dover (Dubrae) and Lympne (Portus Lemanis), all in Kent; Pevensey (Anderida) in Sussex; Portchester (Portus Adurni) near Portsmouth; and Carisbrooke on the Isle of Wight. The Irish (Scoti), too, were becoming increasingly aggressive. It is, therefore, not surprising that a new fort should have been erected at Cardiff and a fleet station at Holyhead, Anglesey. These measures were effective and the province prospered, even after a heavy barbarian assault in 367–369. To this date belong the series of stone watchtowers along the Yorkshire coast, from the river Tees to the promontory known as Flamborough head, and the camouflaged scout ships of Valentinian I (*q.v.*).

In 383 Magnus Clemens Maximus, claiming to be emperor, withdrew many troops from Britain and a later pretender did the same. Early in the 5th century the Teutonic conquest of Gaul cut the island off from Rome. This did not mean that there was any great "departure of the Romans." The central government simply ceased to send the usual governors and high officers. The Romano-Britons were left to themselves, but the cantonal authorities carried on, and towns like St. Albans continued. Their position was weak. Their fortresses lay in the north and west, while the Saxons attacked the east and south. Their trained troops, and even their own numbers, must have been few. It is probable that they followed a precedent set by Rome in that age, and hired Saxons to repel Saxons. But they could not command the fidelity of their mercenaries, and the Saxon peril only grew greater. After the close of the 5th century the Romano-Britons were driven from the east of the island, and the Saxons, though as yet unable to gain a hold on the western uplands, were able to prevent the natives from recovering the lowlands. Half a century later the position was worse: driven from the region of walled cities and civilized houses, into the hills of Wales and the northwest, the provincials underwent an inevitable change. The Celtic element, never extinct and, like most forms of barbarism, reasserting itself in this wild age—not without reinforcement from Ireland—changed the remnants of Roman civilization and in the end absorbed them. The Celtic language reappeared; Celtic art emerged to develop in new and medieval fashions. For Anglo-Saxon Britain *see* ENGLISH HISTORY; for Scotland *see* CALEDONIA. *See* also references under "Britain" in the Index.

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BRITISH ANTARCTIC TERRITORY: *see* FALKLAND ISLANDS AND DEPENDENCIES AND BRITISH ANTARCTIC TERRITORY.

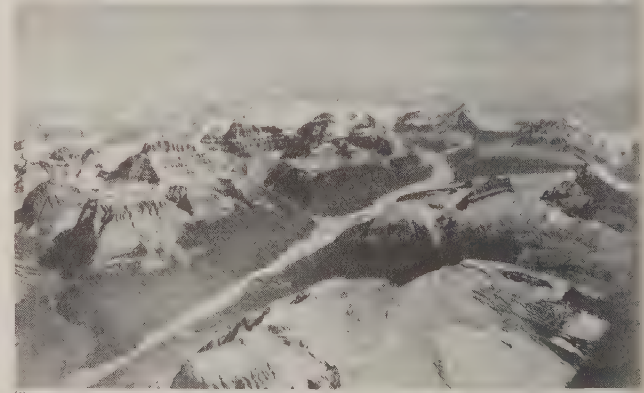
BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE was established in 1831 at York, Eng., partly as a forum for scientists to discuss their work with their colleagues, not only in their own but in related fields, but particularly as a means of presenting to the public generally the ever-increasing importance of science, and of its applications, to the country's economic and social development.

The association pursues these aims in the following ways. First, by the organization of an annual meeting held in a different city in the U.K. each year: the meeting lasts for eight days and is the largest scientific gathering of its kind in the country and the only one which members of the general public can attend on equal terms with scientists. The program covers the whole field of science (natural, biological, technological, and social). Second, the association arranges all over the country and throughout the year, by means of 20 branch and area committees and a central lecture service, local programs of scientific lectures and films. Much of this work is directed at young people, and in addition to single lectures, major Junior British Association meetings and science fairs (which are designed to exhibit the scientific work of young people in schools) are organized in selected areas each year. In 1968 the association launched a new national organization to be known as British Association of Young Scientists (BAYS), the aim of which is to get young people actively involved in planning and running their own scientific programs. Third, the association's Visual Aids Service arranges film and other programs to meet the needs of specialized groups (teachers, professional bodies, etc.) and advises on sources of visual material. Fourth, the association arranges conferences and study groups to examine problems of national and topical interest. Fifth, the association publishes a quarterly journal, *The Advancement of Science,* which aims at keeping scientists informed of developments in fields other than their own and at promoting a wider understanding of science and technology. The association maintains cordial relations with sister associations for the advancement of science in the British Commonwealth and in other parts of the world by correspondence, exchange of delegates at annual meetings, and exchange of publications. The association is a charitable body, run largely by voluntary effort under the direction of a permanent secretary responsible to the council of the association. (Jo. M. R.)

BRITISH COLUMBIA, the westernmost province of Canada, is bounded on the east by the watershed of the Rocky Mountains until it, in its northwesterly course, reaches the meridian 120° W, which is followed north to the 60th parallel, which forms the northern boundary. The southern boundary follows the parallel of 49° N except in the west, where it swings southward to include all of Vancouver Island. Westward, the province fronts the Pacific Ocean for about 600 mi. and the Alaskan "panhandle" for another 400 mi. Within the provincial boundaries are Vancouver Island and the Queen Charlotte Islands, as well as innumerable smaller islands lying off the west coast of Canada. Total area of the province is 359,279 sq.mi. of which about 40% is forested, 5% is suited to agriculture. The area of inland waters is 6,976 sq.mi.

PHYSICAL GEOGRAPHY

Landforms.—British Columbia is essentially mountainous, forming part of that great group of mountain systems known as the North American Cordillera. Within the province (*see* fig. 1), the Cordillera is divisible into three basic units—a northwestward-trending group of mainland and insular mountains along the coast, a system of scattered plateaus and mountains in central British Columbia, and another northwestward-trending mountain system on the east. In the northeast, the province extends beyond the Cordillera to include a small part of the Great Plains of interior North America. The first of these units may be divided longitudinally into three parts—the Coast Mountains (a counterpart of the Cascade Range), an outer mountain area (an extension of the mountains known as the Coast Ranges in the United States), and a coastal trough lying between them. (*See* CASCADE RANGE; COAST RANGES.) The Coast Mountains in combined height and area represent the greatest mountain mass in Canada. Average elevation is 5,000 to 6,000 ft., but peaks over 10,000 ft. occur, the highest of which is Mt. Waddington whose 13,260-ft. elevation exceeds the highest summit in the Canadian Rocky Moun-



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THE COLUMBIA ICE FIELD, SOUTHEASTERN BRITISH COLUMBIA NEAR THE ALBERTA BORDER

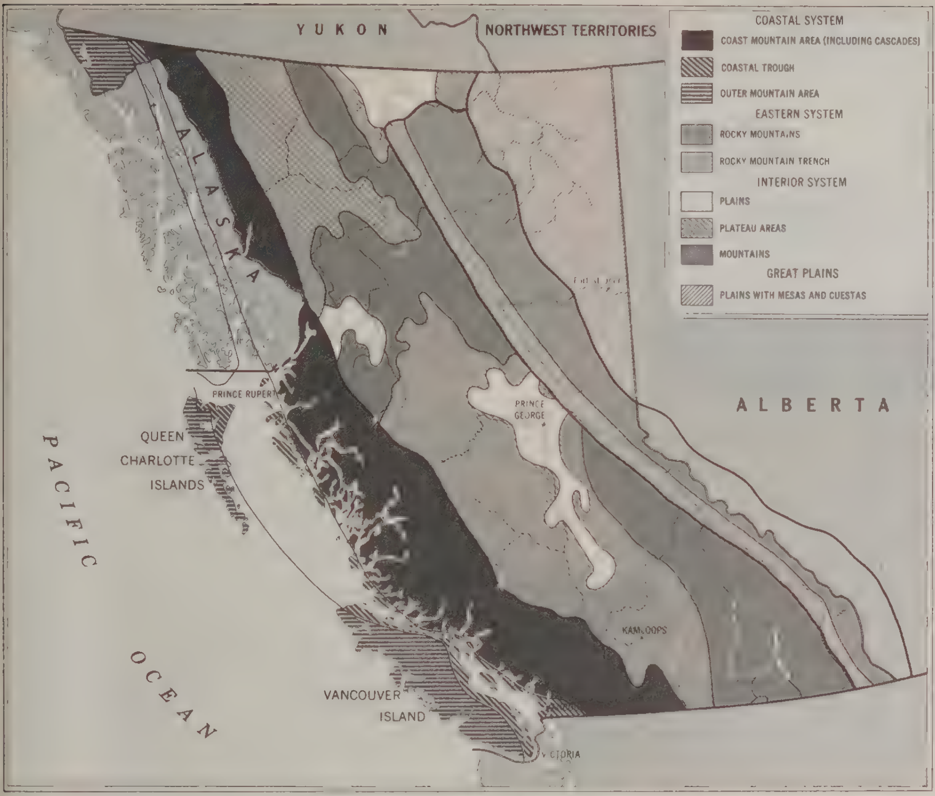


FIG. 1.—LANDFORMS OF BRITISH COLUMBIA WHICH FORM PART OF THE NORTH AMERICAN CORDILLERA

tains. The coastal trough, part of a tremendous structural depression extending from Alaska to the Gulf of California, is largely submerged, but its margins form the east coastal plain of Vancouver Island and the lowland into which the Fraser River delta has been built. Its submerged portions, with interconnecting fjords, form that great sheltered waterway, stretching from Puget Sound to Alaska, known as the Inside Passage (*q.v.*). The outer mountain area includes the ranges of Vancouver Island, Queen Charlotte Islands, the outer islands of southern Alaska, and the St. Elias Mountains. While the Coast Mountains are larger in combined mass, the outer mountain area, in its northern extremity, contains the highest elevations in the province. The St. Elias Mountains, containing the largest group of great peaks in North America, extend through Alaska and Yukon Territory into British Columbia. Though they are considerably higher beyond the provincial boundary, that portion in British Columbia culminates in 15,300-ft. Fairweather Mountain on the Alaskan boundary.

The interior system is comprised of a southern and a northern plateau area, and includes a number of mountain ranges and mountain groups. Among the latter are the rugged and scenic Columbia Mountains in southeastern British Columbia. The southern plateau area, like its U.S. counterpart, the Columbia Plateau, is a gently rolling upland in which the major rivers are deeply entrenched. The plateau, mantled with glacial deposits of varying thicknesses and textures, is in most places timber covered and dotted with upland lakes. Though generally unsuited to sedentary agriculture, parts of the southern plateau area contain extensive open rangelands, and are the scene of most large-scale ranching in the province. The northern plateau area is generally similar to that in the south. In many places broad plateau surfaces stand like tablelands, separated by wide valleys of the major rivers.

The eastern system is composed of the Canadian Rocky Mountains and the Rocky Mountain Trench. The former stretch in a series of parallel ridges, separated by deep valleys, from the 49th parallel to the Liard River. In the vicinity of the Peace River, summit elevations decline to about 6,000 ft., but north and south of the area the Rockies are high and rugged, with peaks exceeding 10,000 ft. The Rockies present difficulties to land transport connections with eastern Canada, but they contain a number of passes, among the more important of which are Pine Pass (2,850 ft.), Yellowhead (3,717 ft.), Kicking Horse (5,320 ft.), Vermillion (5,376 ft.), and Crowsnest (4,453 ft.).

On their western flank the Rocky Mountains slope abruptly into a narrow but remarkably persistent structural depression, the Rocky Mountain Trench. This feature, lying between 2,000 and 4,000 ft. above sea level, extends from the vicinity of Flathead Lake in Montana northward to the Liard Plain. Except near the great bend of the Fraser River, where it opens to the interior plateau, the flat-floored trench is walled by abrupt mountain slopes. It is occupied by the upper courses of several important rivers including the Kootenay, Columbia, Fraser, Parsnip, and Finlay rivers and forms a natural route of travel which is of both historic and modern significance.

Geology.—The Coast Mountains consist almost entirely of middle-aged intrusive rocks and the Rocky Mountains, of ancient rocks, yet the Rockies were formed in comparatively recent Late Cretaceous and Early Tertiary times when ancient rocks were thrust into folds and heavily faulted (*see* ROCKY MOUNTAINS). The western and interior systems contain valuable metalliferous deposits; the faulted and folded sedimentary rocks of the eastern system, and particularly the adjoining sedimentary structures in the northeast, contain coal, oil, and natural gas.

British Columbia underwent widespread Pleistocene glaciation that left conspicuous surface features and profoundly affected the nature and distribution of arable soils. Glacial drift underlies much of the rolling surface of the interior plateaus, while deposits of silt and clay laid down in ice-dammed lakes form the basis of valuable agricultural soils in several interior valleys.

Climate.—Latitudinal extent, rugged terrain, and proximity to the Pacific Ocean greatly affect British Columbia's climate. The interaction of these climatic controls produces remarkable variations in both precipitation and temperature, often within short distances. Victoria, for example, with an average precipitation of 27 in. a year, is less than 100 mi. SE of Henderson Lake, which recorded an annual average of 262 in. Similarly, while Oliver, in the Okanagan Valley, has a frost-free season of 178 days, Princeton, 40 mi. W, has less than 100 frost-free days.

The overall pattern of climate can, however, be appreciated by considering the three main air masses that affect British Columbia.

Polar maritime air dominates the coastal region for much of the year, its particular temperature and moisture characteristics determined by its trajectory over the ocean. In general, it brings mild, humid conditions to the entire coast in winter and warmer, drier conditions in summer. Warm, dry weather which characterizes the southwest coast in midsummer is related to the northward extension of the subtropical high-pressure cell (Hawaiian high). Polar continental air, with source regions east of the Rockies and in Yukon Territory and Alaska, predominates over northeastern British Columbia but only infrequently extends to

BRITISH COLUMBIA GOVERNMENT PHOTOGRAPH

JERVIS INLET, A MAGNIFICENT FJORD WHICH WINDS INLAND AMONG THE MOUNTAINS TO THE NORTH OF VANCOUVER, IS AN ARM OF THE STRAIT OF GEORGIA OFF MALASPINA STRAIT

the coast. In winter the interior is characteristically cold and dry, in summer, warm and dry. Tropical continental air is less important to the climate than are the polar air masses, although in summer tropical air sometimes extends northward from southwestern United States and brings hot, dry conditions to the southern interior valleys.

In general there are strong relationships between climate and physical features. The coast experiences moist, mild conditions throughout the year (the mildest winter temperatures in Canada), southeastern Vancouver Island and the adjacent mainland being particularly favoured. The interior plateaus are dry, with precipitation averaging 15 to 20 in. per year. The Columbia and Rocky mountains experience higher precipitation and lower average temperatures than adjacent plateaus and plains. Extreme northeastern British Columbia is typically subarctic, with short, moderately warm summers and long harsh winters.

Plants and Animals.—About 40% of the province is classed as forested, much of the remainder being made up of alpine barrens, snowfields, and glaciers. Most of the nonforested land is concentrated in the eastern and western mountain systems and in the northern one-third of the province.

Most of the vegetation consists of coniferous tree species although, especially in the central and northern interior, birch and aspen are common, either in pure stands or intermixed with conifers. In the southern interior, particularly in the valleys, open grasslands occur, in some places covering extensive areas on the plateaus. In certain southern valleys such dry land species as sagebrush, rabbit bush, and cactus are common. The most luxuriant vegetation and the largest trees occur on the coast, especially along the southern coast where mild temperatures and abundant rain favour the growth of some of the finest timber stands in the world. Species there include the true firs, hemlock, cedar, spruce, and the Douglas fir, or false hemlock. Similar species, but in less prolific stands, occur in the "interior wet belt," the western flanks of the Columbia Mountains. Most of the southern plateau area supports dense stands of lodgepole pine and Douglas fir, the latter merging with open, parklike stands of ponderosa pine on the grassland margins.

Among the larger fauna are game species such as deer, elk, moose, and bear as well as sheep and mountain goat. Except for bears, populations of these species depend largely on the availability of winter forage. Since 1900 extensive forest fires and logging operations have improved range conditions in this regard, second growth providing suitable forage for browsing animals. Moose, for example, now range in greater numbers and farther south than formerly. Although not found on the coast, they are widely distributed through the interior. Deer are concentrated on the coast, especially on Vancouver Island, and in the southern interior valleys, while elk are largely restricted to Vancouver Island and to valleys of the Columbia and Rocky mountains. Black bears are common throughout, grizzly bears less so, and are associated with the less accessible mountain areas.

Aside from big game, numerous waterfowl and upland game species occur. Grouse, pheasant, and partridge are associated with the grasslands and open forests of the southern interior and with cleared land on the coast. Both salt- and freshwater game fish are abundant, the most sought after being two species of Pacific salmon and rainbow and cutthroat trout.

Fur-bearing animals, including mink, muskrat, marten, and beaver are widely distributed and provide the basis of the historically significant trapping industry.

Parks.—Several million acres of parks have been set aside for public use. There are four national parks, in southeastern British Columbia, totaling over 1,000,000 ac. The provincial park system includes 239 individual parks (170 of them developed), the largest of which are Tweedsmuir (2,425,000 ac.), Wells Gray (1,302,837 ac.), Garibaldi (618,097 ac.), Strathcona (530,000 ac.), and Mt. Robson (513,920 ac.). The park program has shifted from reservation of additional large wilderness areas to the acquisition of numbers of small parks in strategic use areas. The most heavily used park facilities in the province are the public campsites and picnic sites along the more frequently traveled routes. *See* also NATIONAL PARKS AND NATURE RESERVES.

NATIVE PEOPLES

At the time of European contact British Columbia was inhabited by aboriginal peoples with highly developed cultures and grotesquely beautiful art forms. Seven main linguistic divisions have been recognized—Haida, Tlingit, Athapaskan, Tsimshian, Wakashan, Salishan, and Kootenay (Kutenai)—each with several subdivisions. The native peoples had no sedentary agriculture or domestic stock and their distribution and numbers were therefore closely related to the natural food supply. The coast and major rivers supported the main concentrations, for there were bountiful food resources, especially of Pacific salmon, which could be easily taken during the seasonal spawning run to fresh water. There, too, developed the most advanced cultures (*see* also CANADA: *Native*

BRITISH COLUMBIA GOVERNMENT PHOTOGRAPH

THOMPSON RIVER, NORTH OF LYTTON, WHERE IT JOINS THE FRASER

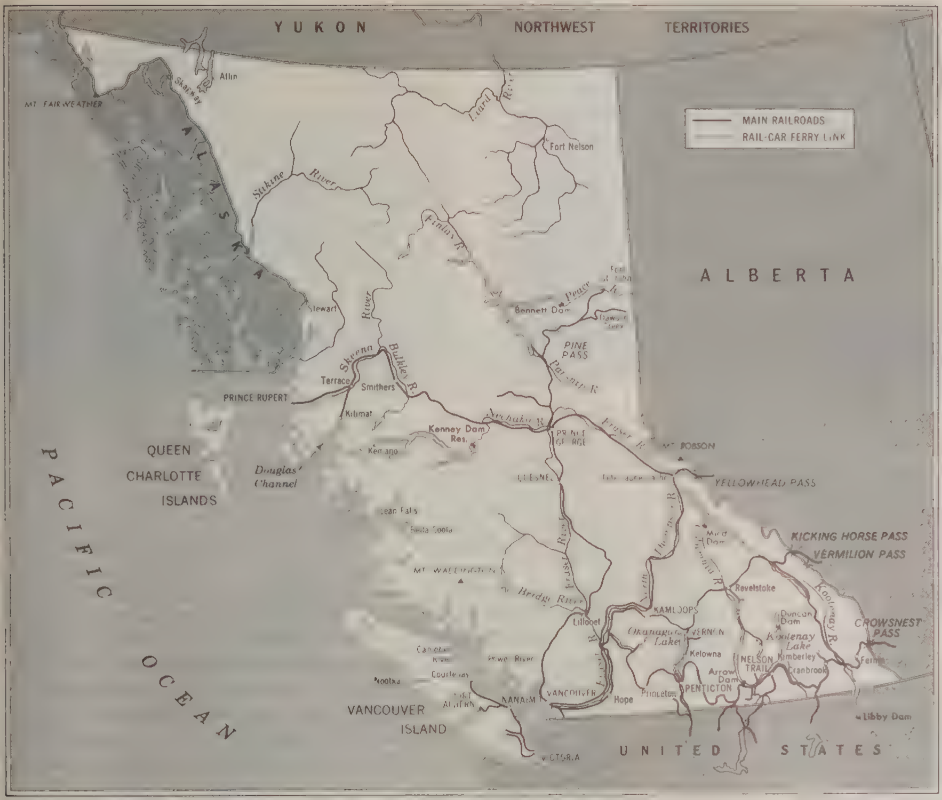

YUKON
NORTHWEST
TERRITORIES
MAIN RAILROADS
RAIL-CAR FERRY LINK
MT. FAIRWEATHER
Atlin
Skagway
ALASKA
Liard River
Fort Nelson
Stikine River
Finlay R.
ALBERTA
Peace R.
Bennett Dam
Stewart
River
PINE PASS
Parsnip R.
Skeena
Bulkley R.
Terrace
Smithers
PRINCE RUPERT
Kitimat
Nechako R.
Kenney Dam Res.
PRINCE GEORGE
Fraser R.
MT. ROBSON
Kemano
QUEEN CHARLOTTE ISLANDS
Douglas' Channel
YELLOWHEAD PASS
PACIFIC OCEAN
Bella Coola
MT. WADDINGTON
Fraser River
Bridge River
Mica Dam
KICKING HORSE PASS
VERMILION PASS
Revelstoke
Kootenay R.
KAMLOOPS
Lillooet
Okanagan Lake
VERNON
Duncan Dam
Kootenay Lake
CROWSNEST PASS
Kelowna
NELSON
Kimberley
TRAIL
Cranbrook
Fernie
Arrow Dam
Powell River
Courtenay
Nootka
PORT ALBERNI
NANAIMO
VANCOUVER
Hope
Princeton
PENTICTON
VANCOUVER ISLAND
Libby Dam
VICTORIA
UNITED STATES

FIG. 2.—DRAINAGE SYSTEMS AND MAIN RAILWAY LINES OF BRITISH COLUMBIA

Peoples). Following white contact the Indian population suffered a severe decline through decimation by introduced diseases and social demoralization. The decline continued until about 1930 but after that time there has been rapid growth. Indian populations in the second half of the 20th century reflected essentially the same distribution as in aboriginal times, but the activities had changed from subsistence to wage-earning employment in fishing and logging operations. In 1967 the Indian population totaled about 45,000, three-fourths of them living on reserves administered by the federal government.

HISTORY

The discovery of British Columbia was an outcome of the long-continued search for the Northwest Passage to the Orient. The first fleeting contact was made in 1774 by the Spaniard Juan Pérez who sailed northward from Mexico. Two years later Capt. James Cook, on his third and last great voyage, established the general outline of northwest North America, though he saw little of what is now the British Columbia coast. While Cook repaired his vessels at Nootka Sound, on the west coast of Vancouver Island, a few pelts of sea otter were obtained from the Indians. When the expedition, on the return trip to England, stopped at Macao on the coast of south China, the fabulous profits that could be made in the sea-otter trade became apparent. Following the publication of Cook's narrative, a veritable armada of trading vessels appeared on the northwest coast. As an outcome, a controversy between England and Spain developed, in the course of which Capt. George Vancouver was instructed to map the area. His surveys during 1792–94 represented the first comprehensive mapping of the coast north of San Francisco.

In 1793 Alexander Mackenzie made the first overland crossing of the continent north of Mexico, reaching the coast at Bella Coola, about 275 mi. NW of Vancouver. His expedition paved the way for occupation of the Pacific slope by the fur traders and trappers of the North West Company which, in 1821, amalgamated with the Hudson's Bay Company. During the following 25 years the Hudson's Bay Company ruled that immense territory west of the Rockies and north of the Spanish North American possessions with beneficent despotism in the interests of the fur trade. Prefaced by the influx of American settlers to the Oregon country, the international boundary west of the Rockies was established in 1846. In anticipation of this, the Hudson's Bay Company had moved its western headquarters from their earlier location in Vancouver, Wash., to Victoria. Partly as a bulwark against further American expansion, Vancouver Island was made a British colony in 1849.

In 1858, with the discovery of gold on the Fraser River and, later, on its tributaries in the Cariboo district, and the consequent influx of miners, the mainland territory was proclaimed a colony under the name of British Columbia. James (later Sir James) Douglas, the governor of Vancouver Island, former chief factor in the Hudson's Bay Company and an outstanding colonial administrator, was appointed governor of the new colony which united with Vancouver Island in 1866.

In 1871 British Columbia became a province of Canada (*see* Canada: *History*). One of the conditions under which the colony entered the confederation was the promise of the speedy construction of a transcontinental railway. Completion in 1885 (through trains, 1886) of the Canadian Pacific Railway led to the founding of the city of Vancouver (incorporated 1886) and the initiation of steamship trade with the Orient.

Associated with the gold rush were the beginnings of permanent settlement and transport development in the interior. In 1858 a route was established between the lower Fraser Valley and Lillooet about 120 mi. N, and in the period 1860–65 the Royal Engineers surveyed and helped to build the Cariboo wagon road via the perilous Fraser Canyon, connecting with Lillooet and leading northward to Quesnel and the Cariboo diggings. Several farms and ranches were established at way points along the Cariboo road to supply the miners. These "mile houses" were spaced about a day's journey apart along the road and were numbered as distances from Lillooet.

The gold boom soon faded but permanent settlement continued to expand, based on the development of agriculture, forestry, and minerals such as the lode metals of the Kootenay country. The Canadian Pacific and the later completed Canadian Northern and Grand Trunk Pacific railways (after 1919, Canadian National Railways) greatly stimulated resource development. The northern branch of the Grand Trunk Line led westward to Prince Rupert, created on the coast 500 mi. N of Vancouver in anticipation of the Orient trade.

Expectations in that direction failed to materialize and, especially after completion of the Panama Canal, which was opened to traffic in 1914, trade and commerce became centred more and more upon Vancouver, with its fine natural harbour and its productive hinterland. By 1900 Vancouver had already outstripped Victoria as the largest city in the province, and later became the third largest in Canada.

After the turn of the 20th century, development of provincial resources reflected external economic conditions—prosperity, recession, buoyant expansion, severe depression, revival, and sustained growth. Much of the impressive development after World

War II was based upon increasing use of forest and waterpower resources and minerals. Installed hydroelectric capacity rose from 500,000 hp. in 1940 to over 1,000,000 hp. in 1950 and to 3,750,000 hp. in the mid-1960s and accounted for three-fourths of the total generating capacity. Over the same period forest utilization showed a marked increase in both lumber production and pulp and paper manufacture. From a daily production of 2,000 tons of pulp and 1,400 tons of paper in 1950, capacity rose to 18,000 and 6,700 tons, respectively, in the late 1960s. Typically, mining fluctuated somewhat, the most notable events being associated with the shift from placer gold to lode mining (particularly the large-scale mining and processing of complex silver-lead-zinc ores in the Kootenay country, beginning in 1920); the exploitation of oil and gas reserves in the northeast, becoming significant in 1956; and the application in the 1960s of large investment capital and strip-mining techniques to copper, molybdenum, and iron ore deposits in central and southern British Columbia. As an indication of change, about one-third of the value of all mineral production over the past century was produced after 1960. The development of electric power and the construction of oil and gas pipelines made fuel and power available for expanding industry in southwestern British Columbia and the adjacent state of Washington. Transportation facilities, especially truck and air transport, were improved, as were radio communications networks covering wide areas. In 1942 the Alaska Highway was completed as a military road linking Dawson Creek with Yukon Territory and Alaska. Following the war it was improved and connected with Prince George (and Vancouver) by the John Hart Highway. Later the publicly owned Pacific Great Eastern Railway was extended northward from Quesnel to Prince George and Fort St. John, providing a rail link between Vancouver and the rapidly developing (gas and oil) Peace River country. The final section of the Trans-Canada Highway, decreasing travel time between Vancouver and Calgary, Alta., by at least 50%, was officially opened in 1962.

Of minor but growing importance was the tourist industry, based primarily on the excellent hunting and fishing, which reached multimillion-dollar proportions.

In political affairs Conservatives and Liberals, who had alternated in power after 1903 when Richard (later Sir Richard) McBride introduced Dominion party politics to the province, formed a wartime coalition in 1941, with the Co-operative Commonwealth Federation (CCF) as the chief opposition. The Social Credit Party led by W. A. C. Bennett won by a narrow margin in 1952 and established a clear majority in 1953, which it increased in 1956 and retained, but with a reduced majority, in 1960; the opposition was formed by the CCF (in 1961 reconstituted as the New Democratic Party) while the Conservatives and Liberals formed small minorities. Social Credit won easily in 1963 with Bennett's government continuing in office. Bennett's party won its fifth consecutive general election in 1966. (*See* also CANADA: *Administration and Social Conditions: Political Parties.*)

A school consolidation program reduced the number of school districts to fewer than 100 (formerly there had been several hundred small districts with rural schools) and large schools were constructed in centrally located settlements. The extensive system of health and welfare services provided by the province (in 1927 British Columbia became the first province to provide old-age pensions) were greatly expanded with the assistance of the federal government after World War II, as were those of the other provinces.

See CANADA: *Administration and Social Conditions: Welfare Services.*

GOVERNMENT AND JUDICIARY

The unicameral provincial legislature, composed of 55 elected members, sits for a maximum term of five years. The government is formed by the majority party, from the elected members of which the premier (party leader) selects an executive council or cabinet. The crown is represented by a lieutenant governor, appointed by the governor-general of Canada.

Administration is effected by a provincial civil service. In addition to royalties and taxes from provincial resources, public revenue is derived from federal subsidies, income tax and succession duties, sales tax, motor vehicle tax, and liquor-control profits. Local government is effected through cities, towns, villages, and district municipalities, each with an elected mayor or reeve (president of village or town council) and a council.

*British Columbia: Incorporated Places of 5,000 or More Population (1966 Census)**

Place	Population				
	1966	1961	1951	1941	1921
Total province	1,873,674	1,629,082	1,165,210	817,861	524,582
Chilliwack	8,681	8,259	5,663	3,675	1,767
Cranbrook	7,849†	5,549	3,621	2,568	2,725
Dawson Creek	12,392†	10,946	3,589	518	—
Fort St. John	6,749†	3,619	884	—	—
Kamloops	10,759	10,076	8,099	5,959	4,501
Kelowna	17,006†	13,188	8,517	5,118	2,520
Kimberley	5,901	6,013	5,933	—	—
Nanaimo	15,188	14,135	7,196	6,635	6,304
Nelson	9,504†	7,074	6,772	5,912	5,230
New Westminster	38,013†	33,654	28,639	21,967	14,495
North Kamloops	11,319	6,456	1,979	—	—
North Vancouver	26,851	23,656	15,687	8,914	7,652
Penticton	15,330†	13,859	10,548	—	—
Port Alberni	13,755†	11,560	7,845	4,584	1,056
Port Coquitlam	11,121	8,111	3,232	1,539	1,178
Port Moody	7,021	4,789	2,246	1,512	1,030
Prince George	24,471†	13,877	4,703	2,027	2,053
Prince Rupert	14,677†	11,987	8,546	6,714	6,393
Quesnel	11,600†	4,673	1,587	653	—
Trail	12,392	11,580	11,430	9,392	3,020
Vancouver	410,375	384,522	344,833	275,353	163,220
Vernon	11,423†	10,250	7,822	5,209	3,685
Victoria	57,453	54,941	51,331	44,068	38,727
White Rock	7,787	6,453	—	—	—

*Populations are reported as constituted at date of each census.
†Changes in boundary since June 1, 1961.
Note: Dash indicates place did not exist during reported census, or data not available.

In the federal government British Columbia is represented by six senators who, after 1965, are appointed to age 75, and by 23 elected members of the House of Commons.

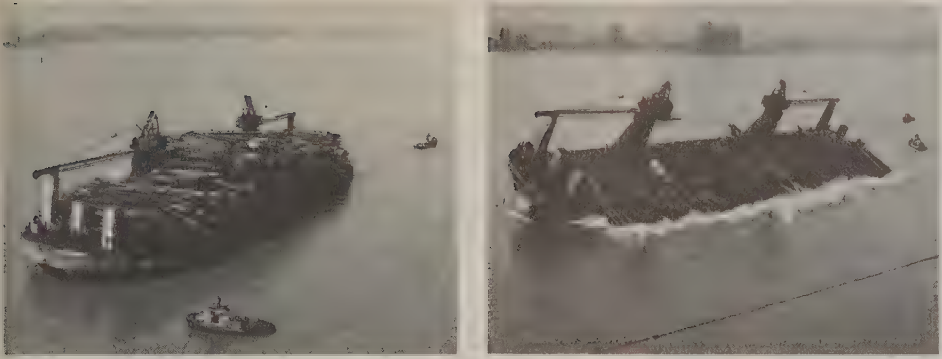
Judges of the supreme and county courts are appointed by the federal government and normally hold permanent office. The province appoints a chief justice of British Columbia, who heads the court of appeal, and minor court judges, including justices of the peace, magistrates, and juvenile court judges.

POPULATION

The population of British Columbia in 1966 was 1,873,674 (up 15% from 1961), about 75% of it concentrated on the east coastal plain of Vancouver Island and in the adjacent lower mainland. About half the total population lives in or near metropolitan Vancouver, and another 18% resides on Vancouver Island, mainly in metropolitan Victoria. In the interior, most people live in the southern valleys, the largest concentration being in the Okanagan Valley. Lesser concentrations are found in the Columbia and tributary valleys west of Kootenay Lake, and in the valleys of the Kootenay and Thompson rivers. The central interior is sparsely populated except for occasional settlements along the main transportation routes. The Prince George area is the largest of these, with a regional population of about 45,000. The Peace River area has a more dispersed rural settlement than the rest of British Columbia but contains fewer people than the associated area of Alberta. Large sections in the northern part of the province have no resident population.

Over two-thirds of British Columbia residents are of British stock, the remaining one-third primarily of Western European origin, notably French (and French-Canadian), Scandinavian, German, and Dutch. Largely because of the importation of indentured labour during early railroad construction and of subsequent federal immigration policy, British Columbia has more Chinese than any other Canadian province, comprising two-thirds of the 40,299 Asians in the province. Before World War II, Japanese were the most numerous Asian group, but as a result of relocation their proportion has declined. Most of the remainder are East Indians of Punjab origin, chiefly Sikhs.

Three-quarters of the provincial population is urban, less than 5% being classed as rural farm dwellers. The largest cities are Vancouver, with a metropolitan area population (1966) of 892,286; and Victoria, metropolitan area population 173,455. Van-



BY COURTESY OF COUNCIL OF THE FOREST INDUSTRIES OF BRITISH COLUMBIA

SELF-DUMPING LOG BARGE ON THE LOWER FRASER RIVER. DEVELOPED IN BRITISH COLUMBIA FOR THE LOGGING INDUSTRY, THE BARGE IS TOWED INTO PLACE (LEFT) AND ANCHORED AT A LOG BOOMING GROUND; THE BALLAST TANKS ARE THEN FLOODED CAUSING THE BARGE TO HEEL (RIGHT) AND SLIDE THE LOAD INTO THE WATER

couver is the chief commercial and manufacturing centre and an important deep-sea port. Victoria, the capital, is an administrative and residential city but retains its early function as a deep-sea port and naval centre. Victoria and adjacent Vancouver Island have become favourite retirement places. Other Vancouver Island cities are Nanaimo, formerly a coal mining town but now a wood-processing and supply and distribution centre, and Port Alberni, associated with sawmilling and pulp manufacture.

In the interior are Penticton, Kelowna, and Vernon, all fruit packing and processing cities in the Okanagan Valley; Kamloops, transport focus and forest products centre at the confluence of the North and South Thompson rivers; Trail, long associated with mineral processing; and Prince George, forest products, transport, and regional commercial centre. The most important coastal settlement north of the Strait of Georgia is Prince Rupert, port city and northwestern terminus of the Canadian National Railway (*see* fig. 2).

EDUCATION

Under the terms of the British North America Act, education is under control of the provincial government. Free public schooling to university entrance level is provided and is compulsory to age 15. Generally, school years are divided into seven years elementary, three years junior secondary, and two years senior secondary school. Instruction is given by correspondence to those students who do not have access to one of the regularly established schools. School buildings and maintenance and teachers' salaries are financed from municipal revenues, supplemented by government grants. Several private and denominational schools also provide courses up to university level. They follow in general a government-approved curriculum to qualify students for departmental (government) examinations and high school graduation certificates. Vocational training schools are located in several larger communities and in the mid-1960s graduated about 30,000 students annually. In 1963 a new Universities Act revised the status of the University of British Columbia at Vancouver (incorporated 1908) and created the universities of Victoria and Simon Fraser (the latter in the Vancouver area). Victoria College had been established in 1903 and was affiliated first with McGill University (until 1915) then with the University of British Columbia (until 1963). Notre Dame, a private university at Nelson, was constituted by special act. Several regional or district colleges were also established to increase the availability of higher education.

Aside from municipally owned libraries and local museums there is the Provincial Library and Archives in Victoria containing a valuable collection of Pacific northwest literature. A provincial museum includes an interesting collection of Indian artifacts. The Provincial Library Development Commission operates three branch libraries, offers mail service to individuals in areas with no municipal or regional public library, and dispatches boxes of books to outlying settlements.

THE ECONOMY

Industries.—*Forestry.*—Among the primary, or extractive, industries, logging holds first place, with a net value of about $300,000,000. The chief species cut are Douglas fir, western hemlock, spruce, western red cedar, and balsam (*Abies amabilis*). Until 1967 Douglas fir was most important both in volume cut and in commercial value. Total annual cut is approximately 1,600,000,000 cu.ft., representing nearly half of the total timber cut in Canada. Although output from interior forests has been increasing, the coast continues to supply most of the annual cut, with the Vancouver forest district (Vancouver Island and adjacent mainland coast) contributing the greatest share of the coastal cut. After 1947 a sustained-yield program was initiated to regulate the timber harvest.

Mining.—Mining has traditionally held second place among the extractive industries, with a net value of over $225,000,000 annually and employing 10,000 workers in the late 1960s. Discoveries of coal and placer gold led to early development of the province. Gold (lode) continued to be mined, chiefly in the Bridge River area, but in value of production it had long been exceeded by the base metals. British Columbia is endowed with a variety of metallic and nonmetallic minerals of which copper, petroleum, zinc, lead, and molybdenum accounted for over 60% of the total value of production in the late 1960s. Natural gas, sand and gravel, asbestos, and cement are also important.

BRITISH COLUMBIA GOVERNMENT PHOTOGRAPH

A LAKESIDE CATTLE RANCH LOCATED 30 MILES EAST OF MERRITT

In the 1960s, mining in British Columbia experienced a dramatic upsurge related partly to international market conditions as a reflection of industrial demand, and particularly to the availability of large blocks of investment capital and to the successful negotiation of very substantial contracts with Japanese industrial interests. Mining expanded from a stage where only small-scale operations were possible, exploiting high-grade ores, to one in which large-scale operations dominated, allowing development of lower-grade ore bodies. Application of strip-mining techniques to extensive copper, iron-ore, and molybdenum deposits and concurrent development of concentrators and transport facilities signified this changing pattern. The Wesfrob iron-copper deposit on the Queen Charlotte Islands, brought into production in 1967, became British Columbia's largest iron mine, and the Granduc mine near Stewart, still being developed in the late 1960s, holds one of the largest copper deposits known in Canada. Large-scale production of molybdenum began in 1965 making it the fifth ranking mineral (by value) in British Columbia.

Substantial reserves of natural gas were proved and petroleum was discovered in northeastern British Columbia. In 1957 a pipeline was completed to bring natural gas from the Peace River area to the Vancouver area and the adjacent United States. Alberta petroleum is brought to the same region by a pipeline completed in 1953. A pipeline to carry petroleum from the Peace River area to Kamloops, where it joins the line from Alberta, was constructed in 1961.

As a result of the introduction of the selective flotation process for separating complex silver-lead-zinc ores, the Sullivan mine at Kimberley (Kootenay area) developed as the largest lead-zinc mine in Canada. Completion of coal contracts with U.S. (Kaiser) and Japanese interests led to a resurgence in the production of coking grade coal at the Crowsnest Pass coalfields.

Agriculture.—Agriculture ranks third among the primary industries; annual farm cash receipts reached $200,000,000 in the late 1960s. Only 5% of the provincial area is classified as agricultural (including open range); arable land amounts to 6,500,000 ac., about 20% of which is actually under cultivation. Because of the dry summer climate, supplementary irrigation is commonly practised on Vancouver Island and in the lower Fraser Valley. In the dry valleys of the southern interior where water is a necessity for cultivated crops, particularly the Okanagan, Thompson, middle Fraser, and Kootenay valleys, more than 200,000 ac. were under irrigation.

In spite of the limited crop acreage, British Columbia's diversity of climate, soils, and terrain conditions made possible a diversity of farm types, ranging from horticultural specialty to livestock ranching. The lower Fraser Valley, including the Fraser River delta, contains the heart of British Columbian agriculture. Nearly half the total annual value of agricultural production comes from this area of diverse enterprises. The Okanagan Valley is next in importance, contributing about 17%, followed by Vancouver Island with about 10%. Each of the other agricultural areas accounts for 7% or less.

The livestock industry constitutes the most valuable phase of agriculture in British Columbia. Dairying, the most important single element, accounts for nearly half the livestock income. Poultry follows, contributing about one-third of the livestock value. Both of these enterprises are concentrated in the lower Fraser Valley and on Vancouver Island. Beef production, on the other hand, is mainly associated with the open grasslands and non-irrigated benchlands of the central and southern interior.

Nearly 90% of the cultivated acreage is devoted to field crops (hay and pasture, small grains and forage seed) the value of which is largely reflected in returns to the livestock industry; horticulture (growing of fruit and vegetables) occupies the remaining 10%.

In crop production, the lower Fraser Valley and Okanagan Valley, Peace River area, and Vancouver Island account for about 70% of the provincial crop value. Most of the cereal grains are grown in the Peace River area while about 85% of the tree fruits (apples, peaches, pears, and apricots) and grapes come from the Okanagan Valley. Because of the long frostless season and mild winters, specialty horticulture in the lower Fraser Valley and on Vancouver Island takes the form of small fruits (strawberries, raspberries, and loganberries), market vegetables, greenhouse horticulture, nursery stock, and flower production.

BRITISH COLUMBIA GOVERNMENT PHOTOGRAPH

HYDROELECTRIC POWER STATION ON THE KOOTENAY RIVER

Fisheries.—Fisheries follow agriculture in order of economic importance, accounting for a landed value of about $50,000,000 a year and employing an average of about 10,000 workers. In contrast to the fisheries of eastern Canada, over two-thirds of the value of British Columbia's fisheries comes from the five species of Pacific salmon—sockeye, pink, chum, coho, and spring. They are easily taken by nets and by trolling when they congregate in coastal waters during the annual spawning run. Gill nets are commonly used in the larger estuaries and at river mouths. Purse seine operations involve more expensive equipment and are usually carried on farther afield than is the case with gill-netting. The salmon catch taken by trollers is almost entirely limited to spring (king, Chinook or tyee) and coho (silver or blueback), since these are the species that most readily take an artificial lure. For the same reason and because of their spectacular fighting qualities when hooked spring and coho form the basis of the saltwater sport fishery in British Columbia. Because of their vulnerability during the spawning run, commercial salmon fishing is carefully regulated by an international (Canada-U.S.) commission. About three-fourths of the catch is canned, largely for export. Herring and halibut follow salmon in economic importance, the distribution of the latter being closely related to shallower areas along the narrow continental shelf. The halibut catch, like that of salmon, is regulated by an international commission.

Furs.—Trapping, historically significant, is the least important of the extractive industries. In the second half of the 20th century it accounted for a net value of less than $1,000,000 annually. Since 1926 the industry has been regulated by a registered trapline system, thus ensuring maintenance of the fur resource. Most of the traplines are in the north, about half of them owned by native Indians. The production of fur farms, however, has been increasing, reaching in the 1960s about $5,000,000 a year.

Hydroelectric Power.—The generation of hydroelectric energy may be grouped among the primary industries. British Columbia is well-endowed with waterpower resources, having an undeveloped estimated potential of 24,000,000 kw. (37,000,000 kw. at 65% load factor). The larger streams are snow-fed and, though inclined to be "flashy," have considerable flows and gradients and offer numerous sites for hydroelectric development. The largest drainage basin lying within the province is that of the Fraser River, embracing an area larger than Great Britain. It contains large waterpower potentials but their development hinges largely on a satisfactory solution to the problem of developing power installations without destroying the salmon, because the Fraser is also British Columbia's most important salmon-spawning stream. Most of the developed power in the province came from hydroelectric installations with a total capacity of more than 3,970,000 kw. in the late 1960s; the capacity of thermoelectric installations was 1,000,000 kw. The largest single hydroelectric development before 1960 was that at Kemano, built to supply the large aluminum refinery at nearby Kitimat (70 mi. SE of Prince Rupert). This development, with an ultimate capacity of over 2,000,000 hp., diverts the impounded waters of the upper Nechako system via a 10-mi. tunnel through the Coast Mountains and drops it to the powerhouse at tidewater. Other large installations are at Campbell River on Vancouver Island, in the Bridge River area near Lillooet, and on the Kootenay and Pend Oreille rivers near Trail. About half of British Columbia's hydropower is generated by private industry and 75% of all electric energy produced is consumed in industry.

The British Columbia Electric Company Limited was amalgamated with the British Columbia Power Commission to form the British Columbia Hydro and Power Authority, under legislation enacted in 1962 and the Power Measures Act of 1964. Its biggest project in the 1960s was the Portage Mountain development on the Peace River. The 625-ft.-high, $1\frac{1}{4}$-mi.-long dam (Bennett Dam) was completed in September 1967 and holds a reservoir 240 mi. long covering an area of 680 sq.mi. (1,761 sq.km.). The ultimate capacity planned for this installation was 2,300,000 kw. A treaty signed with the United States in 1964 provides for cooperative development of the Columbia River (*q.v.*) with storage projects in British Columbia, for increased flood control and power generation downstream in Washington, and for British Columbia to receive payment for these benefits. The treaty involves three dams—Duncan Lake Dam (north of Kootenay Lake) with a crest height of 120 ft. and impounding a reservoir with 1,500,000 ac-ft. of live storage, completed in 1967; Arrow Lakes Dam (near Castlegar) with a crest height of 190 ft., reservoir length of 145 mi. and live storage capacity of over 7,000,000 ac-ft., to be completed in December 1968; and Mica Creek Dam (90 mi. upstream from Revelstoke) 645 ft. high and impounding a reservoir over 85 mi. long with 12,000,000 ac-ft. of live storage. Due for completion in 1973, Mica Dam may include a large power plant.

Manufacturing.—Industrially, British Columbia is a producer of raw and semiprocessed goods which are mainly exported to foreign markets, principally in the United States, United Kingdom, and Japan. The processing of wood, mineral, fish, and agricultural products, based on provincial resources, constitutes the bulk of manufacturing activity.

BRITISH LUMBIA GOVERNMENT PHOTOGRAPH

WELDING GAS PIPELINES IN THE PEACE RIVER COUNTRY

Forest Products.—About two-thirds the net value of all manufacturing is supplied by the forest-based industries which contributed an annual net value of approximately one billion dollars in the late 1960s. Sawmilling uses about three-fourths of the annual cut and accounts for two-thirds of the Canadian lumber output. Most of the mills are scattered through the interior, but the largest, capable of turning out over 300,000 bd-ft. in an eight-hour day, are located on the coast, on Vancouver Island, and the southwestern mainland. Logs are transported by tug-towed rafts, log-carrying barges, and trucks to feed these large mills. Former waste products of logging and sawmilling are utilized in the second major forest industry, pulp and paper milling, which has seen tremendous expansion after World War II. Pulp and paper mills are concentrated on the coast but in recent years the interior has seen rapid expansion. Output is mainly in the form of sulfate pulp and newsprint. British Columbia supplies about 20% of the Canadian newsprint export and about 30% of the wood pulp export. Veneer and plywood mills utilize only 8% of the annual log cut but account for 80% of the Canadian production, primarily Douglas fir plywood.

Mineral Refining and Processing.—Mineral refining and processing ranks next in economic importance to the forest-based manufacturing industries. Most important is the smelting of nonferrous metals which is carried on at two very large plants in Trail and Kitimat. The former produces the major share of Canada's lead and zinc along with many valuable by-products. Although foreign ores are smelted, most of the raw material is supplied by the Sullivan mine at Kimberley. Large blocks of power are required and are supplied by company-owned plants on the Kootenay and Pend Oreille rivers. The Kitimat plant, which depends upon alumina imports, principally from Jamaica, is at the head of Douglas Channel. Its location is governed by tidewater access and availability of large quantities of cheap electric power, supplied by the company's installation at Kemano. Annual capacity of the Kitimat smelter is about 220,000 tons of aluminum ingots.

Agricultural and Fish Products.—Processed agricultural products and fish products are other important manufactures. A large share of the raw materials for the former are imported (*e.g.*, grains and beef animals from the prairie provinces, sugar from overseas), but fish processing utilizes local resources. Until 1940 fish canning and reduction plants were widely distributed along the coast. Since then, with the development of more efficient transport and integrated operations, there has been a trend toward concentration in the Vancouver and Prince Rupert areas. Fish processing accounted for a market value of about $100,000,000 a year in the 1960s.

BY COURTESY OF THE GOVERNMENT OF CANADA FISHERIES

MODERN DRUM SEINER OPERATING IN FITZ HUGH SOUND

Transportation and Communication.—*Railways.*—The railway system has three components—the privately owned Canadian Pacific (CPR), the federally owned Canadian National (CNR), and the provincially owned Pacific Great Eastern (PGER) railways. The CPR main line enters the province via Kicking Horse Pass and crosses the Selkirk and Monashee mountains to Fraser River drainage, which it follows to Vancouver. The CPR Kettle Valley line follows a devious route from the Crowsnest Pass near Fernie to Spences Bridge where it joins the main line, and serves the southern valleys and "boundary country" of British Columbia. The CNR main line crosses the Rockies via Yellowhead Pass, well to the northward of the CPR line. At Tête Jaune Cache, in the Rocky Mountain trench, a northern branch line extends westward to Prince Rupert with a link south to Kitimat. The main line follows the North Thompson to Kamloops whence, like its CPR counterpart, it parallels the Thompson and Fraser rivers to the sea. Short branch lines of both the CP and CN railways extend along Vancouver Island's east coastal plain, northward from Victoria. The PGER line follows a historic route from Vancouver through the Coast Mountains, emerging at Lillooet. From there it extends northward to Prince George and Fort St. John and Dawson Creek in the Peace River country. The link between Prince George and the Peace River area, where it connects with the Northern Alberta Railways, was completed in 1958, that to Mackenzie in 1966, and the link to Fort St. James in 1967.

Highways.—The highway pattern, although less strongly valley oriented, is similar to that of the railroads. In many sections following historic routes, the road system includes eight major highways—the Island Highway, along the east coastal plain of Vancouver Island; the Trans-Canada Highway, extending from Vancouver to Hope, Kamloops, and Revelstoke, to Golden, and on to Calgary, Alta.; the southern transprovincial highway, following a circuitous route between Hope and Crowsnest Pass, and with northward links to the Trans-Canada Highway; the Cariboo Highway extending from Vancouver to Prince George; the northern transprovincial highway extending westward from Prince George to Prince Rupert; the John Hart Highway leading northward from Prince George and crossing the Rockies to the Peace River country; the Kamloops-Jasper (Alta.) Highway extending northward from Kamloops along the North Thompson River; and the Alaska Highway, winding across northern British Columbia from Dawson Creek to the Yukon and terminating at Fairbanks, Alaska.

Air.—Air transport in British Columbia saw remarkable development after World War II. Vancouver's international airport is the western hub of Canada's international air transport and contains major maintenance shops and head offices for Canadian Pacific and Pacific Western airlines. Vancouver is the focus of all air traffic in the province, multiple daily flights connecting that city with Victoria, with the United States, and with points in eastern Canada. Daily flights serve Penticton, Kelowna, Nelson, Castlegar, and Cranbrook in the south; Kamloops, Williams Lake, Quesnel, Prince George, Fort St. John, and Fort Nelson to the north; and the Smithers-Terrace-Kitimat area, Queen Charlotte Islands, and western Vancouver Island. International service originating in Vancouver includes flights to the United States, Europe, the West Indies, Japan, Hawaii, Fiji, and Australia, as well as to Central and South America. The stately Canadian Pacific "Empress" ocean liners which, until World War II, connected Vancouver and Victoria with the Orient and Australia have been replaced by less luxurious but vastly speedier aircraft. Apart from scheduled air services, a large number of charter operations link the more isolated logging and fishing camps with the Victoria-Vancouver area.

Water.—The same terrain characteristics which make land travel difficult enhance the possibilities of water transport. Aside from the Strait of Georgia area, most coastal points are accessible only by boat or, in good weather, by air. The deeply fjorded coastline and intersecting channels provide a sheltered, natural waterway most important in exploiting the abundant resources of sea and forest. Ferry services with multiple daily sailings link Vancouver Island with the mainland; less frequent sailings serve communities northward to Prince Rupert, with interconnection to Alaskan ports. Fine, ice-free natural harbours exist, capable of holding the largest ships, and these figure prominently in the export of British Columbia's products. Over 70% of British Columbia's exports are shipped by sea; international waterborne shipping was about 25,000,000 tons in the late 1960s. The development of bulk cargo-handling facilities in Vancouver has helped to make it Canada's major port in tonnage of cargo shipped. Three foreign markets, the United States, the United Kingdom, and Japan, take more than 80% of British Columbia's exports. Two of these, the United States and Japan, supply three-fourths of the imports.

Tourism and Recreation.—Recreational opportunities abound in British Columbia and tourism is one of its fastest-growing industries. In the mid-1960s an estimated 7,000,000 visitors, half of them from the U.S., spent over $250,000,000 annually in the province. The rapid growth was largely related to the rise in motor vehicle travel and an expanded transport network containing 6,500 mi. of paved highways. The opening of the Rogers Pass section of the Trans-Canada Highway in 1962 led to a marked increase in interprovincial travel, while car-ferry service between northern Vancouver Island and Prince Rupert, begun in 1966, improved tourist access along the coast. Over 6,000,000 visits annually were made to provincial parks in the mid-1960s, about one-quarter of them by campers.

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BRITISH COMMONWEALTH: *see* COMMONWEALTH OF NATIONS.

BRITISH COMMONWEALTH GAMES, a well-established quadrennial series currently embracing the sports of athletics (track and field), badminton, fencing, shooting, and swimming for both men and women; and boxing, cycling, weight lifting, and wrestling for men only. Participants must be amateurs and be qualified by birth or residence in some member country (or a dependency of a member country) of the Commonwealth of Nations.

The idea of such games was first mooted in 1891 by Astley Cooper (1866–94) of Yorkshire, Eng. The series, then known as the British Empire Games, was inaugurated at Hamilton, Ont., in 1930. Eleven countries sent teams for a program of athletics, lawn bowls, boxing, rowing, swimming, and wrestling. At that highly successful first celebration the English team emerged with the largest share of the medals. It was agreed that such games would be held at four-year intervals, preferably midway between Olympic celebrations. The second games were held in 1934 in London and centred on the White City stadium. Women's events, limited to swimming at Hamilton, were added to the athlētics program. Again England won the major share of the gold medals with ten men's and six women's victories in athletics alone. Cycling was added and rowing temporarily dropped from the program. At Sydney, Austr., in 1938 the standards of performance again leapt forward. In only 6 out of the 28 events did the previous games record survive, and one of these was equaled.

The IVth British empire games could not be held until 1950. The enthusiasm at Auckland, N.Z., was unprecedented. The total attendance over seven days was more than 300,000 and the gate receipts approached £90,000. Fencing and weight lifting were added to the program. As in 1938 a feature of the games was the startling superiority of Australia's women athletes, notably M. Jackson, who twice equaled world sprint records.

In 1954 the games returned to Canada, this time held at Vancouver. The highlight was the first double sub-4-min. mile, in which R. G. Bannister (England) beat the world record holder J. M. Landy (Australia) in 3 min. 58.8 sec. The VIth games were organized at Cardiff, Wales, in 1958, with 35 countries and 1,358 competitors taking part. Nine world records were set: Australia four, England three, South Africa and Singapore one each.

In 1962 the Games returned to Australia after 24 years. At Perth the host country won 38 titles to England's 29. P. G. Snell (N.Z.) carried off both the half and one mile. Thirty-five countries with a total of 1,041 competitors took part. The VIIIth Games were staged at Kingston, Jamaica, in August 1966. Badminton and shooting replaced lawn bowls and rowing. England won most gold medals for the fifth time. Many world swimming records were set, while the dominant individual athlete was K. E. Keino (Kenya) who set Games records for both the 1-mi. (3 min. 55.3 sec.) and 3-mi. (12 min. 57.4 sec.) runs.

See H. M. Abrahams (ed.), *Empire Games Book* (1958); N. D. and A. R. McWhirter, *Guinness Book of British Empire and Commonwealth Games Records* (1966). (N. D. McW.)

BRITISH DRAMA LEAGUE, an organization created in 1919 for the encouragement of the art of the theatre, both for its own sake and as a means of intelligent recreation among all classes of the community. Its founder, Geoffrey Whitworth, was its first secretary and later became its first director and chairman of the council. From its inception its work has been mainly among amateur groups, helping them by advice, information, tuition, and the loan of books to improve their standards of production. Most groups borrow acting copies of every play they perform from the league. Its success would not have been possible without its library, started with a gift of books from Annie E. F. Horniman and now one of the principal theatrical collections of the world, containing more than 200,000 books. The journal *Drama* was founded in July 1919. However, it was always the intention of its founder that the league's activities should not be limited to amateurs, and it has urged the following matters on successive governments: the establishment of a national theatre policy adequate to the needs of the people; the establishment of drama departments at the universities; a place for drama in the school curriculum; and the abolition of entertainment duty in respect of live entertainment. The league also organizes an annual one-act play competition and sends officials to judge at local drama festivals.

The main outlines of the league's work are established through annual conferences, of which the first was held at Stratford-upon-Avon, Warwickshire, in 1919, and the annual national festivals of community drama, first organized in 1927. A conference for professional producers was arranged by the league in London in 1960.

The membership of the league, which had its headquarters in London, in the late 1960s was about 5,500. One-third of these were individuals and the rest organizations, including amateur societies, professional repertory companies, the British Broadcasting Corporation, and Independent Television Authority.

See *Twenty-Five Years of the British Drama League, MCMXIX–MCMXLIV* (1944). (I. K. F.)

BRITISH EAST AFRICA, the name given to Uganda, Kenya, Tanganyika (German before World War I), and Zanzibar before their independence in the early 1960s. *See* UGANDA; KENYA; TANZANIA, UNITED REPUBLIC OF. *See* also EAST AFRICA; EAST AFRICAN COMMUNITY.

BRITISH EMPIRE: *see* COMMONWEALTH OF NATIONS.

BRITISH GUIANA: *see* GUYANA.

BRITISH HONDURAS, a British crown colony in Central America, formerly called Belize or Balize, and known as Belice by most Central American countries. Its area is 8,866 sq.mi. Mexico lies northwest, Guatemala west and south, and the Caribbean sea is to the east; the capital is Belmopan.

Physical Geography.—The southern half of the country is a dissected plateau fringed by a narrow coastal plain; the northern half is undulating and low-lying. The southern plateau widens and declines toward the west, ending in the north in a precipitous broken escarpment. The highest measured peak (Victoria peak, 3,680 ft.) rises close to the irregular seaward edge of the plateau and crowns the Cockscomb range. The Cockscombs are isolated from the main watershed which follows the Maya mountains crestline in the southeast and the escarpment in the north.

About half of British Honduras is less than 200 ft. above sea level. This includes the northern lowlands drained by the navigable Belize river and by the New and Hondo rivers flowing into Chetumal bay. South of Belize the coastal lowlands skirting the highlands are crossed by short river valleys. The sea is very shallow inshore and ocean-going vessels anchor one to two miles from land. A submarine escarpment supports a barrier reef running the length of the coast about 15 mi. offshore.

Climate.—The climate of British Honduras is subtropical with a well-marked dry season. The mean temperature at Belize is 74° F. in December and 83° F. in July. Mean annual rainfall increases sharply from Corozal (52 in.) on the northern frontier to Barranco (180 in.) on the southern frontier. At Belize it is 70 in. but year-to-year variations are everywhere large. The dry season lasts from February to April, the wet season from June to October. Trade winds blow onshore most of the year but from October to December northers bring cooler, drier air. Belize was devastated by hurricanes in 1931 and 1961 and Corozal suffered the same fate in 1955.

Vegetation and Animal Life.—Seasonal broadleaf forest covers about 90% of the country. On the limestone soils of the north the forest is deciduous; sapote (*Achras zapota*) and mahogany (caoba; *Swietenia macrophylla*) are locally dominant. In the south the forest is taller and evergreen. On the lime-poor soils of the plateau mahogany is rare and Santa Maria (*Calophyllum brasiliense*) is the most important timber tree. The rivers are largely bordered by swamp forests. The Mountain Pine ridge carries oak and pine (*Pinus caribaea*). Grass savannas with scattered oaks, pines or palmetto palms (*Paurotis wrightii*) are characteristic of the coast south and inland of Belize. Mangroves fringe the coast.

British Honduras has a representative selection of Central American birds and mammals. Several genera of turtles and tortoises exist; the manatee is common; and reptiles are abundant.

Population.—The population at the 1960 census was 90,121; in 1946 it had been 59,220. In 1958 the birthrate was 46.8 and the death rate 9.3 per thousand. In 1960 over one-third of the people (32,690) lived in the former capital and chief port, Belize. Other towns, all small, are the new capital, Belmopan, Stann Creek, Corozal, El Cayo, Orange Walk, Punta Gorda and Benque Viejo. The highlands are virtually uninhabited.

The population is racially very mixed and derives almost wholly from immigrant stock. Negroes predominate in the coastal areas and American Indians are more numerous inland. One-third of the population is Negro Creole and English-speaking. About 6,000 Carib-speaking Negroes live in the southern coastal settlements. Maya Indians make up about one-sixth of the population; they speak Spanish or one of the Indian languages. Since 1957 several groups of Mennonites (*q.v.*) from northern Mexico have established themselves in the Orange Walk and Cayo districts. (D. J. F.)

History.—After the collapse of the great Maya civilization in about the 9th century A.D., the population receded from what is now British Honduras. This inhospitable and deserted coast was not invaded by the Spaniards until British logwood cutters settled on it in about 1638 and began to break Spain's valuable logwood monopoly. The Spaniards made periodic attempts by force and diplomacy to expel these competitors, culminating in a major naval attack in 1798 which was routed by the settlers and their African slaves. Living conditions created good relations between masters and slaves and abolition was readily accepted.

When, in 1847, the Indians in Yucatán rose in revolt against their white Mexican overlords, thousands of refugees sought sanctuary in the northern part of British Honduras. The territory was formally proclaimed a British colony in 1862 and was subordinated to the governor of Jamaica until 1884, when it became a separate colony.

In 1859 Guatemala and Great Britain signed a trade convention which provided that Guatemala and Great Britain would jointly build a road to benefit the trade of both countries. The proposed route ran from the Golfo Dulce (Guatemala) to Guatemala City and the cost was not expected to exceed £100,000. When, however, the joint engineers surveyed the route their estimate came to £145,465 and Guatemala undertook to seek a less costly route. Before this was found trade conditions changed and rendered the proposed road of little value to either party. Guatemala repeatedly rejected Great Britain's offer to settle its claim to British Honduras before the International Court of Justice. After the London constitutional conference, the claim was submitted to U.S. mediation in 1965 but no solution was obtained. (X.)

Administration and Social Conditions.—The first constitution for the British settlements around Belize was codified in 1765 by Adm. Sir W. Burnaby and was expressly based upon local usage and customs. It has been modified several times since.

By the new constitution adopted in 1960, British Honduras remained a crown colony administered by a governor aided by an executive council and legislative assembly. The governor was given normal reserve powers and might withhold his assent to legislation. The new constitution permitted the people of British Honduras for the first time to choose their own prime minister (the leader of the majority political party). There is universal suffrage for those over 21.

Until 1970 the capital of British Honduras was Belize. On March 20 of that year the establishment of the new capital and new city, Belmopan, was approved. Moving began on Sept. 20 and the National Assembly met there on Oct. 10.

The country is divided into six districts: Corozal, Orange Walk, Stann Creek, Toledo, Cayo and Belize; all except Belize are administered by district commissioners. The legal system is based upon the common law of England.

Primary schooling is compulsory between the ages of 6 and 14 and is often in the vernacular. Most schools are Roman Catholic and are partly government-aided. In the early 1960s there were nine secondary schools, a nondenominational technical college and two small teachers' training colleges. The Baron Bliss institute in Belize houses a library and museum. The Belize radio broadcasts in English and Spanish and there are two daily newspapers.

The Economy.—The economy of British Honduras has traditionally depended on its forests. Logwood (used in making dyes) was the most important forest product in the 17th century but was later superseded by mahogany. In the 20th century chicle gum became a major crop and other trees yielded commercial timber.

Mahogany cutting is most active in the northwest of the colony; the trees are located and felled during the wet season and hauled to the rivers during the dry season. A logging railway (the only one in the colony) runs from north of Gallon Jug to Hill Bank on the New river. Tree trunks are floated downstream to the sawmill at Belize. In the 1950s cedar from the same area and pine from the Mountain Pine ridge were exploited. The area over which sapodilla trees are bled for chicle (*q.v.*), or in the south for the inferior crown gum, coincides with the mahogany forests.

One-half of the population is engaged in agriculture. Most farmers follow the Central American pattern of shifting agriculture; only about 5% of the land is under cultivation in any five-year cycle. Farmers and their families cultivate milpas (temporary forest clearings), growing subsistence crops (maize, beans, upland rice) and a cash crop, upon which there is increasing emphasis. The cash crop varies; around Corozal sugar is important; in the Orange Walk area tobacco is cultivated; fruits and vegetables for the Belize market are grown along the northern road; cacao is grown in the Toledo and Stann Creek areas. The main crops of the Caribs are cassava, plantains and coastal coconuts. Exports of citrus fruit are mainly from the Stann Creek valley. Most of the catch from coastal fishing is consumed locally, but lobsters are exported to the United States. Industrial development is very limited. At Stann Creek there is a citrus processing plant, at Belize a sawmill and at Corozal a sugar refinery. The demand for labour is seasonal and underemployment persists.

Much of the colony remains inaccessible. All-weather roads link Belize with El Cayo, Stann Creek (the Hummingbird highway) and Corozal (and hence Yucatán), and Punta Gorda with San Antonio. A regular motor-vessel service links Belize with the southern settlements. There are scheduled flights from Belize to other parts of the colony and to adjoining countries, Jamaica and the United States. Boat services are irregular.

The economy of British Honduras was in 1959 surveyed in the Downie report, which counseled agricultural expansion and controlled immigration; industrial expansion would be fostered by the larger local market so generated. Immigration was also the keynote of the findings of the Evans commission (1948). These suggestions aroused little enthusiasm in British Honduras. The currency is the British Honduras dollar, with an exchange value of British Honduras $4.0 = £1 = U.S. $2.40.

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BRITISH INDIAN OCEAN TERRITORY, a British colony in the Indian Ocean consisting of the Chagos Archipelago (of which Diego Garcia is the largest island) and Aldabra, Farquhar, and Des Roches islands. Chagos lies about 1,200 mi. (1,900 km.) NE of Mauritius, of which it was formerly a dependency. Aldabra, Farquhar, and Des Roches, which previously formed part of the Seychelles, lie about 250 mi. (400 km.) NW, 200 mi. (320 km.) NE, and 470 mi. (760 km.) NNE of Madagascar (Malagasy Republic), respectively. The total population of the territory is about 850 (1969 est.). Most of the inhabitants work, with their families, on copra estates, in guano extraction, and in the turtle industry. Created in November 1965 to provide defense facilities for the British and U.S. governments, the territory is administered by a commissioner. (W. H. Is.)

BRITISH ISLES: *see* GREAT BRITAIN AND NORTHERN IRELAND, UNITED KINGDOM OF; ENGLAND; IRELAND, NORTHERN; IRELAND, REPUBLIC OF; SCOTLAND; WALES; CHANNEL ISLANDS; BRITAIN, etc.

BRITISH LEGION, the only ex-service organization in Great Britain whose membership is open to all ranks who have served with the armed forces of the crown, Red Cross organizations, the wartime merchant navy, and British subjects who served in Allied forces. Before 1921 there were four British organizations of ex-servicemen, namely the Comrades of the Great War, the National Association of Discharged Sailors and Soldiers, the National Federation of Discharged and Demobilized Sailors and Soldiers, and the Officers' Association. In 1920 these organizations reached agreement on the need to form one association to represent all ex-servicemen of all ranks. A constitution was drawn up. A conference of ex-servicemen held in 1921 agreed to adopt this constitution and unite the organizations under the title of the British Legion. A royal charter was granted in 1925. In the years that followed, the Legion continued to develop and grow; in the early 1970s there were nearly 4,500 branches, including 61 overseas.

The British Legion organizes the annual Poppy Appeal, the income being applied for the benefit of members of the ex-service community who are in need. Its general, as distinct from benevolent, work is financed by affiliation fees which represent a proportion of individual subscriptions received from members through the branches. These branches are grouped together in counties, which in turn are grouped in 11 areas covering England, Wales, Northern and Southern Ireland; each area elects representatives to a central National Executive Council.

The work of the British Legion is concerned with the well-being of all ex-servicemen and women whether or not they are members of the organization. Its activities are not confined to those who served in World Wars I and II but include all who have served, at any time, with the defense forces. The Legion provides monthly allowances to permanently incapacitated ex-servicemen and women and to widows of ex-servicemen. It administers residential homes for the aged and convalescent homes, and, through its Associated Industries, provides sheltered employment for disabled ex-servicemen. Assistance is given in connection with house purchase and pensions claims, and, where necessary, representations are made to government departments. In 1964 the Legion formed its own housing association. The organization is nonsectarian and nonpartisan, and is a constituent member of the British Commonwealth Ex-Services League.

See G. Wootton, *The Official History of the British Legion* (1956); *Annual Reports.* (J. R. G.; D. E. Co.)

BRITISH NORTH AMERICA ACT, the act of parliament of the United Kingdom by which in 1867 three British colonies in North America—Nova Scotia, New Brunswick and Canada—were united as "one Dominion under the name of Canada," and by which provision was made that the other colonies and territories of British North America might be admitted. The act was, furthermore, a constitution for the new union. It also divided the province of Canada into the provinces of Quebec and Ontario and provided them with constitutions.

The act conferred on the new dominion (which Canadian statesmen wished to call the "Kingdom of Canada") a constitution "similar in principle to that of the United Kingdom." The executive government was vested in the queen and her successors. These two provisions meant that Canada would have parliamentary and cabinet government. The legislature was to consist of a senate, its members appointed for life from the regions of Canada, and a house of commons elected from the provinces on the principle of representation by population. The act provided that criminal law should be federal and civil law provincial. The federal government was to appoint all senior judges, the provinces to administer the laws and maintain the courts. The act also authorized establishment of a supreme court of Canada.

The allocation of powers between the federal and provincial governments was done by s. 91 and 92 of the act. By the former, the federal legislature is given power to legislate for "the peace, order and good government of Canada" and "for greater certainty" 29 subjects of exclusive federal jurisdiction are listed. In s. 92 the provincial legislatures are given exclusive jurisdiction over 16 subjects of legislation, of which the two most important are (1) property and civil rights; and (2) education. Section 93 defined and safeguarded the educational rights held by religious minorities at the time of union. The act also gave the federal government the right to disallow any provincial act within two years of its passage. The provinces might levy direct taxation only, while the dominion might use any mode of taxation. The act thus provided for a union in which the federal government had general and overriding powers, while the provinces had particular and restricted ones.

The course of judicial interpretation in the judicial committee of the imperial privy council nevertheless transformed the character of the federal constitution under the act by greatly reducing the powers of the federal government and correspondingly increasing those of the provinces. The act provided no process of amendment. Amendments have been made by the imperial parliament at the request of the parliament of Canada.

For information on the British North America act (No. 2), 1949, *see* CANADA: *Administration and Social Conditions.*

See R. M. Dawson, *The Government of Canada* (1947); W. P. M. Kennedy, *The Constitution of Canada, 1534–1937,* 2nd ed. (1938). (W. L. Mo.)

BRITISH SOUTH AFRICA COMPANY, the name of a company formed by Cecil Rhodes (*q.v.*) and Alfred Beit and incorporated by royal charter on Oct. 29, 1889, which enabled British rule to be extended over Central Africa without increasing the responsibilities and expenses of the British government.

Rhodes's ambition was to extend British dominion from the Cape of Good Hope to Cairo. To do this, it was necessary to secure the area north of the Transvaal and west of Mozambique which might otherwise be annexed by the Transvaal, Germany, or Portugal. Since neither the British government nor that of the Cape Colony was prepared to undertake annexation, Rhodes planned a chartered company to accomplish this northward expansion. Although Lobengula, chief of the Matabele and ruler of most of the territory that later became known as Southern Rhodesia, had promised, by the Moffat Treaty of February 1888, not to make treaties with other foreign powers without British sanction, Rhodes saw that this was not a certain enough foundation for British influence and therefore sent to Lobengula three agents (C. D. Rudd, J. R. Maguire, and F. R. Thompson) who, in October 1888, negotiated the "Rudd Concession." This granted the mining rights in Lobengula's territory (rumoured to be rich in gold) in exchange for £100 a month, 1,000 rifles, and an armed steamboat on the Zambezi River. By means of this concession, having bought out rival interests, Rhodes overcame considerable opposition and secured the charter for the British South Africa Company. The company, with an initial capital of £1,000,000, was thereby empowered, for 25 years and subject to the approval of the secretary of state for the colonies, to operate concessions in and to administer the area north of British Bechuanaland (Botswana), north and west of the Transvaal, and west of the Portuguese dominions (no northern or western limits were specified).

The company's territory, proclaimed a British protectorate in 1891, was called Rhodesia in 1895. The company failed to gain control of Nyasaland (administered by the British government after 1891), but it was granted the administration of Northern Rhodesia in 1894. Thereafter, until the early 1920s, its history merged with that of the Rhodesias. The charter was renewed for ten years in 1915, but the company relinquished the administration of Southern Rhodesia to the British government on Sept. 1, 1923, and of Northern Rhodesia on April 1, 1924. In May 1924 the company declared its first dividend. It retained all mineral rights in Southern Rhodesia until 1933, and in Northern Rhodesia until 1964. It surrendered its mineral rights in Nyasaland to the Malawi government in July 1966, so that thereafter only those in Botswana remained. On April 1, 1965, the company merged with the Central Mining and Investment Corporation and the Consolidated Mines Selection Company (closely associated with the Anglo-American Corporation), to form a new holding company, Charter Consolidated Ltd. (M. F. K.)

BRITISH WEST AFRICA: *see* GHANA; NIGERIA; SIERRA LEONE; GAMBIA; CAMEROON, FEDERAL REPUBLIC OF.

BRITTANY (BRITANNY; Fr. BRETAGNE; Breton BREIZ), an ancient province and duchy of France, comprising the country known as Armorica (*q.v.*) until the influx of Celts from Britain. It consists of the northwestern peninsula of France, nearly corresponding to the modern *départements* of Finistère, Côtes-du-Nord, Morbihan, Ille-et-Vilaine and Loire-Atlantique. Its greatest length between the English channel and the Atlantic ocean is 250 km. (155 mi.); the area is 27,194 sq.km. (10,499 sq.mi.).

Brittany consists of two distinct zones, a maritime zone and an inland zone. In the centre there are two plateaus of primary ground, partly covered with *landes* (unproductive moorland); the southern plateau is continued by the Montagnes Noires, the northern dominated by the Monts d' Arrée. The only river basin of any importance is that of the Vilaine, between the two plateaus. In the 19th century the development of canals and railways drew Brittany from its isolation, and agriculture developed remarkably. Much of the *landes* was cleared and converted into excellent pasturage, and on the coast market gardening made great progress. In the fertile districts cereals are cultivated. The richest region is the coast, called *armor*. The climate is oceanic and the prevailing wind is from the west; the winters are mild; the summers

PAUL ALMASY

VIEW OF ROSCOFF, BRITTANY, ON THE ENGLISH CHANNEL, SHOWING FISHING NETS DRYING ON SEAWALL AT LOW TIDE

are cool; on the south coast winter temperatures are as high as on the Mediterranean shores. The gentle maritime climate allows the cultivation of early vegetables, whence this coast came to be known as "the golden belt." The coast is much indented, especially along the English channel; it is rocky and lined with reefs and islets. The mouths of the rivers form deep estuaries, and there are numerous fishing ports (Paimpol, Douarnenez, Concarneau, Le Croisic), military ports (Brest, Lorient) and trading ports (St. Malo, St. Nazaire, Nantes). The canning and metallurgical industries are concentrated in the ports. The Loire-Atlantique is the most active region economically.

History.—The historical evolution of Brittany has been mainly determined by its loneliness. The region has twice been a shelter for the Celts. The earliest inhabitants of whom there is a record were Celtic tribes, probably intermingled with remnants of the earlier race whose monuments are the menhirs, dolmens and cromlechs (most numerous at Carnac, Morbihan). (See *Archaeology* below.) Conquered by Julius Caesar in 56 B.C., Armorica took part in the unsuccessful rising against him in 52–51 B.C. It was only superficially romanized. After the withdrawal of the Romans in the 5th and 6th centuries A.D. there was a considerable immigration of Celts from Britain who took refuge among their continental kinsmen from the Saxon invasion. Till then, the rural population had been mostly pagan; but thenceforward for 300 years Breton history and tradition are largely occupied with records and legends of the Celtic missionaries from Britain and Ireland, who gradually converted the whole country and gave their names to towns and villages (*e.g.*, St. Malo, St. Brieuc, St. Tugdual and St. Pol-de-Léon). Celtic Brittany was divided into a number of petty lordships, upon which the Merovingians and the first Carolingians tried without great success to impose their authority.

In the 9th century a national hero, Nomenoë (*q.v.*) revolted against the tutelage of Charles the Bald and conquered Nantes and Rennes, thus giving to Brittany its definitive extension and its complex constitution of both Celtic and Frankish country. The successors of Nomenoë, nominally vassals of the king but in fact independent, rallied their people against the Norse raiders; in the 10th century Count Alan (Alain Barbe-Torte) finally drove the Norsemen away, preventing them from founding on the Loire a new Normandy analogous to that which they had founded on the Seine. Alan established his capital at Nantes, and the beginning of feudalism in Brittany may be dated at this time.

In the 10th century Conan of Rennes became paramount in Brittany, and his son Geoffrey took the title of duke. The line of Conan ended in the 12th century, after many struggles to subdue the Breton feudal lords. These struggles brought the Breton dukes into contact with their neighbours, the dukes of Normandy and the counts of Anjou, and then with the king of England. The Bretons helped William of Normandy to win the battle of Hastings; but later they had to struggle against him and his successors, who were trying at least to impose their suzerainty on Brittany if not to conquer it. In the 12th century, however, Conan IV, hard pressed by rebellious nobles, sought the help of Henry II of England and gave his daughter Constance in marriage to Henry's son, Geoffrey, who succeeded to the dukedom.

Brittany would have become a dependency of the Angevin (Plantagenet) empire if Geoffrey's heir, Arthur I (*q.v.*) had not been murdered by the English King John and if Arthur's sister, Alix, had not been given in marriage to a Capetian prince, Peter of Dreux (Pierre Mauclerc), by Philip Augustus. A line of French dukes ruled at Rennes until the death of the childless John III in 1341.

France and England again contested for Brittany on the occasion of the civil war between the partisans of two indirect heirs: John of Montfort, supported by the English, and Charles (*q.v.*) of Blois, nephew of Philip VI of France. It was in this war that the Breton hero Bertrand du Guesclin first made his military reputation and that the "Combat of the 30" took place (*see* BEAUMANOIR). The defeat and death of Charles at Auray (1364) secured the dukedom for the house of Montfort. The dukes of the Montfort dynasty (John IV, John V and Peter II) tried to secure Brittany's neutrality between France and England during the Hundred Years' War, conscious of the duchy's intermediary geographic position. The Breton navy served all the powers from Flanders to Spain; and from Nantes, where he had his castle, the duke governed Brittany as an independent country. The constable earl of Richmond, however, rendered great services to the French crown against the English before succeeding his nephew, Peter II, in the dukedom as Arthur III (*q.v.*) in 1457. He was succeeded in 1458 by another nephew of his, Francis II, who died in 1488, leaving his daughter Anne as heiress of Brittany.

Brittany was definitively joined to the crown of France through Anne's successive marriages, with Charles VIII and then to Louis XII (*see* ANNE of Brittany, queen of France). Her daughter Claude became the queen of Francis I of France, under whom the treaty of 1532 was concluded, binding Brittany to France but containing guarantees of its local liberties. Until the Revolution this provincial autonomy survived, local patriotism opposing Bourbon attempts at centralization. The mass of the people had remained unaffected by the Reformation. During the religious wars, Brittany was the scene of much fighting against the Huguenots, and there were many Spanish garrisons. Philippe Emmanuel de Lorraine, duc de Mercoeur, tried to revive the independent duchy for himself and his family in 1588, but was defeated in 1598 by Henry IV, who then restored religious peace by the Edict of Nantes. Apart from some short-lived troubles in the early years of Louis XIII's reign, the province then had a long period of peace interrupted only by an unsuccessful rising in 1675 against new taxation—"the revolt of the stamped paper." At the beginning of the French Revolution, in Nov. 1789, the movement of "federation" was born in Brittany, in reaction against the aristocratic system of the provincial *parlements;* but from 1792 to 1799 the Chouans of Brittany struggled no less than the Vendeans against the antireligious campaign of the first republic. From the end of the 19th century opinion slowly and unequally evolved toward conservative republicanism. In World War I Bretons were among France's best soldiers and sailors; Adm. Pierre Ronarc'h and the largely Breton *fusiliers marins* held a critical position with the English troops on the Yser in 1914. In World War II, Brittany was a centre of fervent resistance against the German occupation.

Characteristics and Customs.—Bretons have never lost their particular character, which combines enterprise and traditionalism. Many have distinguished themselves as seafarers (*e.g.*, Jacques Cartier, the maker of French Canada, and the naval heroes Robert Surcouf and René Duguay-Trouin), and Brittany still provides the French navy with the greater part of its crews. Though large numbers of Bretons emigrate, they generally remain faithful to their traditions. The Catholic faith is widespread in Brittany, where the sermons of two priests, Julien Maunoir (1606–83) and Louis Grignion de Montfort (1673–1716), had a great effect on the people. This faith appears particularly in the pilgrimages or *pardons* at Locronan, Josselin and Ste. Anne d'Auray. Brittany moreover has preserved its old social structure better than other provinces; in the country, families are large and respectful of paternal authority, and the rural nobility still exercises influence.

The Breton language is commonly spoken in parts of Morbihan, Finistère and Côtes-du-Nord, and from the mid-19th century there has been a considerable literary revival (*see* CELTIC LANGUAGES; BRETON LITERATURE). (MI. M.)

Archaeology.—The Lower Paleolithic cultures (Late Acheulean or Micoquian, and Mousterian) are attested by isolated finds of core tools, some of which, and some flakes, were discovered in Pleistocene deposits. Flint being scarce, most sites are found on suitable quartzite outcrops, sometimes in the form of huge factories of Mousterian or Acheulean tradition. The Upper Paleolithic cultures are known only by sporadic indications, apart from the very late Magdalenian sites south of the Loire, and an Epipaleolithic cave with a quartzite blade industry in northern Finistère, at Guiclan.

A littoral form of Mesolithic culture, of Tardenoisian type, is known from sites on the southern coast of Brittany (with the type sites at Téviec and Hoëdic). They contain domestic and ritual hearths, and important family cemeteries were found among the kitchen refuse, often in multiple burials, with tied-up skeletons sprinkled with ochre and covered by ritual hearths or stone mausoleums. Some tombs contained antlers or antler tools.

Pollen analysis has shown that the effects of Neolithic cultivation and deforestation upon the vegetation were noticeable in central Finistère some time before 3000 B.C. Though little is known about the earliest settlements, a site of the end of the Early Neolithic, or the beginning of the Middle Neolithic culture, with traces of hearths, pits and postholes, has been discovered at Guissény, on the north coast of Finistère with a radiocarbon date of before 3000 B.C. It is now submerged at high tide because of the gradual rise of the sea level and this suggests that perhaps most of the first settlements have been eaten away by the sea.

The first wave of the megalithic colonization has an essentially coastal distribution, with chamber tombs of the passage grave type. They are more numerous in the Morbihan district than elsewhere but are more or less evenly disseminated along the west and north coasts and up the channel as far as St. Brieuc bay. The prototypes, with dry-stone walled chambers covered by corbeled vaults, are more numerous in the north. That at Ile-Carn, near Ploudalmézeau, had a radiocarbon date of about 3300 B.C.; the grave goods are meagre—chiefly Western Neolithic sherds.

Later monuments with longer passages were developed, sometimes clustered together under the same cairn; from this point of view one should mention on the northern coast the huge cairn of Barnenez, Plouézoc'h, with 11 passage graves side-by-side. But as a rule the later monuments are more complicated, with side chambers or angled passages. Many passage graves, especially in the Morbihan district, possess engraved or sculptured orthostates, with symbolic or schematic figurations of implements, cattle and of the mother goddess. Generally these monuments contain accumulated grave goods, and were used at least until the end of the Late Neolithic.

A very local but very wealthy series of large mounds in the Carnac region, covering a central funerary closed chamber, sometimes with secondary cists, has given beautiful rare stone axes and great quantities of callais disk-shaped heads and pear-shaped pendants (Tumiac near Arzon, Mané-er-Hroëc'h and Mané-Lud at Locmariaquer, and St. Michel and Le Moustoir near Carnac).

A series of unchambered low long barrows, probably of northern European connections, are delimited by rows of slabs leaning outward in the monuments of the interior. In the southern coastal districts, these monuments, which may pertain to the last Middle Neolithic cultural traditions, are influenced by the local megalithic chamber-tomb architecture.

The Late Neolithic cultures cover the whole peninsula, including the interior. Standing stones, or menhirs, are very numerous and can be very large (between 6 and 10 m. high). Relics of different types of alignments of standing stones, sometimes with semicircles of stone blocks, are not restricted to the celebrated area of Morbihan, where of course the alignments in rows near Carnac, with thousands of stones, are very impressive.

The typical collective Late Neolithic megalithic tombs belong to the gallery-grave class and are widespread. They present different variations, with end or lateral entrances (these sometimes covered by a lintel stone, or preceded by a perpendicular vestibule, sometimes with a porthole slab at the separation) and with internal subdivision in two chambers in the complete monuments. The construction mound sometimes remains and there can be a duplication of the lateral orthostates. In southern Finistère a few monuments are made of mutually supported blocks, without capstones. A few gallery graves are adorned with sculptures, schematic representations of the mother goddess by pairs of breasts and engraved metallic or stone weapons (Tressé, Trégastel, Trébeurden and Commana). The grave goods of these gallery graves are often of exclusively Late Neolithic type, but in some coastal monuments there are Chalcolithic elements, such as bell-beaker ware.

The bell-beaker culture has in Brittany an important diffusion, chiefly along the coasts, but is known only as an intrusive element in the goods of the pre-existing collective tombs. The finer-decorated beakers can show at the same time comb and cord impressions. West European copper-arsenic daggers, wrist guards and rare V-perforated buttons complete the cultural assemblage. To perhaps the same culture belong numerous pieces of gold foil ornaments, chiefly from the richest Morbihan passage graves.

The Early Bronze Age in the western half of Brittany is characterized by an intrusive culture, with Wessex connections, constituting a series of about 30 huge single-grave eastern barrows. In the northern Trégorrois, the tomb may be a wooden coffin or a cist made of schist, and in other districts they can be cists or vaults with dry-stone walls and capstones. The grave goods are often truly "princely," containing daggers of copper or bronze with wooden hilts and leather sheaths, both ornamented with gold nails in the richest tombs, copper and bronze flat axes, flint ogival arrowheads of exquisite workmanship and archer's wrist guards; jet and amber spacer beads of the crescentic necklace type are also found. To the same period belong crouched single graves in stone cists, and there have been some finds of gold jewels, lunulae, wire torques, a ring disk and bronze flat axes.

The barrows of the Middle Bronze Age are smaller and usually contain dry-stone walled chambers, sunk underground and covered by a capstone, with bronze triangular daggers and biconical pots as grave goods. Their distribution covers only western Brittany, but they are very numerous in some districts. Hoards of the end of the period are also numerous, sometimes containing long swords deriving from the triangular daggers.

Late Bronze Age tombs are little known, but a series of very small barrows containing cremations may belong to that period. A dwelling site has been located at Loguivy on the northern coast. Hoards became extremely important and are numerous, with a greater variety of types of implements. The later ones include huge deposits of quadrangular socketed axes. These finds are contemporary to the Early Iron Age cultures of eastern Gaul. Numerous hoards of isolated finds of large gold jewels, torques and bracelets, also belong to the Late Bronze Age.

Only very late First Iron Age (Hallstatt period) cremation barrows were utilized, chiefly near the Morbihan. Some Hallstatt swords, daggers and *situlae* have been discovered, especially in hoards around the mouth of the Loire. Second Iron Age (La Tène period) sites and finds are more numerous, chiefly in the west. Funerary geometrical granite stelae are widely distributed; some were engraved with Celtic patterns; others were discovered *in situ*, surrounded by cremation urns in sorts of cemeteries. Other cemeteries, with inhumations, subsist in the west. Many artificial underground galleries or souterrains have been discovered, and also some coastal settlements, most of the pottery of the last centuries before the Roman conquest coming from these types of sites. This pottery can be very fine, with a lustrous graphitic slip. There are also some important hill forts (Huelgoat; Kercaradec, near Quimper; and Péran, near St. Brieuc, with vitrified double ramparts), and a distinctive series of promontory forts with multiple earthworks around the southern and western cliffs.

Each of the different Gaulish tribes, the *Redones*, the *Coriosolitae*, the *Osismi*, the *Veneti* and the *Namnetes*, had its characteristic mintage. They left traces of a social and administrative organization, and their boundaries merged into the limits of the subsequent Gallo-Roman cities. Roman civilization has left everywhere diffuse remains but few important ruins remain. The Merovingian civilization arrived at its western limit along the border of the maximum extension of the Breton language during the dark ages. The Breton invaders left almost no material traces, apart from a few Celtic bells. In the west, a peculiar type of pottery (instead of the usual Merovingian ware) bridges the archaeological gap between the late Gallo-Roman times and the middle ages. See ARCHAEOLOGY. (P.-R. G.)

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BRITTEN, (EDWARD) BENJAMIN (1913–), leading British composer of the mid-20th century, and an outstanding pianist and conductor, was born at Lowestoft, Suffolk, on Nov. 22, 1913. He showed precocious musical talent, and at the age of 12 became a pupil of Frank Bridge. From 1930 to 1933 he studied as a scholar at the Royal College of Music, London, with John Ireland (composition) and Arthur Benjamin (piano). While there he wrote a set of choral variations, *A Boy Was Born* (1933, revised 1958). He then worked as a composer for the radio, theatre, and cinema, coming into close contact with the poet W. H. Auden; but such marginal creations could not long satisfy the ambitions of a young composer who was already earning an international reputation, notably with the *Variations on a Theme of Frank Bridge*, for string orchestra (Salzburg, 1937).

In 1939 he moved to the U.S. and there wrote his first stage work, the operetta *Paul Bunyan* (New York City, 1941), for which Auden, also in the U.S., provided the libretto. A commission from the Koussevitzky Foundation led to the composition of the opera *Peter Grimes* (libretto by M. Slater after the poem by George Crabbe), completed after Britten's return to England in 1942 and first performed at Sadler's Wells, London, June 7, 1945. *Peter Grimes*, which was widely produced outside England, placed Britten in the forefront of 20th-century composers of opera. Later operas include: *The Rape of Lucretia* (1946); *Albert Herring* (1947); *Billy Budd* (1951); *Gloriana* (1953), written for the coronation of Queen Elizabeth II; *The Turn of the Screw* (1954); *A Midsummer Night's Dream* (1960); *The Litter Sweep* (1949; from *Let's Make an Opera*), in which both the audience and the cast—mostly children—join; and *The Golden Vanity* (1967), for boys' voices and piano. Music specifically designed for children to perform was always one of Britten's concerns, and boys' voices often add a fresh, raw colour to many of his choral scores. A leading role in *The Turn of the Screw* calls for a boy soprano.

In 1964, with the first performance of Britten's first church parable, *Curlew River*, his conception of musical theatre took a new direction. *Curlew River*, intended for church performance, brilliantly combined influences from two cultures and two venerable theatrical traditions, the Japanese Nō theatre and English medieval religious drama. From their fusion was born the first parable and its successors, *The Burning Fiery Furnace* (1966) and *The Prodigal Son* (1968). Certain features of this remarkable trinity were undeniably innovatory, but an important precedent had already been established in the church pageant opera, *Noye's* [Noah's] *Fludde* (1957), which made use of one of the Chester miracle plays, while the Oriental influence, prominent in the church parables, had been a concern of Britten's since his U.S. period, when he was first introduced (by Colin McPhee) to the music of Bali. This early interest was quickened into creative life by a visit to Bali in 1956, and became stylistically apparent in his three-act ballet, *The Prince of the Pagodas*, first given in London at Covent Garden in January 1957.

Britten's operas reveal a versatile dramatic gift and a prolific inventiveness. Among their many distinctive features must be singled out his vivid approach to word-setting (which, in *Herring*, encompassed a remarkable musicalization of the vernacular), his masterly treatment of the extended orchestral interlude (already pronounced in *Grimes*), and his skill in matching the particular dramatic situation with the most appropriate musical form.

All Britten's works for the musical theatre brought evidence of his persistent efforts to expand the frontiers of the convention, often beyond the confines of the opera house proper. This continual willingness to experiment, combined with his natural disinclination to adopt the manner of "grand" opera as the 19th century understood it, led to profoundly fruitful musical results. His church parables and chamber operas broke new theatrical ground in a very real sense, and Britten found new styles, forms, and sonorities to accompany his exploration of new theatrical environments. He proved that the idea of serious musical theatre could flourish in places other than the opera house.

His first chamber opera, *Lucretia*, marked the inception of the English Opera Group, with Britten as artistic director, conductor, and composer: an example of musical adventurousness and theatrical enterprise working in close harness. Out of this undertaking grew the Aldeburgh Festival, held at the Suffolk fishing town where Britten settled in 1947. The festival, despite the claims made on his time by metropolitan engagements and concert tours abroad, increasingly developed to become the centre of his creative life and musical activities. At nearby Snape was built a fully equipped concert hall, The Maltings, opened by Queen Elizabeth II in 1967.

Britten's creative talent enriched most of the principal media of music. Preeminent among his nontheatrical music are his song cycles, some with piano, some with orchestra. The most important, which established his stature as a songwriter, are: (for voice and piano) *Seven Sonnets of Michelangelo* (1940, written for the tenor Peter Pears, his lifelong friend and artistic partner); *The Holy Sonnets of John Donne* (1945); *Winter Words* (1953); *Six Hölderlin Fragments* (1958); *Songs and Proverbs of William Blake* (1965); and *The Poet's Echo* (1965); and (for voice and orchestra) *Our Hunting Fathers* (1936; text devised by Auden); *Les Illuminations* (1939); the *Serenade* (1943); and *Nocturne* (1958). His three *Canticles* (solo chamber cantatas of a type peculiar to Britten) contain some of his most personal invention.

His many choral works, among them the *Hymn to St. Cecilia* (1942; text by Auden), *Ceremony of Carols* (1942), *Rejoice in the Lamb* (1943), *St. Nicolas* (1948), *Spring Symphony* (1949), *Cantata Academica* (1960), *Cantata Misericordium* (1963), and *Voices for Today* (1965; written for the 20th anniversary of the United Nations), were crowned in 1961 by the composition of his *War Requiem*, a massive work for large-scale choral and orchestral forces, which could be said to sum up many of the major characteristics of the music of his middle period. The first performance of the *War Requiem* at Coventry Cathedral on May 30, 1962, made an unprecedented impact, and the work scored a success outside England comparable only with that of *Peter Grimes*.

Though lyric and dramatic texts were often the source of his inspiration, his instrumental works should not be overlooked. Two string quartets (1941 and 1945), a piano concerto (1938, revised 1945), a violin concerto (1939, revised 1950), the *Diversions* for piano (left hand alone) and orchestra (1940, revised 1950), and *Sinfonia da Requiem* (1940) are evidence of a confident handling of the larger instrumental forms that achieved its most substantial and assured expression in the Symphony in D for Cello and Orchestra (1963), perhaps Britten's finest instrumental composition. Written for a Russian virtuoso cellist, Mstislav Rostropovich, it sustained the long-standing tradition whereby many of Britten's works were intimately associated with the technical gifts of outstanding performers—both instrumental and vocal. He was created Companion of Honour in 1953 and awarded the Order of Merit in 1965.

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BRNO (Ger. BRÜNN), second city in population of Czechoslovakia and chief city of the south Moravian region, lies on the eastern foothills of the Moravian heights at the confluence of the Svratka and Svitava rivers, 115 mi. SE of Prague. Pop. (1961) 323,309.

The original settlement was Celtic and the modern name Brno comes from the Celtic *brynn* ("hill town"). The citadel on Spilberk Hill (288 m. or 945 ft.) can be traced back to the 10th century, and throughout the Middle Ages German traders began gradually to develop the old town (which was incorporated as a city in 1243) to the east of the hill. In the 14th century the margraves of Moravia acquired and for long kept the control of the city and neighbourhood. The old town has two squares which are focal points, the Zelny trh with its 17th-century fountain and the namesti Svobody with the Baroque St. Mary's pillar. North of the namesti Svobody are the beautiful churches of St. Thomas and St. James (the latter was for centuries known as the "German" church). In and near the Zelny trh are a whole cluster of historic buildings, the old parliament of the Moravian nobility, the Gothic cathedral, and the town hall.

The old town, dominated and protected by the castle, endured, and survived three severe sieges: in 1428 by the Hussites, in 1464 by George of Podebrad, the Bohemian leader, and in 1645 by the Swedes. Brno was also the French headquarters before the Battle of Austerlitz. The Spilberk Castle under Habsburg rule became a political prison and was famous for the confinement of the Carbonari group of Italian patriots in the 19th century and especially as the background to Silvio Pellico's noted *Le mie prigioni.* At the same time Gregor Mendel worked on his theory of heredity.

The Spilberk has been transformed since the mid-19th century into a pleasant design of gardens and ring roads surrounding the old citadel. In 1919 the remnants of the old university became the nucleus of Masaryk University. Through the 19th century, and into the 20th, the new town of manufacture and trade grew up south and east of the railway. Textiles (wool, linen, cotton) predominate traditionally, and also manufactures dependent on adjacent farming (brewing, flourmilling, sugar refining), but the range of products is large. A famous gun, the ZB (later manufactured in Enfield, Eng., as the Bren gun) was developed at Brno. Because of its nearness to the great Macocha Caverns, a few miles to the north, the city has considerable tourist traffic.

BROACH (Bharuch), an ancient city and modern district of the state of Gujarat, India. The city is on the right bank of the Narmada about 30 mi. inland, 200 mi. N. of Bombay and 45 mi. S.S.W. of Baroda. Pop. (1961) 73,639. There is a considerable cotton industry including large mills and ginneries, and a guild of cotton merchants; flour milling and various handicrafts are also carried on. The fort containing civil courts, jail, church, municipal offices, etc., stands on a hill above the river.

Broach (ancient Bhrigukaccha, Bharukaccha) was one of the most celebrated harbours in India. It is mentioned in the *Periplus of the Erythraean Sea* (*c.* A.D. 80) and in Ptolemy as Barygaza; and also occurs in the epic *Mahabharata.* In the 2nd century it was ruled by the Kshaharata satraps, and in the 7th century by the Gurjaras when it appears in the *Travels* of the Chinese pilgrim Hsüan Tsang. Incorporated into the Muslim state of Gujarat, it was annexed to the Mogul empire by Akbar in 1572. The Marathas became its masters in 1685 and held it until 1782 when it was captured by the British. After changing hands again several times it was finally ceded to the East India company in 1803. Objects of interest are a stone mosque constructed out of an older Hindu temple, and the temple of Bhrigu Rishi 10 mi. to the east.

Broach District has an area of 2,986 sq.mi. Pop. (1961) 891,969, all of whom speak Gujarati. (M. R. P.)

BROADCASTING, the transmission of radio and television programs intended for general public reception, as distinguished from private radio messages directed to specific receiving stations. In its commonest form, broadcasting may be described as the systematic diffusion of entertainment, information, educational and other features for simultaneous reception by a scattered audience, individually or in groups, with appropriate receiving apparatus. The subject matter may be either audible or visual, or a combination of both. Sound broadcasting in this sense may be said to have come into being about 1920, while television broadcasting began in 1936.

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I. BROADCASTING SYSTEMS OF THE WORLD

From 1919 onward, amateur wireless telegraph experimenters, numerous even before World War I, used telephony more and more in preference to Morse telegraphy, and in Great Britain, the United States and several European countries broadcasting began spontaneously with transmissions of phonograph records and amateur performances for the amusement of other experimenters. At the same time the radio industry began to foresee and prepare for a future of evidently great but unknown possibilities. Experimental work was undertaken for the improvement of microphones and for the development of receiving apparatus which could be operated with a minimum of technical knowledge. Stations already in existence began the transmission of a few planned and regularly scheduled programs, using amateur performers at first. Later they were able to obtain the services of professional talent, with many artists offering voluntary appearances because of the novelty of the new art. New structures were erected especially for the purpose of transmitting programs, and a demand arose for equipment capable of receiving the broadcasts. Thus, an innovation comparable in cultural importance to the introduction of printing was launched tentatively upon a responsive audience, almost before the import of the new medium was realized, and before the financial organization of broadcasting services or their relations with the theatre, the musical profession, the press or existing radio services had been settled.

Existing radio laws, which had been specifically designed to regulate the use of wireless telegraphy by the maritime industry and a few wireless experimenters, did not adequately provide for the new application of radio to program broadcasting, and confusion in the licensing of stations and assignment of wave lengths was inevitable. Despite the many obstacles, however, broadcasting flourished; between 1920 and 1924 stations were built in the major countries of the world, and by 1930 most nations had well-established systems in operation. The number of broadcasting stations in the world increased from about 600 at the end of 1925 to 1,300 in

1935, and to at least 10,000 by the early 1960s.

1. International Regulation.—Each nation regulates and controls broadcasting within its own territory. However, the radiations from a broadcasting station do not respect national boundaries, and international co-operation was an early and obvious necessity if chaotic conditions of interference between stations were to be avoided. The world-wide problem was first considered at the International Radio Telegraph convention of Washington, D.C., held in 1927, and was later given to the jurisdiction of the International Telecommunication union (ITU), with almost every nation participating. The international aspects of radio, including broadcasting, were later regulated by agreements signed at the Madrid convention of that body in 1932 and subsequently modified by conventions in Cairo, Egy. (1938), Atlantic City, N.J. (1947) and at Buenos Aires, Arg. (1952).

To resolve regional problems beyond the scope of the ITU, other international regulating bodies were organized along continental lines. Thus, the task of arranging an orderly solution of European broadcasting problems was undertaken by the International Broadcasting union, formed in April 1925 at a conference of European broadcasters meeting in the headquarters of the British Broadcasting company (BBC). The task was one of extreme difficulty, as the conflicts to be adjusted were those of perfectly legitimate interests, and the unofficial status of the union left its decisions subject to ratification or reversal by the several national governments; however, a tentative European plan was largely in operation by Nov. 1926. In 1929 the union was recognized as expert adviser to the ITU. Revised European plans for the allocation of medium and long wave lengths were agreed upon in subsequent years, principally at Lucerne, Switz., in 1933 and at Copenhagen, Den., in 1948. Attempts at world-wide short-wave planning were made at ITU conferences at Mexico City in 1949, and later at Florence, Italy (1950), and Rapallo, Italy (1950), but these attempts broke down, mainly under the impact of the beginning of the war in Korea in June 1950. With the development of television and of very-high-frequency (VHF) sound broadcasting after 1945, a conference was held at Stockholm, Swed., in 1952 to allocate channels in the European region.

Whereas the allocation of frequencies, arranged through the ITU, was a matter of agreement between governments, there were many other aspects of broadcasting which could be regulated without direct reference to their governments by the broadcasting organizations concerned. The International Broadcasting union, more commonly known as the Union Internationale de Radiodiffusion (U.I.R.), contained members representing all countries of the European zone with the exception of the U.S.S.R. The overrunning of Europe by the German army in World War II resulted in many of the members of U.I.R. coming under German control or being cut off from access, and after the war it was decided that the U.I.R. should be dissolved and a new union formed. Political difficulties soon arose over membership. The Soviet Union insisted that not only the broadcasting organizations of the Ukraine and White Russia (which were recognized by the ITU) should take part, but also those of five other Soviet republics, not members of the ITU. A number of western European organizations did not admit this claim, but nevertheless a new union called the Organisation Internationale de Radiodiffusion (O.I.R.) was formed and some western countries, including France, Belgium and the Netherlands, joined it. All the organizations which objected to the Soviet claim, except the BBC, remained members of the U.I.R.; the BBC did not join either body. Thus, there were now the Soviet-dominated O.I.R. with its headquarters in Brussels, Belg., representing the broadcasting organizations of 22 countries, and the U.I.R. with its headquarters in Geneva, Switz., and 10 members. Finally 11 western members of the O.I.R. resigned and joined with the remaining members of the U.I.R. and the BBC to form in Feb. 1950 a new European Broadcasting union (E.B.U.) with headquarters in Geneva and having as full members the broadcasting organizations of western Europe as well as those of Greece, Yugoslavia, Turkey, Lebanon, Syria, Egypt, Morocco and Tunisia. The headquarters of the O.I.R. moved to Prague, Czech.

In the American hemisphere, an agreement on the division of broadcasting channels between the United States and Canada was reached through diplomatic negotiation in 1932, and the Havana treaty of 1937 allocated broadcasting frequencies between Canada, Cuba, Mexico and the United States. The North American Regional Broadcasting Agreement conference, representing essentially the same nations, began reconsideration of the entire American situation at conferences held at Havana, Cuba, in 1947 and at Montreal, Que., in 1949. Broadcasting organizations of the American continent formed in 1946 the Asociación Interamericana de Radiodifusión (A.I.R.), which by the late 1950s represented more than 4,000 sound broadcasting and 400 television stations. Some aspects of the correlation of broadcasting in both the old world and the new were also handled by United Nations Educational, Scientific and Cultural organization (UNESCO).

By the international agreements indicated above, domestic broadcasting was assigned to two frequency bands in the radio spectrum: long-wave channels in the region from 150 to 550 kc. and medium-wave channels in the region from 550 to 1,660 kc. Short-wave international broadcasting (that is, broadcasting intended primarily for reception outside the originating country) was using various bands of frequencies in the range from 2,200 to 30,000 kc. Short-wave radio signals propagate over long distances more efficiently than do the longer waves of domestic stations, and, being amenable to concentration into narrow beams, they can be directed toward a selected country or region for maximum effectiveness.

As the congestion of the medium- and long-wave bands increased, more and more countries (particularly in Europe) found that domestic reception in these wave bands was seldom free from interference. They therefore turned with increasing emphasis to the VHF band (87.5 to 100 mc.) which had been assigned to broadcasting at the conference at Atlantic City. Because of the comparative shortness of their range, VHF transmissions provide reception which is reasonably free of interference from most distant stations and allow a greater number of stations to operate within a given area.

2. Financial Support; System Organization.—Broadcasting is an expensive enterprise, not only from the standpoint of technical facilities but also because of the large fees commanded by actors, musicians and other artists engaged. There is no revenue from the audience in the form of admission charges to offset these expenses; in order to sustain itself, broadcasting was forced in its early days to seek its own sources of financial support. Various systems of support have been evolved and in many countries are found in combination. The simplest is that in which broadcasting is financed from public funds, either in the form of a grant from general taxation or, more commonly, in the form of an annual licence fee paid for the right to operate radio-receiving apparatus. There are several ways in which broadcasting can be made self-supporting and profitable on a commercial basis. The commonest is the system of sponsorship, by which commercial interests take over the responsibility of paying for a program at a given period on a station or network. The commercial interest pays a fee which contributes to the general running of the broadcasting service and pays all the costs of the program. Advertising is included in the transmission, which is announced as being presented by the firm concerned. In another commercial system the cost of the programs is borne by the broadcasting organization or its licensee, and the necessary revenue is obtained by selling advertising time inserted in appropriate breaks in the program—a method known as "spot" advertising.

A further system makes its programs available only to those viewers or listeners who either subscribe to the service, pay by a coin-slot device for the item desired, or else pay a bill submitted retrospectively for programs actually seen or heard. Various techniques are used to prevent the program from being received by those not prepared to pay—generally by "scrambling" the transmission and making its reception possible only to those equipped with the necessary facilities.

Pure commercial broadcasting was exemplified by the United States domestic system, in which government regulation was indirect and primarily concerned with technical matters. Transmitting stations were licensed by the federal government, which has charged licensees a nominal fee since 1964; no fees were assessed for the ownership or use of receivers. Program production and transmission was continued by private individuals, corporations or other organizations, most deriving their income from paid advertising announcements. Nearly 5% of the U.S. domestic stations were noncommercial, supported by educational, religious and similar organizations. Most commercial broadcasters devoted a certain portion of their program time to unsponsored public-service broadcasts. In this category were educational programs, news, weather and market reports, forums, talks by the president of the United States, religious services, official government announcements and special events of wide public interest. Each licensee had complete freedom in programing his station, subject only to broad regulations relating to propriety, good taste and equitable rights to all sides in time allowed for controversial topics. In a corollary sense, listeners also were free to select whatever programs interested them, and each broadcaster was responsive to public acceptance of his programs in order to attract listeners.

The system originally adopted in Great Britain, on the other hand, could be considered as the prototype of absolute and direct government control of broadcasting. All phases, from programing to technical operation of transmitters, were administered by the British Broadcasting company (1922) and from 1927 by the British Broadcasting corporation, both publicly financed monopolies. Revenue was derived chiefly from an annual tax imposed upon the owner of each receiver, and no paid advertising was accepted. Like the commercial broadcasters of the United States, the BBC remained sensitive to the public reaction to its programs, and the results tended to become similar in both systems. In 1954 the British system was modified by the Television act, which set up a second public body, the Independent Television authority, whose programs were financed partly from public funds but mainly by "spot" advertisements.

The organization of broadcasting in other nations lay between the extremes of the U.S. commercial system and the British public-corporation system, with many variations and combinations of the features of both. In Canada, for example, broadcasting was controlled by the Canadian Broadcasting corporation (CBC), which paralleled the BBC in principle, but which also licensed privately owned stations to supplement its own services, and paid advertising was permitted. In general, broadcasting within the American hemisphere tended to follow the commercial pattern, while in Europe it more nearly resembled the original British system. In all systems, the interconnection of stations into chains or networks by telephone lines or short-wave radio circuits for the simultaneous broadcasting of programs was widely practised.

Europe had acquired broadcasting problems peculiar to itself, among which were the proximity to one another of small, densely populated nations, multilanguage populations within the range of a single station, poor reception conditions in some areas and economic obstacles to the widespread ownership of receivers in other regions. Broadcasts in different languages simultaneously on different stations or sequentially over the same station, and efforts toward co-operative international programs had met with some success in overcoming language barriers. The inaccessibility of broadcast reception to many people, either for economic reasons or because of poor reception conditions, had been offset by relaying programs from centralized distribution points. These might go to individual or group subscribers, and group listening in public assemblages became prevalent in some parts of Europe.

II. PROGRAMS

Radio and television programs are inclined toward one or the other of two objectives: to convey information or to provide entertainment. In the information category fall lectures, news, weather and market reports, public addresses, forum and round-table discussions, religious services, political speeches and special events such as the coronation of a king or the inauguration of a president. In some countries where broadcasting is a government monopoly, propaganda may be woven into programs of this class, either openly or surreptitiously. Elsewhere, as in the U.S., a particular effort is made to maintain a clear-cut distinction between those parts of a program that are factual and those that represent opinion and comment. Advertising announcements are similarly set off from the other portions of the program.

In the field of entertainment, broadcasting makes use of every form known to the theatrical world: from grand opera to popular music, from boxing matches to baseball and from vaudeville to drama. In addition, radio and television have developed some special forms of their own as, for instance, their serialized dramas offered in daily installments, or their panel and quiz programs.

1. Audience Attitude.—The disposition of a radio or television audience, which is composed principally of individuals in the privacy of their own homes, differs considerably from that of an audience in a theatre or lecture hall. There is none of the crowd atmosphere that prevails in a public assembly, and each listener is no more than casually aware that he is actually a part of a large audience. This engenders a sense of intimacy which causes the listener to feel a close personal association with the speaker or performer. Furthermore, people will not accept in their own homes many of the candid forms of expression which they readily condone and support on the stage or in literature; hence the broadcaster must constantly mind the decorum of his programs and avoid anything that is in bad taste according to the standards of his audience, lest he suffer the penalty of a deluge of complaints.

2. Responsibility of the Broadcaster.—Because it owes its licence to operate to the state, if indeed it is not state operated, and because of its intimate relationship to its audience, broadcasting exists in a quasi-public domain, open in all its phases to public scrutiny. It is therefore invested with a moral as well as a legal responsibility to serve the public interest and must remain more sensitive to public opinion and political sentiment than most other forms of public expression. In fulfilling this obligation, the broadcaster—even though he chooses to exclude all discussion of controversial topics from his programs—may, nevertheless, by the mere selection and combination of material induce a mass disposition toward or against certain purposes or preferences. Because a national broadcasting system has the attention of far more people at any one time than could possibly be assembled in the largest convention hall or reached by the printed page, the program builder has great power to influence the political and social thinking of a mass audience. This, coupled with the persuasive intimacy of the microphone and the television camera, makes broadcasting as potent a force for good or evil as any social influence. From the standpoint of society, then, it is important that broadcasters be governed by ideals and standards that take account of their public responsibilities.

3. Audience Influence.—For economic reasons as well as those outlined above, evaluation of audience opinion and response is important to the broadcaster. Two factors serve to indicate the reaction of the public to a program: the letters received from listeners and viewers; and a determination of the number of persons listening or watching, weighed against the total potential audience, simultaneous programs on competing stations, etc. Audience measurement presents difficult problems because there is no box office by which to determine the exact number of listeners. Mail received by the broadcast stations from listeners comes principally from persons who have the time and inclination to write letters, and cannot be regarded as wholly representative. More accurate results are obtained by telephone-sampling methods or by special recording devices attached to individual receiving sets. The latter, installed with the owner's consent, record the amount of time the set is used, when it is turned on and off, and the stations tuned in; however, they are expensive and therefore limited to small samples of the total audience. Whatever the method of rating, broadcasters are quick to alter or discontinue any program that shows lack of audience appeal, and the listeners are thus influential in determining the nature of programs offered them. In commercial broadcasting, sponsored programs are also affected by their apparent success or failure in selling the goods advertised.

4. Public Service Programs.—Certain aspects of broadcasting considered as a public service call for brief mention. These are its relations with the organized musical life of the community, its specifically educational (as distinct from its general cultural) mission, its religious role, its news functions and lastly its political functions. The advent of broadcasting arrested a decline which was beginning in the musical life of many nations because of a variety of circumstances, among them the increased costs of ordinary musical performances, the growing popularity of light, showy and ephemeral entertainment, the development of motion pictures and the dance hall, and the diminished incomes of the old leisure classes. Broadcasting did not check or alter these tendencies, but it has compensated for them by the universal diffusion of music that had been quite beyond the reach of the masses, by interpreting that music through broadcasts by critics, lecturers and journal contributors, and often by performing works that under existing conditions private promoters cannot afford to finance.

On its strictly educational side, broadcasting addresses itself to two main classes—the schools, in which listening is communal and the instruction given is amplified by the teacher on the spot, and the adult student. Opinions differ as to the relative importance of broadcasting in the two cases. In Great Britain, for example, the school side was dealt with first, adult education being a later development, the full potentialities of which can be realized only under a system of alternative programs. In Germany, on the other hand, adult education took precedence, and a special service with a station of its own was created for its purposes, while Austria provided courses of varied kinds, often of an advanced character, in its radio programs. Broadcasting has been used for keeping scattered professional men in touch with progress (*e.g.*, country doctors in Poland) and for giving primary education to children in mobile homes (*e.g.*, of Dutch bargemen) or scattered outside school range (*e.g.*, in the U.S.S.R.). A service of particular value is that of scientific instruction for agriculturists. Languages are taught by nearly all broadcasting organizations, and the BBC has been particularly successful in the teaching of English to European and overseas audiences.

The part played by broadcasting in the religious life of communities varies from country to country; there are few countries, apart from Communist countries, in which religious programs are not broadcast. In Great Britain a definite policy of broadcasting a simple form of service and addresses without sectarian bias was adopted after agreement had been obtained among the accredited representatives of the chief Christian churches as to common fundamentals. In the United States, programs devoted to the various faiths and presented in rotation were organized by a joint council of churches. Fears were felt that the ability to receive religious services at home would deplete the congregations of the churches themselves. Experience did not justify these fears, and any loss to the churches on this score was more than compensated by the spread of their influence, as well as by the value of the religious broadcasts to invalids and aged persons.

5. Programs for External Reception.—International broadcasting—that is to say, the transmission of programs by a country expressly for audiences beyond its own frontiers—dates from the earliest days of broadcasting itself. Soviet Russia began foreign-language transmissions for propaganda purposes early in the 1920s, and was followed first by fascist Italy and then by national socialist Germany. France, Great Britain and the Netherlands were next in the field among European countries, though their first use of short-wave broadcasting was aimed at French-, English- or Dutch-speaking populations overseas. Great Britain began foreign-language broadcasting early in 1938 with a program in Arabic and programs in Spanish and Portuguese directed to Latin America. Broadcasts in French, German and Italian were added at the time of the Munich crisis in Sept. 1938. By Aug. 1939 countries broadcasting in foreign languages included Albania, Bulgaria, China, France, Germany, Great Britain, Hungary, Italy, Japan, Rumania, Spain, in addition to the United States, the U.S.S.R. and Vatican City.

Between 1939 and 1945 foreign-language broadcasting developed as a means of psychological warfare, and the programs of the BBC in particular had an important effect in maintaining morale among countries under German occupation. The development of international tension after World War II led to the continuance by many countries of their foreign-language services.

III. THE PROCESS OF BROADCASTING

The actual process of broadcasting, though complicated in detail by the variety of the items broadcast and by their number, is simple enough in outline. Most of the performances take place in a studio, which is carefully arranged so as to give, for the necessarily small room, an acoustical condition that results in a pleasing sound at the receiver. This requires a certain amount of echo elimination by acoustic treatment. Speakers, singers and players address themselves to the microphone, and an expert operator in a control room, following closely the speech or music, almost continuously makes fine adjustments of the amount of electrical impulse modulating the transmitter to allow for changes of original sound volume, an operation necessitated by dynamic range limitations of the radio system. The transmitting gear proper is usually separate from the studio, and may be as far away as 80 mi. or more, connected with the studio by a special line. Another class of broadcast of importance is the picking up at the place of origin of public concerts, operas, plays and public speeches, as well as of ceremonies, sporting events, etc. This is done by portable microphone gear connected, not necessarily by wire, to the control room. The special interest of these broadcasts to the listener is that they enable him to feel himself as a participant or member of the audience. In the case of music, large-scale performances are often, for psychological as well as acoustic reasons, more successful as "outside" than as studio broadcasts; but public halls, churches, theatres, opera stages, open spaces, and so on, all present special acoustic problems which have to be solved according to the circumstances.

Of outstanding importance in the organization of broadcasting is the simultaneous broadcast, or network broadcast. This involves a system of interconnected telephone lines or radio links by which a studio or other place of performance can be connected to as many transmitters as may be desirable or possible. Network operation requires the closest timing and co-ordination over the whole system. In the United States and Canada the method is practised among groups of stations affiliated for an exchange of programs.

IV. ADMINISTRATIVE ORGANIZATION OF BROADCASTING

It has been indicated that there are two main types of organization handling public broadcasting—the commercial and competitive type and the government-managed type—and that the former tends to approximate the latter so far as its relations with the public are concerned. The same may be said, to a certain extent, of the administration and public-relations side of broadcasting. Given the immense cultural, educational, political and propagandist possibilities of the medium, it was unthinkable that governments should disinterest themselves in the programs. Accordingly there is a control, to a greater or less degree, universally imposed on broadcasting. Under a purely commercial system, this control is moderate, indirect and negative; while, at the other end of the scale, a despotic or dictatorial government will normally employ broadcasting for the propagation of its own ideas. Between these extremes lie (1) "good will" commercial broadcasting tempered by government regulation, as in the United States; (2) systems constituted as commercial companies, but subjected to the continuing supervision of a government department, and limited as to profits; (3) companies commercial in form, in which the government holds a controlling interest; and (4) organizations of the type of the British Broadcasting corporation or the Danish radio council, in which a national broadcasting authority is constituted by, but stands apart from, the ordinary machinery of the state. The success of an organization of the last type depends essentially upon the public's acceptance of its executives and its traditions, a confidence that is independent of the public's political outlook toward the government of the day.

The executive or internal organization of broadcasting is similar in all countries, but there is one important divergence of practice that should be mentioned. In some countries the engineering side of the work is wholly in the hands of the state communications authority, and the broadcasting organization is a distinct body limited to the planning and execution of programs. In others the engineer service is as much a part of the broadcasting organization as are the program and the administrative departments. That the question is not a simple one may be gauged from the fact that of the two most highly developed services in Europe the one works under the first and the other under the second system.

(J. C. W. R.; G. G. A. W.; W. F. L.)

V. UNITED STATES SYSTEM

In the United States broadcasting has been developed by private enterprise, with a minimum of government supervision. This freedom from restraint, while at times giving rise to unsatisfactory conditions, encouraged competition and was doubtless an important factor responsible for the rapid growth which took place. There is complete absence of any restriction or hindrance to the ownership and use of receiving apparatus, in that no licences are required and there are no fees to be paid. Since there is no financial support derived directly from the listeners through the payment of a fee, other and less direct sources of support came to be relied upon. Private enterprise was forced to find its own means of economic justification, and this added a further element of competitive effort to the development of the industry.

1. History of Development.—The first known radio program in the U.S. was broadcast by R. A. Fessenden from his experimental station at Brant Rock, Mass., on Christmas Eve, 1906. Two musical selections, the reading of a poem and a short talk apparently constituted the program, which was heard by ship wireless operators within a radius of several hundred miles of Brant Rock. In the experiment a water-cooled microphone was used to modulate an Alexanderson alternator, and 1 kw. of power was radiated at the frequency of 50 kc.

Other early experimental broadcasts include those of Lee De Forest, who in 1908 conducted a successful demonstration using apparatus set up in the Eiffel tower in Paris. In 1910 De Forest installed a 500-w. transmitter in the Metropolitan Opera house in New York city and broadcast a program in which Enrico Caruso took part. By 1916 David Sarnoff, who, as an engineer employed by the Marconi Wireless Telegraph Company of America, had been conducting experiments in the broadcasting of music, visualized and proposed to his company a scheme for a "radio music box" which could be manufactured and sold for home reception of musical and educational broadcasts.

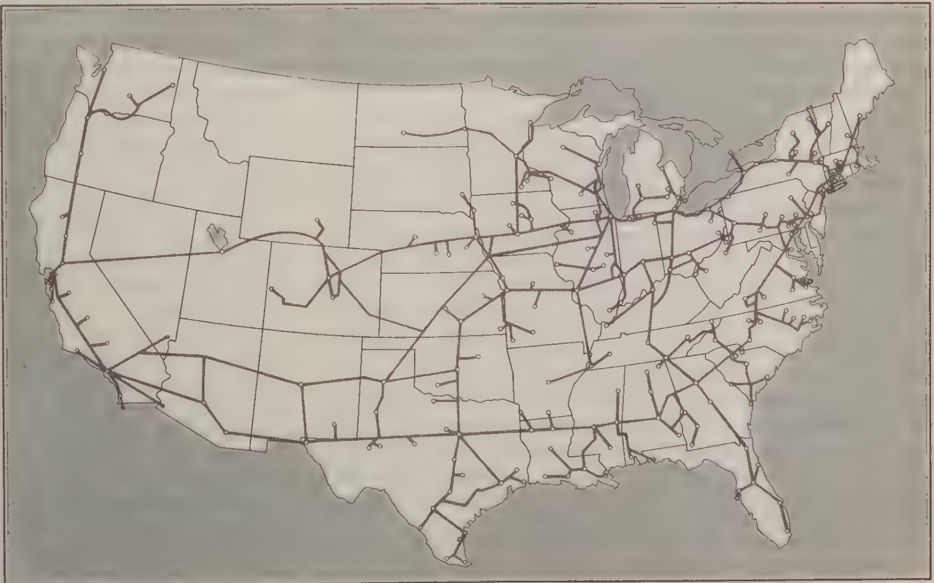
Following the relaxation of military restrictions on radio at the conclusion of World War I, many experimental radio stations started operation. The operators of these small stations—often equipped with homemade apparatus—were amateurs whose interest centred more in radio as a science than in its possibilities as a means of mass communication or mass entertainment. They played phonograph records and sometimes called upon their friends and neighbours for impromptu performances. The range of such broadcasts was but a few miles, and the receiving apparatus necessary to hear them was mostly in the hands of other experimenters who, like the broadcasters themselves, pursued radio as a hobby. With the development of commercial broadcasting, amateurs were restricted to their original sphere—that of semiprivate communication with other amateurs—and were prohibited from other broadcasting.

From this beginning, the evolution of broadcasting was rapid: many persons not directly interested in the technical aspects of radio were attracted by the novelty of listening to "music from the air." They created a demand for ready-built receivers suitable for operation by the layman. The increase in the number of listeners, in turn, justified the establishment of stations especially for the purpose of broadcasting entertainment and information. This stage of development was reached about 1920, when station KDKA at the plant of the Westinghouse Electric and Manufacturing company in East Pittsburgh, Pa., began broadcasting regularly scheduled programs, operating at 833 kc. with 50 w. of power. KDKA first went on the air in the evening of Nov. 2, 1920, with a broadcast of the returns of the Harding-Cox presidential election. This occasion was generally conceded as marking the beginning of broadcasting in its modern form. The success of the KDKA election broadcast and of the musical programs that were initiated thereafter motivated others to install similar stations, and a total of eight were operating by the end of 1921.

The popularity of these early stations made evident two possible sources of financial support to offset the operating costs of broadcasting. First, there were possibilities for profit in the manufacture and sale of receiving equipment; and second, the fame attained by the organizations operating the first broadcast stations called attention to the value of broadcasting as an advertising medium. Advertising appealed not only to manufacturers of radio apparatus but to businessmen in general, and in the course of time it became the principal means of support for the U.S. system of broadcasting.

During the period 1921–22 the sale of radio receiving sets and of component parts for use in home construction of sets began a boom which was followed immediately by a large increase in transmitting stations. By Nov. 1, 1922, 564 broadcast stations had been licensed to operate.

Station WEAF was established in New York in Aug. 1922 by the American Telephone and Telegraph company for the purpose of offering broadcasting facilities on a time rental basis to all who wished to broadcast. By this time the radio channels had become so crowded by stations that it was difficult for any more to find adequate places. Also there were many interests which desired to broadcast their own special programs but did not wish to go into the project so deeply as to invest in station equipment. Sponsored program broadcasting, as instituted in this way, was clearly based on advertising value, and the definite undisguised use of radio



BY COURTESY OF AMERICAN TELEPHONE AND TELEGRAPH CO.

FIG. 1.—TYPICAL TELEVISION BROADCASTING NETWORK ROUTE SYSTEM

Actual route layouts vary for different networks and programs broadcasting for advertising purposes was started.

2. Interconnection of Stations.—The first use of wire telephone lines in 1922 for interconnecting a station in New York city and a station in Chicago, Ill., to broadcast simultaneously a description of a football game introduced a new idea into radio broadcasting. The use of a long-distance telephone line to bring programs of special interest into the field of local reception simultaneously at a number of places was of evident value in broadcasting features of national appeal. It was of both economic and cultural importance. Performances by leading artists at a centrally located station studio could be sent out to other stations. Smaller stations could afford to offer programs, obtained by wire, of much greater excellence than those they could produce for themselves. A regular interchange of programs by wire was initiated between WEAF in New York city and WCAP in Washington, D.C., and subsequently other stations were added to the chain. For special features of national importance large groups of stations were temporarily interconnected.

In 1926 the National Broadcasting company (NBC) purchased WEAF and with it as the key station established a permanent network of radio stations, for which it undertook to originate and distribute regular daily programs. Some of these were sponsored by advertisers and furnished revenue to both the network and its associated stations; others were sustaining, with part of the time being set aside for public-service features.

About 20 years later, when television stations had been established in various cities, their interconnection into networks followed the pattern set by radio (*see* fig. 1), the intercity facilities being leased from the American Telephone and Telegraph company. After earlier experiments, the latter provided a coaxial cable for a telecast of the 1945 Army-Navy football game by several eastern stations. In 1948 the first commercial television network service was offered, employing coaxial cable between New York and Washington, D.C., and microwave relays from New York to Boston, Mass. The telephone company then began laying cables westward, and early in 1949 Chicago and St. Louis, Mo., were joined with the eastern cities. In the meantime, development of microwave relays had shown them to possess advantages over the coaxial cable, and thus relay towers were used in extending the network westward to the Pacific coast. A coast-to-coast circuit was completed in 1951 and was inaugurated with a telecast of the Japanese peace proceedings from San Francisco, Calif., on Sept. 4.

3. Short-Wave Broadcasting.—Shortly after broadcasting became established on the wave lengths around 300 to 400 m. it was discovered that much shorter wave lengths, in the range from 15 to 50 or 60 m., could be received over long distances. The use of these waves was developed not only for intercontinental radio telegraph and telephone services but also for the broadcasting of programs directly to other countries or for the exchange of programs between national networks by radio relay using short waves.

Prior to World War II some of the larger U.S. broadcasting stations operated experimental international short-wave transmitters of their own. During the war, the United States government leased these and contracted for the installation of others, all of which were supplied with programs under the supervision of government agencies. Some of these programs were for the entertainment of the U.S. armed forces scattered throughout the world; others were part of the psychological warfare and were directed to the peoples of neutral, Allied and Axis nations. Conversely, U.S. listeners were able to tune in directly the short-wave broadcasts of other countries, including those with which they were at war. At the conclusion of the war, there was no incentive for private broadcasters to resume international transmissions. Consequently, the international stations continued to be operated by private concerns under contract with the government, and their programs were originated under the title "Voice of America" through the U.S. Information agency (USIA).

4. FM Broadcasting.—Frequency modulation (FM) is merely a different method of applying modulation to the radio-frequency carrier of a broadcasting station, in contrast to the amplitude type of modulation (AM) that is used by standard stations. (See *Technical Aspects,* below.) With the development of the technique of radio transmission at the very high frequencies (VHF), FM was applied—notably by E. H. Armstrong in 1936—as a means of reducing interference. The service range for reliable reception of VHF signals is limited approximately to the horizon as seen from the transmitting antenna (practically, about 50 to 100 mi.). Thus, it is possible to duplicate frequency assignments to FM stations within a few hundred miles of each other without causing interference between stations. This was not an unwelcome situation from the viewpoint of the Federal Communications commission (FCC), which is charged by law with the responsibility for licensing and regulating broadcasting stations. The commission and its predecessor always had been beset with the problem of trying to accommodate more applicants for stations than there were channels available, and the possibility of duplicating FM channels throughout the United States made room for a large number of new broadcasting stations.

Commercial development of FM began in 1940 when the FCC allotted 40 channels in the 42–50 mc. band for this purpose, and about 60 FM stations were in operation by the end of 1942, when expansion was halted by World War II. In 1945 the original 40 channels were replaced by 100 channels in the 88–108 mc. band.

Although FM attracted a loyal following of listeners, it never attained the universal popularity of the already established AM system. As a result, many FM stations failed to find economic support from commercial advertising and their total number dwindled to about 500 by the mid-1950s. In an effort to open up new sources of revenue for FM broadcasters, the FCC in 1955 authorized them to transmit auxiliary programs not intended for public reception. These programs are transmitted simultaneously with the station's regular programs, without interference to the latter, by means of an inaudible subcarrier. The auxiliary program can be heard only from special receivers which, being under control of the FM stations, may be leased on a fee basis. This method is applied to "store-casting" (programs of music with announcements relating to certain retail stores, where receivers are provided to reproduce them), or for "background" music in restaurants and other public places. A resurgence of public interest in FM occurred in the late 1950s, stimulated by the popularity of FM receivers in connection with high-fidelity ("hi-fi") sound-reproducing systems for home use. (*See* HIGH-FIDELITY SOUND SYSTEMS.) The advantages of FM were further enhanced when the FCC in 1961 gave its approval to FM multiplex broadcasting, a system that made possible the simultaneous transmission—on a single FM channel—of the two signals necessary for stereophonic reproduction.

5. Radio *v.* Television Broadcasting.—At the beginning of World War II, U.S. radio broadcasting was approaching its zenith as a source of home entertainment. In the evenings, various commercial programs vied with each other for the attention of the audience by presenting elaborate features ranging from serious music to comedy-variety. A console radio set was to be found in the living room of nearly every American home, and it was the centre of group listening by the family to their favourite programs.

With the evolution of television after the war, however, television receivers began to replace living-room radio sets and there was a corresponding shift of audience from radio to television, especially during the evening hours. This loss of listeners was eventually reflected in the business aspects of radio, with many advertisers converting their major evening programs to television. On the other hand, radio still retained certain advantages of its own, in that it did not require immobility on the part of its listeners, who might thus go about other duties while listening. It also was easily received on portable receivers, including the large number of automobile sets in use, and it was capable of reaching areas of the country that were beyond the range of existing television stations. There was a trend, therefore, toward changes in radio programming to make it most attractive to persons in these situations by the inclusion of more short features, recorded music, and news and weather reports throughout the day.

From the business standpoint, commercial television began principally with the construction of stations by firms already engaged in radio broadcasting. Television costs, including investments in apparatus, production of programs and operating expenses, were notably higher than those of radio. The cost of advertising by television was correspondingly high, but in view of the millions of persons who could be reached at one time, even the expenditure of several hundred thousand dollars for a single spectacle such as "Peter Pan" was justifiable economically.

6. Educational Broadcasting.—In the early days of U.S. broadcasting, about 170 AM stations were operated by colleges, churches and other nonprofit organizations. Although most of these ceased operating because of lack of funds and limited audiences, a few were still on the air as noncommercial stations in the 1960s. Educational AM stations were treated by the government on the same basis as commercial stations, insofar as assignment of frequencies was concerned. However, in the course of making allocations for FM and TV, the FCC set aside certain channels for the exclusive use of noncommercial educational stations.

7. Fee or Pay Television.—Although commercial television in the U.S. followed the pattern set by radio broadcasting in being supported by advertising, many people contended that a fee system—popularly called pay-TV or box-office-TV—would constitute a better method of paying for the programs. Under the proposed system, the viewer would pay a stipulated sum for the privilege of watching a program on his home receiver. Proponents argued that this would make possible the broadcasting of theatre performances, new motion-picture films and sporting events not otherwise available to television. Several methods for the collection of the fees were proposed, ranging from coin-slot mechanisms attached to the subscriber's receiver to monthly billing similar to the practice of public utilities. Nonsubscribers would receive only a distorted and unintelligible rendition of picture and sound.

8. Receiving Sets.—The first commercial radio receivers were crystal detectors or regenerative vacuum-tube sets using two or three tubes and were hardly more than adaptations of amateur apparatus of the time. In the typical case, a length of wire stretched from house to garage served as an antenna, and a wire from the receiver to a water pipe furnished a ground connection. Power to operate the vacuum tubes was supplied by storage or dry-cell batteries. Because of the great public interest in broadcasting and the consequent demand for receivers, however, advances came in rapid succession. The next steps were to the use of high-frequency amplifiers in "tuned RF" circuits, with elimination of regeneration effects by neutralizing techniques in the vacuum-tube circuits which ended the annoying squeals and howls of the early regenerative receivers, and to crude loud-speakers that permitted listening without the use of ear attachments. The batteries were replaced by power supplies that could be plugged into wall outlets, and eventually by self-contained power packs that were an integral part of the receiver. New vacuum tubes were developed, and the number of tubes in an average set increased to seven or eight. At the same time there was a shift to the superheterodyne type of circuit. Attention was then concentrated by manufacturers upon improving performance. Single-dial tuning, self-contained loop antennas, improved loud-speakers and essentially distortion-free sound reproduction, plus the housing of the entire apparatus in a single attractive cabinet, completed the transformation of broadcast receivers from the status of a novelty that challenged the operators' skill into reliable, easy-to-use instruments for home entertainment. (*See* Radio Receiver.)

Many broadcast receivers produced in the 1930s included shortwave bands which enabled listeners to tune in directly on foreign stations, or to listen in on police, aeronautical and amateur communications. Another innovation of the era was push-button station selection that eliminated tedious dial tuning. Advances in automobile receivers raised them from the status of accessories to that of optional built-in equipment, and their popularity was marked by the more than 36,000,000 that were in use in the early 1960s. The special tuners required for FM reception were first sold as converters for attachment to AM receivers, but were later incorporated into combination sets. After World War II there was no longer much demand for the deluxe console style of radio receiver because of the growing public interest in television, and manufacturers confined their production almost entirely to table models and portable sets. The development of transistors made possible the design of compact, lightweight portables, capable of operating up to a year on a single set of dry-cell batteries.

Rapid progress in television receiver design and manufacturing methods brought sets with 16- and 21-in. pictures at lower prices than had been in effect for 10-in. sets two or three years earlier. A "printed-circuit" technique, employing a photo-etching process to replace much of the laborious hand wiring formerly required, led to price reductions for all classes of radio and television receivers. Finally, the introduction of the shadow-mask kinescope made possible a practical mass-produced colour television receiver.

9. Government Regulation.—When broadcasting emerged in the U.S. as a new industry, the only legal regulations in force dated from 1912, and these pertained primarily to the maritime use of radio-telegraphy for the purpose of promoting the safety of life at sea. The administration of these regulations was entrusted to the U.S. department of commerce. Under this largely irrelevant set of laws, a rapidly increasing number of broadcasting stations (from about 50 in 1922 to more than 500 in 1923) were crowded into narrow wave bands, and interference from overlapping stations became intolerable. After several national conferences with broadcasters and other interested parties, the commerce department put into effect an orderly system of frequency assignments in what is now part of the standard AM band. The largest transmitters then in use had an output of only 500 w., but the advantages of increasing power were recognized and the way was cleared for the use of increased power. Stations of 5 to 10 kw. were established during 1925 and at least two stations (WGY, Schenectady, N.Y., and KDKA) were experimenting with still higher power. At the same time, the commerce department concluded that some limit should be placed on the total number of stations to be licensed because of the shortage of channels. This action created much dissatisfaction among those whose applications were denied, until finally a Chicago station precipitated a climax by the unauthorized use of a channel assigned, by international agreement, to Canada. In the ensuing lawsuit brought against the station by the department of commerce, the courts ruled that the department had no authority to deny licences or to enforce frequency assignments. The situation then became chaotic, with many stations choosing their own frequencies and operating almost independently of any government regulation, until congress enacted the Radio act of 1927. This act placed the responsibility for licensing stations in the hands of a Federal Radio commission of five men appointed by the president. The commission was given broad powers to classify stations, assign operating frequencies and otherwise regulate broadcasting, and was required to grant licences only "if public convenience, interest and necessity will be served thereby." An amendment in 1928 provided for an equality of broadcasting rights for various sections of the country and the establishment of a group of clear channels, each of which was to be occupied by a single high-powered station to give it the maximum range of service. Other channels were designated as regional and local, to be shared by low-powered stations in different parts of the country.

On July 1, 1934, there was established by act of congress a Federal Communications commission of seven men to deal not only with matters of national broadcast regulation but also with interstate and foreign telephone and telegraph communication by wire and radio. The commission was divided into three divisions, of which one, called the Broadcast bureau, carried on substantially the functions previously exercised by the Federal Radio commission, which the new communications commission superseded.

10. The Government and Television.—During the 1930s, a dozen or more television stations were experimenting with the broadcasting of dramas, sporting events and—in 1940—even the national political conventions. Since no commercially produced receivers were as yet available to the public, audiences were limited to those few experimenters who built their own or otherwise acquired experimental models. In 1940 the FCC invited the broadcasting and radio manufacturing industries to compile and submit a set of standards upon which a commercial television broadcasting service might be built. This invitation led to the formation of a National Television Systems committee (NTSC), composed of engineers and scientists drawn from all of the interested organizations, which devised a technical pattern for black-and-white television and attempted to provide for the future addition of colour. The NTSC plan was adopted by the FCC and commercial TV was authorized to start July 1, 1941. However, the potential business boom that might have been released was arrested by the intervention of World War II and the consequent diversion of radio plants to the production of military apparatus.

At the end of the war, the FCC allocated to television 13 VHF channels between 44 and 216 mc. (later reduced to 12 channels between 50 and 216 mc., by deleting channel 1), and commercial television got under way. While stations in various cities could share each channel with stations in other localities, a limit was imposed on the total number of stations that one channel could accommodate by the necessity for geographic separation to avoid interference, and it was soon realized that 12 channels were not sufficient to provide a nationwide TV system. On the other hand, the remainder of the VHF band was occupied by other radio services, leaving no room for more television channels. By 1948 there were 20 stations on the air, about 80 others were partially completed and over 300 new applications were pending before the FCC. This situation led the commission to issue a "freeze" order on Sept. 30, 1948, which postponed the granting of all further TV authorizations until additional channels could be found in another part of the radio spectrum. After many months of technical hearings, 70 new ultrahigh-frequency (UHF) channels between 470 and 890 mc. were allocated to television broadcasting. On the basis of appropriate separation of stations, a nationwide plan was devised, allotting the 82 VHF and UHF channels, city by city, to nearly 1,300 communities, and 242 of these assignments were reserved for noncommercial educational stations. The number of channels allotted to each city was approximately in proportion to population (*see* Table I).

Table I.—*Number of Channels Allotted per City in the U.S.*

Population	No. of channels
1,000,000 and above	6 to 10
250,000 to 1,000,000	4 to 6
50,000 to 250,000	2 to 4
Under 50,000	1 or 2

11. Station Call Letters.—With a few exceptions, broadcasting stations east of the Mississippi river are identified with call letters whose initial letter is W, and those to the west with the initial letter K. Where there are exceptions (*e.g.*, KDKA), the call letters were assigned prior to adoption of the present system. Call letters are ordinarily arbitrary combinations of letters, but some stations have been able to secure combinations which include initials of their company or city name. Television and FM stations that are associated with AM stations frequently use the call letters of the parent station with a suffix -TV or -FM.

12. Colour Television.—Crude pictures in colour were demonstrated as early as 1930; subsequently, experiments in colour television proceeded along with the advancements in the monochrome system. By 1950, colour television had been developed to the point where its commercial use seemed feasible. After consideration of three competing systems that were espoused by different concerns, the FCC approved a "field sequential" method proposed by the Columbia Broadcasting system (CBS). This was a refinement of an earlier technique in which red, blue and green filters moved in rapid succession in front of both the camera lens and the kinescope tube in the receiver, the filters being mounted on synchronized rotating disks. Following the FCC approval, CBS used the system for a limited number of broadcasts. However, because of the difference in scanning rates between it and the existing black-and-white system, the new colour system produced only zigzag lines to viewers watching it on ordinary receivers, and the system did not meet with general acceptance.

Thereafter, the National Television Systems committee was revived by the television manufacturers and broadcasters, and it met to reconsider the entire problem. Following months of deliberation and many field tests, the NTSC agreed upon a set of specifications whereby colour signals could be contained within the existing monochrome structure, and thus be "compatible." This meant that although a colour receiver would be necessary for viewing a broadcast in colour, the owners of standard black-and-white sets would still be able to receive colour programs in monochrome. It would then be possible to intersperse programs in colour among those in monochrome without prejudice to the existing audience that had already invested in monochrome receivers. This factor was important in the launching of an economically successful colour TV system since it permitted a gradual rather than a revolutionary transition from monochrome television to colour.

The new NTSC standards were adopted by the FCC in Dec. 1953, and their first use for a major network program occurred in the telecast of the Rose Bowl festival from Pasadena, Calif., on New Year's day 1954, by the National Broadcasting company (NBC). Subsequently, NBC presented colour programs in increasing numbers, and was later joined by CBS and ABC, until in the early 1970s all were using colour almost exclusively. Many independent stations were equipped to transmit local programs in colour. *See* Television: *Compatible Colour Television.*

(R. B.; W. F. L.)

VI. BRITISH SYSTEM

In Great Britain, as in several other countries, broadcasting grew out of the activities of amateurs who were experimenting with wireless telephony. This followed the removal of military restrictions on the use of radio by amateurs at the close of World War I. The first broadcast concert on record in Great Britain originated at a garden fete at Hampstead in July 1922, of which it was said that listeners were treated to an entertainment of "unconsidered trifles of the lightest type." A footnote to the printed program stated that an organ pipe would be blown prior to the transmission to assist listeners in adjusting their receivers. Regular programs were inaugurated soon after under the auspices of the British Broadcasting company, using transmitters of about 1 kw. power and operating in the medium-wave band.

Reception difficulties in many parts of Britain led in 1925 to the erection of the Daventry station 5XX, which for the first time employed the new long wave length of 1,500 m. for broadcasting and the then relatively high power of 30 kw. This station could be heard satisfactorily on the continent as well as throughout most of Britain, and it became one of the most famous stations in Europe during the ten years of its existence. Other stations were later added to the BBC system to provide for regional broadcasts and to make available additional programs.

The British Broadcasting corporation, a publicly financed corporation ultimately responsible to parliament but in practice enjoying a considerable degree of independence, was given, by its original charter in 1927, a monopoly covering all phases of broadcasting in Britain. This monopoly was maintained until the revised charter and licence of 1952, when the setting up of the Independent Television authority was foreshadowed. The monopoly of sound broadcasting was maintained. Programing and operating costs were balanced by income from a receiver licence tax—amounting in 1959 to £1 a year for sound only, and £3 a year for sound and television (plus an excise duty of £1)—and by revenue from various printed publications. Three distinct radio services were provided (Home Service, Light Programme and Third Programme) to permit each listener a choice of news, talks, features, plays, variety shows or music. In Sept. 1957 a fourth service, Network Three, was added to provide for special minority interests. Special broadcasts were also available to schools.

The BBC operated extensive commonwealth and international short-wave services, the costs being borne by grants from the public treasury. Television research sponsored by the BBC led to the development of a workable system, and regular transmission of television programs from the London station at Alexandra palace was introduced in July 1936. Television in Great Britain stopped during World War II but began again in 1946.

(J. C. W. R.; G. G. A. W.)

VII. BROADCASTING AS A BUSINESS

One element of importance in advertising is the number of possible customers it reaches. The value of combining the toll broadcasting idea with the network broadcasting idea, to increase the audience and thereby to justify the expense of better programs, was self-evident.

WEAF, the pioneer U.S. sponsored-program broadcasting station, being owned by the telephone company which also operated the long-distance telephone service of the country, naturally served as an important centre for the development of commercial network broadcasting. Arrangements were worked out whereby the cost of such service could be distributed equitably between the program sponsor and the individual stations using the program.

For sponsored programs the individual chain stations received a portion of the chain rental charges paid by the advertiser. These stations could also obtain, by paying a fee, nonsponsored programs supplied by the central management of the chain.

In 1926 the National Broadcasting company, organized by the General Electric company, the Westinghouse Electric and Manufacturing company and the Radio Corporation of America, purchased WEAF and undertook the management of WJZ and WRC, both of which were owned by the Radio Corporation of America. The network broadcasting activities centring on these stations were continued and expanded.

The Columbia Broadcasting system originated in 1927 as an outgrowth of the United Independent Broadcasters and the Columbia Phonograph Broadcasting system. In Oct. 1934 the Mutual Broadcasting system began operation. The Blue network, established in Jan. 1927 as NBC's second network, was sold by the latter company and became independent in 1942. Three years later its name was changed to the American Broadcasting company. The DuMont Television network came into being with the advent of television, and operated as a "live" interconnected network until 1955, when it shifted to the use of motion-picture films.

1. Patents and Copyrights.—During the early boom period of radio broadcasting, many companies and individuals started the manufacture and sale of receiving sets and parts with small regard for the infringement of patents. With the number of patents running into thousands, it was a difficult task even to determine what patents might be infringed by given apparatus. In 1920 and 1921 several large electrical and communication companies which, taken together, controlled an important group of radio and other communication patents, entered into a cross-licensing agreement whereby each of the companies was enabled to proceed in its field with a satisfactory patent situation. A considerable number of manufacturers and groups of patents were outside this arrangement but, after a period of negotiation and some litigation, licences were extended to the larger independent manufacturers under royalty agreements, and by 1927 it was generally possible for a responsible manufacturer to equip himself with such licences as would ensure him the right to put on the market receiving equipment of modern design.

The question arose as to whether the performance of a musical composition before a microphone in a private studio, so that it was broadcast by radio, constituted an infringement of copyright. The American Society of Composers, Authors and Publishers (ASCAP) championed the cause of the holders of copyrights, and ultimately established a recognition among broadcasters of the right of the copyright proprietors to compensation for the use of their compositions. There was discord over the matter of equitable rates of compensation, but by 1927 this seemed to have been adjusted in most cases through private negotiations. Further dissension between broadcasters and the ASCAP in 1940–41 brought about the formation of Broadcast Music, Inc., by the broadcasters. These two organizations subsequently operated in competition as licensing agents for the radio performance of copyrighted music.

2. Developments Related to Broadcasting.—The rapid strides made in the improvement of sound pickup and reproducing apparatus to meet the needs of radio broadcasting had a stimulating effect upon other devices used for sound reproduction. The phonograph, for example, was manufactured in greatly improved form, combined in the same cabinet with radio receiving sets so that the amplifier and loud-speaker portions might be used by either. Another development related to broadcasting and often used in combination with broadcast pickup of speakers in large halls or in open air was the public address system. By means of microphones placed directly in front of the speaker and powerful amplifiers and loud-speakers or sound projectors appropriately located, large crowds could be addressed successfully with reduced strain on both the speaker and his auditors. Sound motion pictures likewise benefited from many of the technical developments of broadcasting. Adaptation of the studio apparatus and the studio technique of broadcasting to sound recording for films was a simple step, the principal difference being in the ultimate use of the signal for the operation of the recording device instead of for the modulation of a radio transmitter. Television, of course, was the chief beneficiary of the techniques developed by radio broadcasting, and found a ready-made pattern to guide almost every phase of its progress.

3. Business Progress.—The phenomenal expansion of U.S. radio broadcasting in 1921 and 1922 impelled many small concerns to enter the field, especially in the manufacture of receivers. By 1926 the market was flooded with overproduction of sets which were being sold to the public at distress prices, and failures among the smaller companies were common. Further tolls were taken by the financial crash of 1929, and many broadcasting stations also were forced to cease operation because of reverses. The business of broadcasting as a whole, however, remained fairly prosperous during the general depression and even managed to continue its expansion. At the same time, the number of receiver manufacturers had been reduced to a score or so of the larger and sounder concerns, and the industry settled down to an era of prosperity.

Another setback occurred when FM failed to revolutionize the broadcasting business to the extent predicted by its partisans; of the more than 1,000 FM stations in existence in 1948, only about half were still in operation a decade later. The most successful FM stations were those located in areas that were inadequately served by AM broadcasting. Beginning in 1948, the growth of television gradually cut into the advertising sales and profits of radio broadcasting in those localities where the two forms of broadcasting were in competition.

4. Organizations.—The manufacturers have an Electronic Industries association and a radio division in the National Electrical Manufacturers' association. These are active in standardization work. The National Association of Broadcasters interests itself in legislation and in general investigations for the benefit of its members, which include a majority of the broadcasting stations. Through the co-operative efforts of these various associations and other interests, radio fairs or shows are held for the exhibition of equipment, usually in conjunction with national conventions or conferences of broadcasters or manufacturers.

The American Institute of Electrical and Electronic Engineers provides facilities for the discussion and publication of technical papers and the furtherance of standardization in the radio arts. The Joint Council on Educational Television and the National Association of Educational Broadcasters are interested in educational broadcasting, and the National Council of the Churches of Christ in the United States of America is concerned with religious broadcasts. (R. B.; W. F. L.)

VIII. TECHNICAL ASPECTS

In the United States, four distinct types of broadcasting are in use, which may be classified as (1) standard-band AM sound broadcasting; (2) international short-wave sound broadcasting; (3) FM or frequency modulation sound broadcasting; and (4) television broadcasting. In many respects the technique involved is similar for all classes, while in other ways it is quite different. (*See* also RADIO.)

1. Apparatus and Performance.—The essential physical elements of a broadcasting system are: (1) studio, microphone or television camera, transmitter and antenna—which, in combination, are capable of generating, modulating and radiating electromagnetic waves with intensity that is (ordinarily) equal in all directions; and (2) any number of receivers at diverse locations, each able to detect the radiated waves and reproduce the original program.

The technical objective in broadcasting is to transmit and reproduce programs as realistically as possible, with a minimum of distortion and interference. Broadcasting stations maintain high standards of transmission, but many receivers—especially those of small size and low cost—are not capable of reproducing all that is transmitted. The ear, however, is tolerant to a moderate amount of distortion and is aided by the imagination in the interpretation of speech and music, giving the listener an illusion of naturalness. In television broadcasting, the fact that the eye is less tolerant in overlooking distortion and interference imposes more rigorous limits on both transmitting and receiving equipment.

Interference results from stray electrical waves, sometimes of natural origin and sometimes man made, which become inseparably mixed with radio signals and are converted by the loud speaker into noise, or by the television receiver into blemishes on the screen. Standard and international short-wave broadcasting stations (using amplitude modulation) rely on the use of high-powered transmitters to override such interference. Satisfactory service is thus rendered under ordinary conditions of reception, but in the industrial or highly congested districts of large cities the interfering electrical pulses may at times be so intense that noise-free reception is impossible. Frequency-modulation broadcasting, in which the program is carried in the form of variations in the frequency of the radiated waves, is less susceptible than amplitude modulation to interference of this type and in many cases may be received with clarity in locations where amplitude-modulated signals are completely overridden by noise. Television signals utilize VHF and UHF bands which are fairly free from natural or static interference, but are sometimes subject to man-made interference such as that caused by automobile ignition systems or by radiations from electrical machinery.

2. Broadcasting Frequency Allocations.—The total radio frequency spectrum (*see* Frequency, Radio) is arbitrarily divided into five groups. Certain bands of frequencies within each group are set aside for broadcasting, partly through international agreements for standardization, and partly because of technical differences in the propagation characteristics of radio waves at various frequencies. (See *International Regulation*, above.) The groups, their names and the classes of broadcasting services which generally (but not exclusively) use them are:

Low frequency (LF)	30 kc. to 300 kc.	AM (Europe)
Medium frequency (MF)	300 kc. to 3 mc.	AM
High frequency (HF)	3 mc. to 30 mc.	International
Very high frequency (VHF) ...	30 mc. to 300 mc.	FM and TV
Ultrahigh frequency (UHF) ...	300 mc. to 3000 mc.	TV

The licensing authority in each nation makes its own assignments of specific frequencies to individual stations, within the limits of the internationally allotted bands. The allocations system of the U.S. in the early 1960s is shown in Table II.

Table II.—*Frequency Allocations for U.S. Broadcasting Stations*

Class of station	Frequency band	Channel width	No. of channels	Maximum power*
Standard AM . .	535-1,605 kc.	10 kc.	107	Clear channel 50 kw. Regional 5 kw. Local 500 w.
International . .	6,000-21,700 kc.	—	—	50 kw. minimum
FM				
Noncommercial educational . .	88– 92 mc.	200 kc.	20	Metropolitan 20 kw. Local 1 kw.
Commercial . .	92–108 mc.	200 kc.	80	
Total			100	
Television				
VHF low band Ch. 2 to 6 . . .	54– 88 mc.	6 mc.	5	100 kw. picture (peak)
VHF high band Ch. 7 to 13 . . .	174–216 mc.	6 mc.	7	316 kw. picture (peak)
UHF band Ch. 14 to 83 . . .	470–890 mc.	6 mc.	70	5,000 kw. picture (peak)
Total			82	

*AM and international stations are rated by actual power output of transmitter. FM and TV stations are rated in terms of effective radiated power (E.R.P.), which takes into account the efficiency of the transmitting antenna as compared with a simple dipole antenna. TV picture power is measured at its maximum instantaneous value, which occurs at the tips of synchronizing pulses. TV sound power is measured by its average value, and is approximately one-half of the rated picture power. International and TV bands are shared with other radio services.

Certain channels in the AM broadcast band are set aside for the exclusive use of high-powered clear-channel stations, while others are by treaty assigned to other American countries. The remaining channels are, in the U.S., given over to lower-powered stations for the coverage of regional or local areas. Frequency assignments of stations in the latter classes may be repeated among a number of stations whose geographical separations are sufficiently great to avoid interference within the intended service range of each station. Thus approximately 3,200 AM stations are accommodated in the 107 broadcast channels which are available for this use. Television and FM stations in cities within a few hundred miles of each other also share their channels because of the normally short range of transmission in the frequency bands where they operate. Under unusual atmospheric conditions, however, when propagation of VHF and UHF signals extends beyond its normal limits, there may be "co-channel" interference between stations in different cities sharing the same frequency, especially at locations between the two cities. In television transmission a process of off-setting the carrier frequencies of each station by a slight amount helps to reduce the disturbing effects of such interference.

3. AM *v.* FM.—In sound broadcasting practice, an AM station nominally occupies a channel 10 kc. wide in the radio frequency spectrum, while a FM station requires one 200 kc. wide. Hence the entire standard AM band of 535 to 1605 kc. as used in the U.S., which provides sufficient 10 kc. channels for 107 AM stations without duplication, would accommodate only five 200 kc. channels. FM must therefore be confined to the VHF and UHF regions, where its wide channels take up a relatively smaller percentage of the spectrum. VHF and UHF are less subject to interference from most causes than is the standard band of AM, so that an incidental dividend in the form of immunity is gained by the choice of these frequencies. On the other hand, the useful range of VHF and UHF stations is limited effectively to local areas, while the normal range of AM stations may be several hundred miles, or even farther at night.

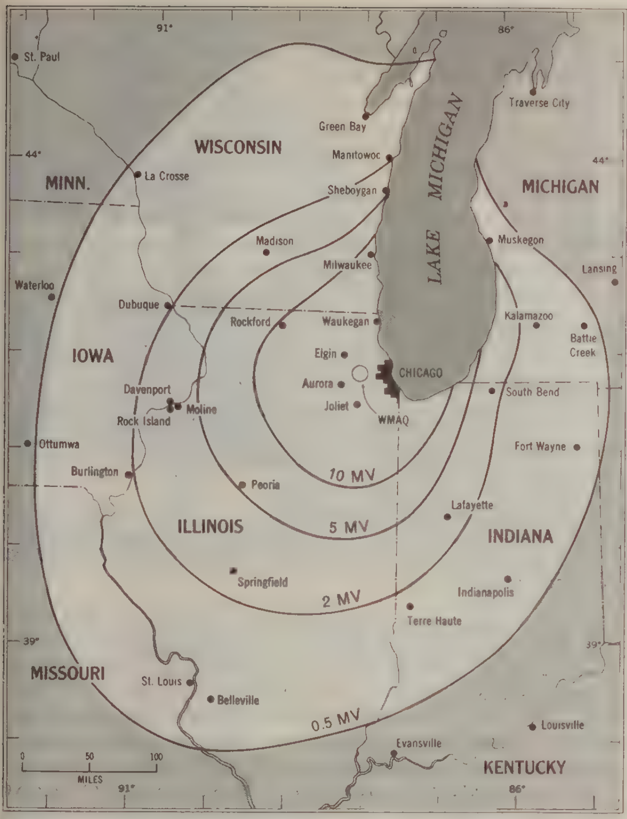
4. Propagation of Radio Waves.—Satisfactory reception of broadcasts depends upon the signal strength of the station at the receiver location, interference conditions in the vicinity of the receiver and the quality of the receiving apparatus. A station's effective signal strength is proportional to the intensity of the electric field of its radiated wave, which diminishes as the wave travels outward from the station. This diminution is caused in part by diffusion of the wave's energy throughout a constantly enlarging volume of space, and in part by absorption of energy from the wave by the earth and other intervening objects. The power of the station, the efficiency and directional properties of its antenna, the distance between the station and the receiver, the attenuation of the wave in spanning this distance and the possible arrival of signals over more than one path are the factors which collectively determine the signal strength at a given receiving location. The magnitude of the signal strength is measured in units of millivolts per metre, and the voltage at the input terminals of the receiver is proportional to this quantity.

A contour plot of the signal strength of a standard broadcasting station for the region about Chicago is shown in the diagram of fig. 2. This represents the direct or so-called ground-wave radiation. For receivers located within 50 to 75 mi. of the station, the ground-wave intensity as compared to the intensity of interference is the criterion for satisfactory reception. Based on the average interference conditions prevailing in different locations where receivers are used, the signal strengths considered necessary to override noise and provide satisfactory reception in the standard-broadcast band are:

City business area	10 to 25 mv. per metre
City residential area	2 to 5 mv. per metre
Rural area	0.1 to 0.5 mv. per metre

It should be remarked that the interference conditions at the receiver location are the determining factor in this respect, since interference at the transmitter location has no effect upon the performance of the receiver.

Reception at distances of about 100 mi.—more or less—from



BY COURTESY OF NATIONAL BROADCASTING CO., INC.

FIG. 2.—RADIO CONTOUR MAP SHOWING DIRECT GROUND-WAVE FIELD STRENGTH AROUND WMAQ, CHICAGO, ILL. RADIATED POWER IS 50 KW.

the station may be disturbed by another phenomenon, even though the noise level in that region might be too low to cause interference. This condition is fading, which results both from changing atmospheric conditions and from the simultaneous reception from the same station of waves that have traveled over separate paths. All antennas radiate some energy upward at various angles; this energy passes above and does not affect receiving antennas near the station. Some of this energy is reflected back toward the earth by the Kennelly-Heaviside layer of ionized gases and may arrive at a distant point to combine with the ground-wave signal. Depending on the relative lengths of the paths traveled by the two waves, the result may be additive or subtractive, with reinforcement or cancellation of the signal strength. Because the reflecting layer varies in height, the path of the reflected wave is variable and the final result to the listener is fading of the signal, a phenomenon that is familiar to all who have listened to distant broadcasting stations.

Differences in wave propagation between daytime and nighttime, and between seasons, also affect standard-broadcast reception. Reliable daytime service is limited almost exclusively to the region near the station wherein the ground wave constitutes a usable signal. This area is nearly constant for a given station and is called the primary service area. Reflection effects are practically nonexistent for standard-broadcast waves during daylight hours, but at night they act to expand the range of the station into a secondary service area. This area receives reasonably reliable nighttime service but is subject to fading, as was previously pointed out. Another phenomenon that is capable of causing interference with nighttime reception of a distant station occurs when two or more stations in different locations are operating with the same carrier frequency. Under these conditions reflected waves from several stations may reach the receiving antenna with comparable signal strengths to produce a motley babble of sounds. Alternate reception of two stations, as first one and then the other fades, or the production of a steady low-pitched tone resulting from a heterodyne beat between carrier frequencies of the two stations, are other commonly observed results of the same conditions.

Reception of television and FM stations, because of their very high carrier frequencies, was expected to be confined substantially to the areas within which their ground waves are effective, or approximately within the area bounded by the visual horizon of the transmitter antenna. However, experience in the U.S. proved the necessity for revising this theory. Frequent but erratic reception of signals from stations hundreds of miles distant and interference between stations beyond the presumed range of each other called for re-evaluation of engineering concepts regarding reflection of ultrahigh-frequency waves from the Kennelly-Heaviside layer. Another type of reflection was also troublesome in television reception—the reflection of signals from buildings, hills and other nearby objects of similar size. The practical result in this case was one or more repeated or "ghost" images appearing in the reproduced picture and horizontally displaced from the true image. A difference of one mile, for instance, between the lengths of the direct and reflected wave paths would produce a second image displaced approximately 3% of the width of the picture in the direction of the horizontal scanning. This objectionable condition can be remedied in most cases by the use of a properly oriented directional receiving antenna.

IX. BROADCASTING TECHNIQUE

Sound and television broadcasting technique involves considerable elaboration of the bare essentials of a radio transmitting and receiving system. Studio facilities must be provided not only for the performance of the programs but also for the rehearsals which precede the actual broadcasting of each program. In order that other programs may be in preparation while one is being broadcast, several studios must be available. These must be of different sizes to accommodate various-sized groups of artists. Means must also be provided for selecting the studio which is ready to broadcast and connecting it to the broadcast transmitter. These many links between the performer and the listener may be classified as follows in the order in which they function: (1) the studio or place of program origin; (2) the microphone or television camera, and associated preamplifiers; (3) the mixer and volume-control system; (4) the central or main control room; (5) the electric cable or microwave relay to carry the programs from the main control room to the transmitting station (or simultaneously to many stations of a network); (6) the transmitting station; (7) the broadcast receiver. The basic elements of a typical broadcasting system are shown diagrammatically in fig. 3.

Besides studios, microphones and TV cameras, of course, a well-organized staff is necessary to produce the programs and operate the equipment that broadcasts them. As an example, the personnel immediately involved in the production of a television show in the studio and control booth are outlined in fig. 4.

1. The Studio or Place of Origin.—A broadcasting studio is a specially arranged room in which the artists perform for broadcasting. It is made soundproof to shut out extraneous noises and its walls are treated with sound-absorbing material to control the amount of reverberation. Reverberation is the multiple reflection of a sound wave back and forth between the studio walls, part of the energy being absorbed by the walls at each reflection. The result is an exponential decay of the sound intensity in the studio, and the length of time required for reduction of the sound to the point of inaudibility (or more precisely, to one-thousandth of its initial pressure) is called the reverberation time of the studio. How long this should be for the most pleasing effect is more a matter of aesthetic than of scientific considerations. Excessive reverberation, however, causes an annoying empty-room effect which detracts from the listener's enjoyment of the program. In television studios, lighting apparatus, as well as space for stage settings and cameras, must be provided.

Certain types of programs—news events, sports, church services, public speeches and the like—cannot be moved into a studio and must be broadcast from their places of origin. In these cases, portable microphones, television cameras and amplifiers are often carried to the scene in especially equipped cars or vans. From

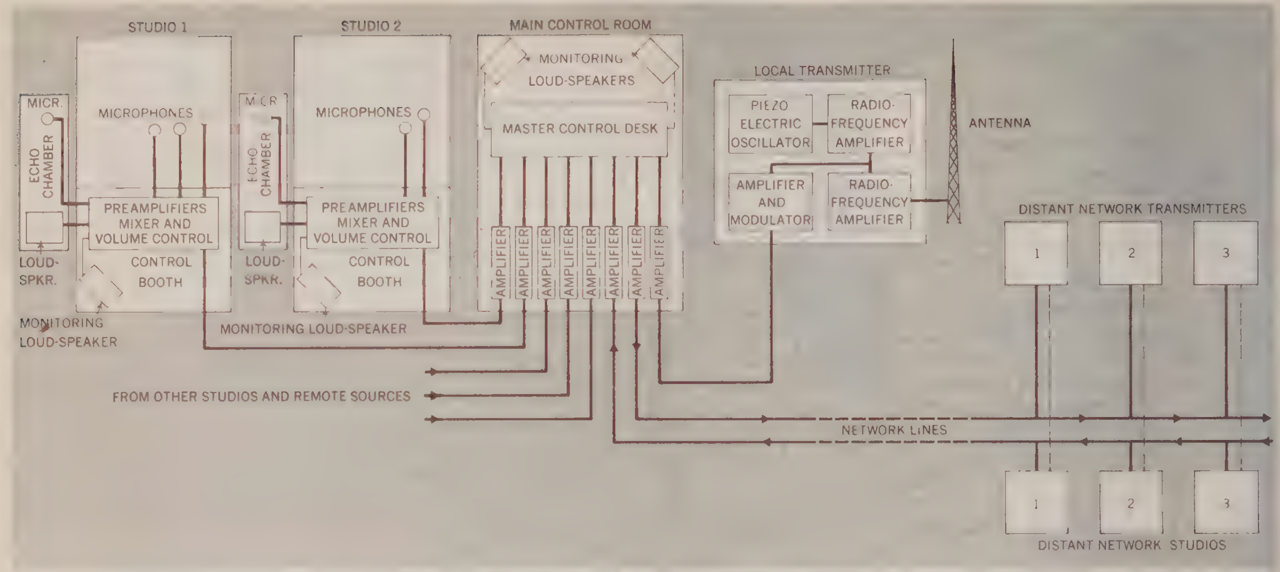

STUDIO 1
STUDIO 2
MAIN CONTROL ROOM
MONITORING LOUD-SPEAKERS
MASTER CONTROL DESK
LOCAL TRANSMITTER
PIEZO ELECTRIC OSCILLATOR
RADIO-FREQUENCY AMPLIFIER
AMPLIFIER AND MODULATOR
RADIO-FREQUENCY AMPLIFIER
ANTENNA
MICR.
MICROPHONES
ECHO CHAMBER
PREAMPLIFIERS MIXER AND VOLUME CONTROL
LOUD-SPKR.
CONTROL BOOTH
MICR.
MICROPHONES
ECHO CHAMBER
PREAMPLIFIERS MIXER AND VOLUME CONTROL
LOUD-SPKR.
CONTROL BOOTH
AMPLIFIER
AMPLIFIER
AMPLIFIER
AMPLIFIER
AMPLIFIER
AMPLIFIER
AMPLIFIER
AMPLIFIER
MONITORING LOUD-SPEAKER
MONITORING LOUD-SPEAKER
DISTANT NETWORK TRANSMITTERS
1
2
3
FROM OTHER STUDIOS AND REMOTE SOURCES
NETWORK LINES
1
2
3
DISTANT NETWORK STUDIOS

FIG. 3.—ELEMENTS OF A RADIO BROADCASTING NETWORK

these, audio (sound) signals are relayed to the main studio through telephone lines or short-wave links, and video (picture) signals through coaxial cables or microwave transmitters. Or, when the program is not to be broadcast at the time it is performed, it may be recorded on magnetic tape or motion-picture film for later broadcasts. Tape recording, disc recording (electrical transcriptions) and motion pictures are also applied extensively for inscribing complete programs especially produced in the studio for the purpose. Copies may then be syndicated to any number of individual stations for broadcasting. Television films taken directly from a picture tube reproduction of a program while it is in progress are called kinescope recordings and may be used for rebroadcasts by other stations.

In the late 1950s video tape recording of television programs in both monochrome and colour began to assume a prominent role in broadcasting. The tape, consisting of a plastic film ribbon coated with a magnetic oxide, is fed at high speed past a rotating recording head, and the video signal is stored in the magnetized oxide particles. This type of recording has the important advantage of being ready for immediate playback without development or other processing, a property which is especially valuable to nationwide networks where time-zone differences create program scheduling problems. A broadcast designed to appeal to a 7 o'clock after-dinner audience, for instance, may be tape-recorded at the time of its original performance in New York and then repeated after a suitable time delay for audiences in the later time zones. A viewer in Los Angeles will then see the television show at the intended hour by his local time, instead of at 4 o'clock in the afternoon. (*See* TAPE RECORDING, MAGNETIC.)

2. The Microphone, Television Camera and Preamplifiers.—The operation of all microphones depends upon the action of the minute pressure variations or the imperceptible air currents that constitute sound waves. The motion of the air is converted through suitable means into a change of resistance or capacitance in an electric circuit, or into the motion of a conductor in a magnetic field. In all cases the final result is a fluctuating electric current whose variations correspond to those of the air pressure or velocity in the sound wave (*see* MICROPHONE). For radio broadcasting, microphones are usually supported on floor stands or suspended by overhead cables. In television, where it is desirable to keep them out of camera view, they may be mounted on long-armed boom stands or, in the case of informal programs, miniature microphones on neck straps may be worn by individual performers.

The function of the television camera is analogous to that of the microphone in sound broadcasting. Its nucleus is a light-sensitive tube such as an image orthicon or a Vidicon, which converts an optical image of the studio scene, as focused onto its screen by a lens system, into varying electrical pulses that represent the picture. Cameras as well as other TV equipment require frequent testing and adjustment to assure optimum performance, and are usually checked out with test patterns before each program. Cameras are usually mounted on large metal stands called dollies. These have a platform on which the camera operator stands and are equipped with rubber-tired wheels for mobility. (*See* TELEVISION: *Fundamentals of Picture Transmission and Reception.*)

Both microphones and light-conversion devices generate currents that are often too feeble to permit transmission over a distance of more than a few feet before being amplified. The amplifiers used for this purpose are called preamplifiers. In sound broadcasting one preamplifier is used for each microphone, and the preamplifiers are ordinarily located in the control booth adjacent

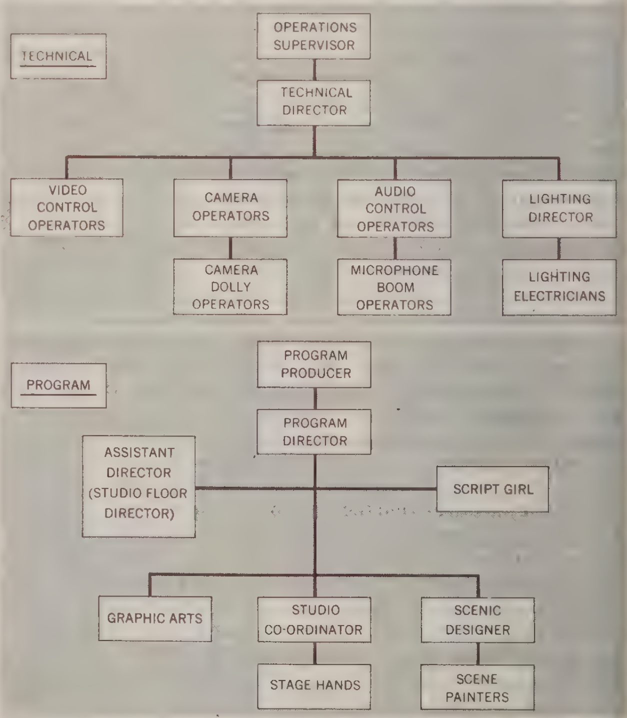

TECHNICAL
OPERATIONS SUPERVISOR
TECHNICAL DIRECTOR
VIDEO CONTROL OPERATORS
CAMERA OPERATORS
AUDIO CONTROL OPERATORS
LIGHTING DIRECTOR
CAMERA DOLLY OPERATORS
MICROPHONE BOOM OPERATORS
LIGHTING ELECTRICIANS
PROGRAM
PROGRAM PRODUCER
PROGRAM DIRECTOR
ASSISTANT DIRECTOR (STUDIO FLOOR DIRECTOR)
SCRIPT GIRL
GRAPHIC ARTS
STUDIO CO-ORDINATOR
SCENIC DESIGNER
STAGE HANDS
SCENE PAINTERS

FIG. 4.—TECHNICAL AND PROGRAM CREWS FOR TYPICAL TELEVISION PROGRAM STUDIO PRODUCTION

to the studio. In some systems, the mixed output of a group of microphones is connected to a single preamplifier. For television, however, the currents from the camera cannot easily be transmitted over even a short distance, and the preamplifier is located inside the camera close to the picture tube.

3. The Mixer and Volume Control System.—Amplified currents from each microphone are connected to a fader and switching system in a control booth adjacent to the studio, where an operator mixes microphone outputs or switches from one to another as required. A master volume control enables him to maintain constant sound level on the outgoing program, as monitored by a volume indicator meter and loud-speaker.

A television control booth, besides having a similar set of microphone controls, has a mixer-switching system for the camera video signals. The scene being picked up by each camera, as well as the composite picture being transmitted to the audience, are displayed on kinescope monitors, and video levels are observed by means of cathode-ray tubes.

4. The Main Control Room.—This is the central point of the studio system and serves as a clearinghouse for the sequence of programs from the different studios, remote origins and networks. Successive programs from these various sources, after being amplified to standard intensity levels for line transmission, are switched in scheduled order to the line or short-wave circuits which carry them to the broadcasting transmitter. The latter may be located at some distance from the studios and control room. Other functions of the main control room include supervisory monitoring of all programs, communications in connection with program traffic and the switching of channels for program distribution to and from the networks.

5. The Electric Cable or Microwave Link.—A suitable means is required for conveying program signals from the main control room to the station transmitter—which may be as far as 20 or 30 mi. distant—or, in the case of networks, to stations in other cities. For sound broadcasting, special circuits leased from the telephone companies are customarily used. These circuits are especially designed to transmit the full range of musical tones (from about 0.1 to 5 kc. per second, or wider ranges in some cases). The circuits consist of wide-band channels on carrier systems, cable pairs employing light loading or, in rare cases, open wire. Equalizers (corrective electrical networks) at the terminals assure uniformity of response to various frequencies. Similar circuits are used for bringing local remote programs from halls, theatres, etc., to the main control room.

Television signals require the use of coaxial cables or microwave relays because of their wider frequency range (from about 30 cycles to 4.2 megacycles per second). The coaxial cable consists of a small wire supported by insulating beads and extending concentrically within a copper tube. From four to eight such cables, each slightly larger than a lead pencil, are encased in an outer lead sheath which is laid underground in ducts from city to city. (The term "coaxial cable" is also applied to the sheath and its contents.) In one such system, amplifiers are required at intervals of about four miles along the route to compensate for energy losses, and each conductor is capable of carrying one television program plus 600 telephone messages in one direction.

Microwave systems installed by the American Telephone and Telegraph company for cross-country television transmission employ frequencies in the region of 4,000 mc. In these, a low-powered carrier wave is frequency modulated by the video signals and beamed from antennas mounted on a series of towers spaced about 25 or 30 mi. apart. One type of antenna used is a refracting horn, having the outward appearance of a square-based pyramid standing on edge. Another, which has a wider frequency range, resembles a cornucopia mounted on end. At each tower there is receiving equipment to pick up the incoming signals, shift their frequency and amplify them and finally retransmit them to the next tower. Such systems have a capacity of six television programs in each direction. Because of the frequencies used and the narrow beams in which they travel, the microwave signals are private and are received only at the telephone company's terminals, from which they are distributed to television stations. The public, therefore, does not receive television programs directly from the microwave beams, but only after they have been delivered to and broadcast by a local television station. Many stations also employ similar microwave equipment of their own, operating in other frequency bands, for local transmission of television picture signals from points outside of their studios to their control rooms, or for interconnection between their control rooms and their transmitters.

6. The Broadcast Transmitter.—This final link in the transmitting system for broadcasting serves a threefold purpose: (1) generation of the high-frequency carrier current necessary to achieve radiation of radio waves; (2) modulation of the carrier current in accordance with the program; (3) conversion of the modulated carrier current into electromagnetic waves.

The high-frequency current is generated initially by a vacuum-tube oscillator operating at a low energy level and controlled by a piezoelectric oscillator. The latter utilizes the electro-mechanical property of certain crystals, notably quartz, to generate currents of exceedingly stable frequency and thus ensures that the station will adhere to its assigned frequency or wave length. A series of radio-frequency amplifiers employing large vacuum tubes and resonant circuits, and having successively increasing power capacities, amplifies the output current from the crystal oscillator up to the level of power which the station is authorized to use. At some point in the series of amplifications, the amplified program currents from the microphone or television camera are introduced to modulate the carrier.

After being modulated and amplified to the power level authorized by the station licence (such power varies from 100 w. for local stations up to 50 kw. for clear-channel stations), the radio-frequency currents are transferred to an antenna which radiates their energy in the form of electromagnetic waves. To be an efficient radiator, an antenna must possess physical dimensions which are comparable with the wave length of the signal. Thus, the lower-frequency (longer wave-length) stations of the standard broadcast band require larger antenna structures than do the short-wave and ultrahigh-frequency stations. The most popular type of antenna among standard station operators is the vertical radiator, consisting of a single steel tower whose height is from one-half to one full wave length. Towers of this kind vary in actual height from 100 up to 1,000 ft. This form of antenna radiates waves of substantially equal intensity in all compass directions and also directs the maximum amount of energy along the surface of the earth, thereby eliminating wasteful high-angle or skyward radiation. (*See* ANTENNA [AERIAL].)

Television and FM stations utilize extremely short wave lengths and their antenna dimensions are correspondingly small. This permits the use of multielement antennas to concentrate radiation parallel to the surface of the earth, thereby producing a maximum useful signal intensity with a minimum of transmitter power.

To avoid undue interference to the large number of listeners who may reside in the vicinity of a high-powered broadcasting station situated within a city, most standard transmitters are located in rural areas some miles distant from their studios. This also avoids the absorption effects which large city buildings have for waves of these frequencies. Television and FM transmitters do not present the same problems, because of the higher frequencies on which they broadcast, and are ordinarily placed atop the highest building or other object near the centre of the area to be served, with the object of obtaining the maximum coverage of the surrounding area.

7. The Broadcast Receiver.—The function of the receiver is to intercept, select and amplify the signals from any desired broadcasting station within range, and to reproduce an image in sound or light and sound of the original studio performance. All receivers, whether for AM, FM or TV, utilize the same basic principles for selection and amplification.

An antenna, which may be an assembly of metal rods on the rooftop for TV or FM, or a coil of wire inside a portable AM receiver, is the interceptor that captures a tiny bit of the energy radiated by the broadcasting transmitter. However, the antenna is impartial and picks up all stations that are neither too weak nor too

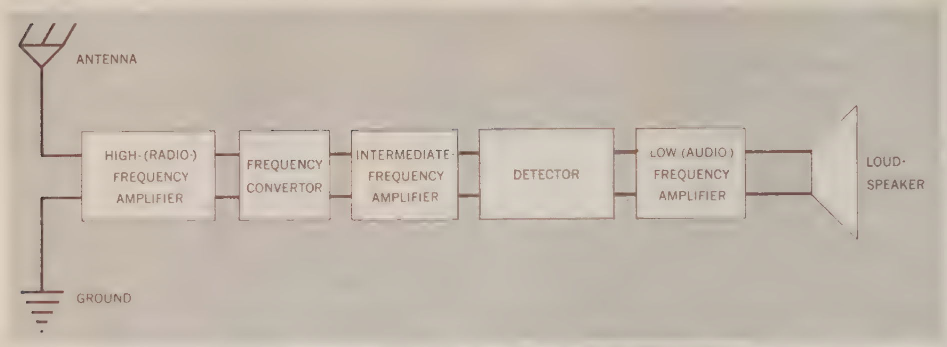

ANTENNA
HIGH-(RADIO-) FREQUENCY AMPLIFIER
FREQUENCY CONVERTOR
INTERMEDIATE-FREQUENCY AMPLIFIER
DETECTOR
LOW (AUDIO) FREQUENCY AMPLIFIER
LOUD-SPEAKER
GROUND

FIG. 5.—COMPONENTS OF SUPERHETERODYNE RADIO RECEIVER

Modulated radio-frequency signals delivered to the receiver by the antenna-ground system are amplified, converted to a lower intermediate frequency and further amplified. The detector extracts the modulation in the form of audio-frequency currents which, after amplification, actuate the loud-speaker

distant. Selection of the desired station from this jumble of signals depends upon the fact that each station broadcasts on its own individual carrier frequency, and makes use of the remarkable ability of resonant electric circuits to respond to alternating currents of one specific frequency and to reject those of all other frequencies. Several such resonant circuits, arranged so as to be adjustable through a linkage with the tuning dial, allow the listener to tune in the desired station and exclude all others. The tuning dial is equipped with a scale and indicator and is usually calibrated directly in kilocycles, megacycles or television channel numbers.

To amplify the feeble signals supplied by the antenna, the receiver makes use of vacuum tubes or transistors, whose circuits are combined with the selective tuning circuits so that amplification and selection both progress in a step-by-step manner through the radio-frequency portion of the set. Since the late 1930s the superheterodyne principle of amplification has been employed almost exclusively in broadcast receivers (*see* fig. 5). In this system the original carrier frequency of the station, after a small amount of preliminary amplification, is converted to a new and lower intermediate frequency, without effacing the modulation, in order to facilitate further amplification. The intermediate frequency has a fixed value in any given receiver: it remains constant regardless of what station may be tuned in. This simplifies the receiver by reducing the number of resonant circuits that must be made variable for tuning and also affords other technical advantages. In television receivers, there are two intermediate frequencies because of the separate aural and visual carrier waves radiated by the television transmitter.

Following selection and amplification, the signal undergoes a process of detection or demodulation, in which the audio or video information is separated from the radio-frequency carrier; the latter, having served its purpose, is effectively discarded at this point. The audio- and video-frequency signals are then ready to be amplified and applied to the loud-speaker or kinescope tube to reproduce the sound or picture.

8. Colour Television Techniques.—Besides adding interest to the picture for viewers, colour has an appeal to advertisers through its ability to display products in an attractive manner.

Colour television requires studio lighting levels of the order of 400 foot-candles, as compared with 125 foot-candles for monochrome, primarily because of the light lost by absorption in the camera colour separation filters. Also, flat, shadowless lighting is imperative for pleasing colour rendition. Both of these requirements tend to increase the number of lighting fixtures in use at one time and add to the heat load which must be taken up by the studio air-conditioning system.

Colour schemes in scenery and stage props must, of course, be natural, and some of the artifices of monochrome television, such as scenery painted in all gray tones and brown lipstick in makeup, are obviously not permissible. Colour television makes effective use of brightly coloured costumes, but street clothing often must be toned down; light blue shirts, for instance, are preferable to plain white ones.

The skin tones of performers' faces, besides being at the usual centres of interest in a picture, are also the most difficult to reproduce faithfully in colour, so their rendition on a colour monitor is the criterion by which the accuracy of reproduction is most often judged. Since several cameras are ordinarily employed interchangeably for different views in the course of a program, these must be carefully colour-balanced to avoid any perceptible hue changes when the scene shifts from one camera to another. This is accomplished by preliminary alignment of the cameras while they are focused on a colour test chart. Amplifiers and other equipment through which the colour signals pass are adjusted with the aid of a colour bar test signal which is electronically generated. This signal, consisting of yellow, cyan, green, magenta, red and blue colour patches, plus black and white, is also sometimes broadcast as a test pattern prior to the start of a day's programs for the use of viewers in adjusting their colour receivers. As a reference for setting the colour temperature of the white areas of colour monitors used in the studios and other points in a broadcasting system, a standard illuminant C lamp is used.

Television transmitters are essentially no different for colour than for monochrome, but auxiliary equipment providing fine control over phase-, linearity- and frequency-response characteristics is usually necessary since rigid control of these factors is of prime importance to proper transmission of a colour picture.

See also references under "Broadcasting" in the Index volume.

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(W. F. L.)

BROADSTAIRS AND ST. PETER'S, a seaside town and urban district of the Isle of Thanet, Kent, Eng., is 20 mi. E.N.E. of Canterbury by road. Pop. (1961) 16,979. Broadstairs and St. Peter's is a noncorporate member of the Cinque ports (*q.v.*) under Dover. From 1837 to 1851 Broadstairs was a favourite resort of Charles Dickens, who, in a sketch called *Our English Watering-Place,* described it as "left high and dry by the tide of years." A concert pavilion was opened in 1933 and in 1935 the council bought the Northcliffe estate of 263 ac., including a golf course. In Harbour street is York gate, a flint arch built in 1540. A small pier for fishing boats was first constructed in the reign of Henry VIII. The town overlooks seven bays, in one of which, Viking bay, the modern viking ship "Hugin" landed in 1949 with 32 Danes from Frederikssund to commemorate the landing nearby of Hengist and Horsa (*q.v.*). Kingsgate, north of Broadstairs on the coast, changed its name from St. Bartholomew's Gate in honour of Charles II's landing there in 1683; the imitation Norman castle was built in 1760. The North Foreland lighthouse is an adaptation of one built in 1732 on the site of a timber structure of 1636.

BROADWAY, a village and parish of Worcestershire, Eng., stands on the main Oxford road, 21 mi. S.W. of Worcester. Pop. (1951) 2,564. The village, in a picturesque setting at the foot of the north Cotswolds, is frequented by artists, and is noted for its Tudor and Jacobean houses in Cotswold stone on either side of the broad High street; in particular, the gabled Tudor House. The Abbot's Grange (14th century with 17th-century additions) overlooks the green on which a market was held in medieval times, and the 17th-century Lygon Arms is still a hostelry. St. Eadburgh's church (Norman with later additions) stands about a mile from the main village opposite Court farm, which incorporates the 16th-century gatehouse of Broadway Court. The Beacon tower, built in 1797, marks the highest point of the parish. Charles I stayed in Broadway in 1644 and 1645. Buses run to and from Evesham. (Er. H. S.)

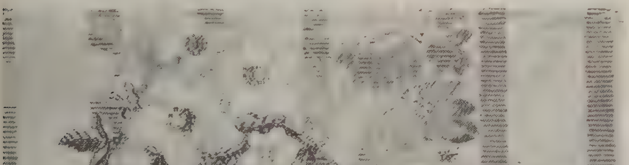
BROCA, PAUL (1824–1880), French surgeon and physical anthropologist noted for his research on the brain and skull, was born on June 28, 1824, at Ste. Foy-la-Grande, Gironde. In 1866 he became a member of the Academy of Medicine in Paris and, in 1867, professor of surgical pathology and later of clinical surgery. He published treatises on cancer, aneurysm and other subjects; in 1861 he announced his important discovery of the seats of articulate speech in the left frontal region of the brain, since known as the convolution of Broca, thus furnishing the first anatomical proof of the existence of brain localization. But his name is associated most closely with the modern development of physical anthropology in France. He founded the Laboratoire d'Anthropologie de l'École des Hautes Études (1858), the Société d'Anthropologie de Paris (1859), the *Revue d'anthropologie* (1872), and the École d'Anthropologie (1876), of which he was named director. His numerous researches were concerned with the science of craniology, for which he originated techniques and methods. He also studied the comparative morphology of the brain, the topography of the skull and brain, and prehistoric trepanations. He died on July 9, 1880, in Paris.

See also his *Mémoires d'anthropologie,* 5 vol. (1871); and "On the Phenomena of Hybridity in the Genus Homo," in E. W. Count, *This Is Race* (1950). (H. V. V.; X.)

BROCADE, a textile to which a design of low relief has been added during the process of weaving. A brocaded textile is easy to identify. On the reverse side the various silk yarns float unattached across the areas where they are not required in the brocaded motifs. As a result, brocade is never reversible. The brocaded portions are woven by hand-shuttles and are entirely independent of the textile itself, which is woven by the automatic throw-shuttle.

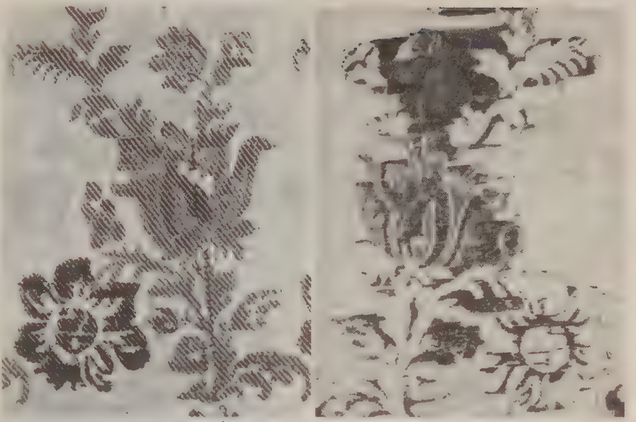
During the process of weaving brocaded textiles, the reverse side is exposed to the weaver and the finished brocaded areas are hidden from view. In the era of hand-drawn looms, as many as 125 strands of silk yarns of varied hues and tints were introduced in each repeat of the large-scaled, elaborate brocaded silks.

Brocading began in ancient times long before the era of silk, when women enhanced the attractiveness of a linen or worsted textile with coloured yarns inserted between the warps (the threads running lengthwise) by means of a primitive bone or metal needle. This method continued to be used up to the invention of the shuttle and the hand-drawn loom. Any of the various types of yarns, such as linen, cotton, wool, silk or the modern synthetic yarns, may be used. These yarns may be woven into a textile of any of the basic weaves—plain, twill or satin—as well as those with woven patterns, including simple and compound weaves in either silk, linen or cotton. The most difficult brocading to produce is that in which both extra warps and wefts (threads that run crosswise to the warps) are used in combination.



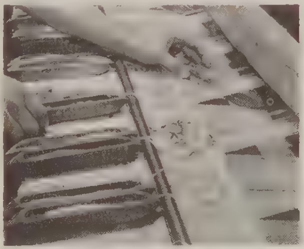
BY COURTESY OF THE SCALAMANDRÉ MUSEUM OF TEXTILES

FIG. 1.—SILK BROCADED TAFFETA AND RIBBED STRIPES OR BANDINGS OF FOLIAGE MOTIFS, WOVEN IN THE LISÉRÉ PROCESS. PATTERN DERIVED FROM THE TIME OF LOUIS XV. (TOP) RIGHT SIDE OF CLOTH; (BOTTOM) REVERSE SIDE SHOWING EXTRA FLOATED WARP THREADS



BY COURTESY OF THE SCALAMANDRÉ MUSEUM OF TEXTILES

FIG. 2.—SILK BROCADED LINEN DAMASK, WITH 16TH-CENTURY ITALIAN DESIGN ON PATTERNED SELF-COLOURED BACKGROUND EMBELLISHED WITH FLORAL MOTIFS. (LEFT) RIGHT SIDE OF CLOTH; (RIGHT) REVERSE SIDE SHOWING UNUSED STRANDS OF SILK



BY COURTESY OF THE SCALAMANDRÉ MUSEUM OF TEXTILES

FIG. 3.—ITALIAN DESIGN LINEN DAMASK (FIG. 2) BEING BROCADED ON 50-IN. LOOM

When the brocaded motifs are small in scale and widely spaced, the intervening unused threads are frequently clipped around the edges of the design; patterned fabric is, in reality, an imitation brocade, known as broché. This method was applied especially to lightweight silks. There is also a variety commonly known as warp brocading in which clusters of extra floated warps are introduced in areas where brocaded strips are desired. This type, however, is correctly known as liséré; it was popular during the reigns of Louis XV and Louis XVI in France when petite floral motifs were introduced in the stripes.

With the invention of the Jacquard machine and automatic weaving in the early 19th century, it became possible to combine the weaving and brocading of textiles in order to increase production. However, in mechanical weaving, when no hand-shuttles are used, the number of colours for brocading is limited to approximately six, and the finished fabric is classed as a "brocaded lampas."

In mills where hand-shuttles are used for brocading in conjunction with the power loom, the shuttles are placed vertically and immediately in front of the weaver at the areas where required on the textile already woven. As certain of the warp threads are raised by means of the Jacquard attachment for the next throw of the shuttle for the basic weave, the weaver slips, by hand, certain of the shuttles resting before him for the colour required in that specific portion of the brocaded pattern.

In the production of a 50-in. brocaded textile, in which the design is repeated twice or more across the width, two weavers work side by side to hasten the weaving. Even so, brocading is a slow and tedious process. Not more than a yard, and often less, is an average day's production; hence its high cost.

Brocading probably originated in the Bronze Age. Fragments of rudimentary brocaded wool fabrics have been discovered in the tree coffins of that era that had been submerged in salty marshes and so preserved. The patterns were obtained by floating coarse wool yarns over several threads that formed crude square, triangular and lozenge motifs. Chinese brocaded silks are known to have been made a couple of centuries before the Christian era. One of the oldest in existence dates from about A.D. 238. Specimens of Persian, Syrian and Sicilian silks from the 11th century and later have been preserved; they are elaborately brocaded with gold threads. The cathedral in Regensberg, Ger., has a 12th-century Siculo-Saracenic brocaded textile woven in Palermo, Sicily, for a robe of Henry IV, emperor of the Holy Roman empire. The kincobs of India were highly desired as the brocaded silks used by Indian princes. They frequently had insets of precious jewels, and gilded silver wire was used in brocading. Spanish artisans brocaded silks with metallic threads.

BY COURTESY OF THE SCALAMANDRÉ MUSEUM OF TEXTILES

FIG. [illegible].—LAMPAS WEAVE WITH INSET MEDALLION OF BROCADED SATIN. DESIGNED AND WOVEN BY FRENCH TEXTILE DESIGNER PHILIPPE DE LA SALLE. 18TH CENTURY

The Lucchese brocaded silks of Italy date from the 14th century; they were followed by those of Florence, Venice and Genoa. The French were weaving brocaded silks in the city of Lyons during the 17th century. The baroque and rococo eras of Louis XIV and Louis XV were known for their magnificent brocades. Upon the revocation of the Edict of Nantes (1685), hundreds of Huguenots migrated to England and settled at Spitalfields in London. As a consequence the English likewise began producing fine brocaded silks in the early 18th century. Some of these are to be seen in the Victoria and Albert museum in London.

The Latin word *brochus*, meaning projected or pointed, and the French words *broché* and *brocart*, originally meaning a sharp-pointed thin rod of iron and later a needle or pointed bobbin, all give clues to the origin of the word brocade. This method of weaving is known in Italy as *broccato* and *spolinato*, which stems from the Italian word *spolino*, the shuttle used to weave the brocaded areas. The Spaniards call it *brocado*. Obviously, the origin is Latin.

See WEAVING: *Jacquard Attachment;* TEXTILES. (J. K. T.)

BROCCOLI. Two distinct plants of the mustard family (Cruciferae) have been called broccoli in the United States. Sprouting broccoli (*Brassica oleracea* var. *italica*), Italian or green sprouting broccoli is a fast-growing, upright, branched, annual plant, two to three feet tall that bears dense, green clusters of flower buds at the ends of the central axis and the branches. Heading broccoli, cauliflower broccoli or broccoli were names formerly applied to slow-growing forms of cauliflower (*B. oleracea* var. *botrytis*). After sprouting broccoli became popular in the U.S. (about 1930, though it had been well known in Great Britain and on the continent for a long time), "broccoli" ceased to be applied to the late form of cauliflower.

Sprouting broccoli is native to the eastern Mediterranean and Asia Minor. It was cultivated in Italy in ancient Roman times, was introduced into England about 1720 and to America probably in colonial times. Like cabbage, of the same species, it thrives in moderate to cool climates. It is propagated by seeds, either sown directly in the field or by transplants. Broccoli reaches harvest in 60 to 150 days, depending upon the variety and the weather. The flavour resembles that of cabbage but is milder. About 40,000 ac. are grown annually in the U.S.; yields average about six tons per acre. *See* also CABBAGE; CRUCIFERAE. (V. R. B.)

BROCHANTITE, a mineral species consisting of a basic copper sulfate, has been found associated with malachite, etc., in copper mines at several places. A microscopical examination of the green copper ores of secondary origin in the Clifton and Morenci districts of Arizona proves brochantite to be of extremely common occurrence mostly intergrown with malachite, which effectually masks its presence. Brochantite crystallizes in the monoclinic system. The crystals are usually small and are prismatic or acicular, or needlelike, in habit; they have a perfect cleavage in one direction. They are transparent to translucent with a vitreous lustre and are of an emerald-green to blackish-green colour. Specific gravity is 3.9; hardness 3.5 to 4. The formula is $Cu_4[OH]_6SO_4$. (L. J. S.)

BROCK, SIR ISAAC (1769–1812), British soldier and administrator, was born at St. Peter Port, in the island of Guernsey, on Oct. 6, 1769. He entered the British army as an ensign in 1785 and by 1797, at the age of 28, he became a lieutenant colonel. He was sent to Canada with his regiment in 1802 and was stationed almost continuously at Quebec, Niagara or York (Toronto), until the outbreak of the War of 1812. He was promoted to the rank of colonel in 1805, and to that of major general in 1811. In 1810 he assumed command of the troops in Upper Canada (Ontario), and was appointed provisional lieutenant governor of the province. In the early months of the war, he was the heart and soul of the defense of Upper Canada. He organized the militia of the province, and on Aug. 16, 1812, took Detroit from the United States army under Gen. William Hull. On Oct. 13 his troops defeated the American invaders at Queenston Heights on the Niagara frontier. During the engagement, however, Brock fell, mortally wounded. For his services in connection with the capture of Detroit he had been gazetted, three days before his death, a knight commander of the order of the Bath.

The best biography of him is F. B. Tupper, *Life and Correspondence of Sir Isaac Brock* (1845). (W. S. WA.)

BROCK, SIR THOMAS (1847–1922), English sculptor, born at Worcester on March 1, 1847, is best known for the Imperial memorial to Queen Victoria in front of Buckingham palace. He was the pupil of J. H. Foley, but was influenced by the romantic movement. He was known primarily as a portrait sculptor and among his portraits are those of Gladstone (1902) and Longfellow (1884), both in Westminster abbey. Also by Brock are the tomb of Lord Leighton in St. Paul's cathedral, busts of King Edward VII (1911), Lord Lister (1913) and Edwin Abbey (1917). His statue of Captain Cook (1914) stands in the Mall in London. His colossal equestrian statue of the Black Prince was set up in the city square in Leeds in 1901. He did seven statues of Queen Victoria and the design for her head on the coinage of 1897. In 1911 he was created knight commander of the Bath. He died in London on Aug. 22, 1922. (I. S. McN.)

BROCKDORFF-RANTZAU, ULRICH, GRAF VON (1869–1928), German foreign minister at the time of the treaty of Versailles and one of the architects of German-Soviet understanding in the 1920s, was born in Schleswig on May 29, 1869. Educated for the law, he entered the diplomatic service in 1894. As German minister in Copenhagen from 1912 to 1918 he supported the Danish policy of neutrality during World War I and was able to maintain German-Danish trade. Appointed secretary of state for the German foreign department on Dec. 18, 1918, and foreign minister on Feb. 13, 1919, he went to the conference of Paris at the end of April and argued in vain for an amelioration of the conditions of peace. Unable to dissuade his government from ratifying the treaty of Versailles, he resigned his post on June 21, 1919. He continued, however, to work for a revision of the treaty (*Dokumente*, 1920; *Dokumente und Gedanken um Versailles*, 3rd ed., 1925) and also for changes in international law. In Nov. 1922 he was appointed ambassador in Moscow, where he and G. V. Chicherin together worked to consolidate the *rapprochement* between Germany and the U.S.S.R. that had been inaugurated by the treaty of Rapallo. The German-Soviet treaty of Berlin (April 1926) counterbalanced the Locarno pact of 1925, which had seemed to link Germany too closely with the western powers. He died while on leave in Berlin on Sept. 8, 1928. Aristocratic in his way of life, the "Red Count" was a convinced democrat in politics.

See E. Stern-Rubarth, *Graf Brockdorff-Rantzau* (1929); H. Helbig, *Die Träger der Rapallo-Politik* (1958). (R. Mo.)

BROCKEN is the highest point (3,747 ft.) of the Harz mountains (*q.v.*). Its huge, granite-strewn dome commands magnificent views in all directions: to Magdeburg and the Elbe, Leipzig and the Thuringian forest. A mountain railway (12 mi.) reaches the summit. In the folklore of north Germany the Brocken holds an important place, and long after the introduction of Christianity traditional rites continued to be enacted there annually on Walpurgis night or witches' sabbath (May 1). It is represented in a famous scene in Goethe's *Faust*.

BROCKEN BOW (Spectre of the Brocken), a phenomenon frequently observed on mountain peaks but recorded in literature with special reference to the Brocken, a peak in the Harz Mountains of Germany, is apparently an enormously magnified shadow of an observer cast, when the sun is low, upon the upper surfaces of clouds that are below the mountain. The shadow, often accompanied by coloured bands, is known as the spectre of the Brocken and is given a mystical significance in the folklore of the mountain. The apparent magnification of size is now explained as an illusion that occurs when an observer judges his nearby shadow to be at the same distance as objects seen through the thin underlying cloud.

The phenomenon of rainbowlike bands around a shadow on clouds and called the Brocken bow or glory is commonly observed from airplanes. When an airplane is flying above a cloud layer in sunlight, a system of coloured rings is seen around the shadow of the airplane on the clouds. This ring or bow has a diameter about the same as or larger than the wingspread of the airplane.

The phenomenon is recognized as one of diffraction (*see* Light: *Diffraction*) and the droplets of the cloud are thought to behave like tiny mirrors which, if the analogy is correct, would produce the same effect as a diffraction screen. The effect is visible only against the shadow. (H. R. B.)

BROCKES, BARTHOLD HEINRICH (1680–1747), German poet who introduced into his country's poetry a new simplicity and feeling for nature, was born at Hamburg, Ger., on Sept. 22, 1680. In 1720 he was appointed a member of the Hamburg senate. He died in Hamburg on Jan. 16, 1747. His poetical works were published under the title *Irdisches Vergnügen in Gott*, 9 vol. (1721–48); he also translated Giambattista Marini's *La Strage degli innocenti* (1715), Alexander Pope's *Essay on Man* (1740), and James Thomson's *Seasons* (1745). His verses, although often artificial and crude in form, express a sincere and reverent attitude toward nature and a religious interpretation of natural phenomena.

See Brockes' autobiography in the *Zeitschrift des Vereins für Hamburger Geschichte*, ii (1847); A. Brandl, *B. H. Brockes* (1878).

BROCKHAUS, FRIEDRICH ARNOLD (1772–1823), German publisher and editor of a famous encyclopaedia, was born at Dortmund, Ger., on May 4, 1772. In 1808 he purchased the copyright of the *Konversations-Lexikon*, which had been started in 1796, and in 1810–11 he completed the first edition of this encyclopaedia, later renamed *Der Grosse Brockhaus;* a second edition under his editorship was begun in 1812. The encyclopaedia reached its 16th edition, 1952–57. In 1818 Brockhaus moved to Leipzig, where he established a large printing house. Among his many literary undertakings were critical periodicals and large historical, bibliographical and reference works. He died at Leipzig, Aug. 20, 1823.

The business was carried on by his sons Friedrich (1800–1865), who retired in 1850, and Heinrich (1804–1874), under whom it was considerably extended. During 1842–48, Heinrich Brockhaus represented Leipzig in the Saxon second chamber. He was made honorary citizen of that city in 1872 and died there on Nov. 15, 1874. He was succeeded by his sons Eduard (1829–1914) and Rudolf (1838–98): Eduard was a member of the *Reichstag* (1871–78).

The business was continued by members of the family and after World War II was established at Wiesbaden.

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BROCKTON, a city of Massachusetts, U.S., is about 20 mi. S of Boston and 30 mi. NE of Providence, R.I. The Brockton standard metropolitan statistical area consists of the city of Brockton and nine towns (Abington, Bridgewater, East Bridgewater, Hanson, West Bridgewater, Whitman, Avon, Stoughton, and Easton), which until the 1950 federal census was classified as part of the Boston area. Pop. (1970), city of Brockton, 89,040; standard metropolitan statistical area, 189,820. For comparative population figures *see* table in Massachusetts: *Population.*

Originally within the boundaries of the Plymouth Colony, the area was sold by the Indians to Myles Standish in 1650 for 7 coats, 9 hatchets, 8 hoes, 20 knives, 4 moose skins, and 10 yards of cotton. Brockton was part of Bridgewater until 1821 and thereafter the town of North Bridgewater until taking its present name in 1874; it was incorporated as a city in 1881.

Shoe manufacturing started in the area about 1750. Just prior to the American Civil War the McKay sewing machine was invented, enabling the uppers and soles of shoes to be speedily sewn together rather than pegged. More than one-half of the shoes worn by the Union Army during the Civil War were made in the area, and "Brockton Shoes the World" became the city slogan.

Certain significant technological developments started in the area. In Whitman the first canal in America was dug; in Bridgewater's foundries the plates for the "Monitor" were cast; steam was first introduced to shoe factories in Stoughton (1870). Brockton also introduced systems of sewage disposal (1893) and street lighting (1884) that were widely copied. Shoe manufacturing declined after 1920, but remained important; diversification developed and more than 400 firms manufacture about 200 different products. (Jo. Gi.)

BROD, MAX (1884–1968), Austrian writer, is perhaps better known as the friend of Franz Kafka (*q.v.*) and editor of his posthumous works than for his own novels. Born on May 27, 1884, in Prague, he studied law and worked as a government official. A convinced Zionist, he left for Palestine in 1939. His interpretation of Kafka, in *Franz Kafka, eine Biographie* (1937; trans. 1947), is controversial. His many novels blend fantasy, mysticism, and eroticism, and are written with narrative skill and limpidity of style. His masterpiece is probably *Tycho Brahes Weg zu Gott* (1916; trans. as *The Redemption of Tycho Brahe*, 1928), a historical novel with a mystical flavour. Other novels—*e.g.*, *Die Frau, nach der man sich sehnt* (1927) and *Zauberreich der Liebe* (1928; *The Kingdom of Love*)—deal sensitively with the problems of love. The essays *Heidentum, Christentum, Judentum* (1921) and *Diesseits und Jenseits* (1946–47) attempt to define a modern Zionist's intellectual position. Also of interest are a life of Heine (1934; trans. 1956) and *Der Meister* (1951; trans. 1951), a novel about Jesus. Brod's autobiography, *Streitbares Leben* (1960), is a valuable source for the cultural life of Prague. Among his last works is a volume of reminiscence and comment, *Der Prager Kreis* (1967). He died in Tel Aviv on Dec. 20, 1968. (H. S. R.)

BRODIE, SIR BENJAMIN COLLINS, 1st Bart. (1783–1862), English physiologist and surgeon, a contributor to the study of joint diseases, was born in 1783 at Winterslow, Wiltshire. He was assistant surgeon at St. George's hospital for more than 30 years. In 1810 he was elected a fellow of the Royal society. Probably his most important work is *Pathological and Surgical Observations on the Diseases of the Joints,* in which he attempts to trace the beginnings of disease in the different tissues that form a joint, and to give an exact value to the symptom of pain as evidence of organic disease. This volume led to measures of a conservative nature in the treatment of diseases of the joints, with consequent reduction in the number of amputations and the saving of many limbs and lives. His name is applied to certain diseases of the bones and joints.

Brodie was created a baronet in 1834, and was the first president of the General Medical council. He died at Broome Park, Surrey, on Oct. 21, 1862.

BRÖGGER, WALDEMAR CHRISTOFER (1851–1940), Norwegian geologist and mineralogist remarkable for the great range of his researches, was born in Christiania (Oslo) on Nov. 10, 1851. He was professor of mineralogy and geology in the University of Stockholm, 1881–90, and from 1890 in the University of Christiania, of which he later became rector. His petrographical memoirs on the Permian igneous rocks of the Oslo province form landmarks in the advance of petrogenic theory and he contributed greatly to the knowledge not only of the rarer minerals, the nephilite-syenite pegmatites of the province, but also of the mineralogy of the Archaean (Early Pre-Cambrian) granite pegmatites of southern Norway. He dealt also with the fossiliferous Paleozoic rocks of the Oslo region and his investigations on the glacial deposits greatly extended the knowledge of the former distribution of land ice in southern Norway. Brögger died at Oslo on Feb. 17, 1940. (C. E. T.)

BROGLIE, the name of a distinguished French family descended from a Piedmontese nobleman, Amedeo Broglia, conte di Cortandone, whose son François Marie (Francesco Maria; 1611–56) emigrated to France in 1643 and took the title comte de Broglie. François Marie served as a cavalry leader and rose to the rank of lieutenant general in the French army before he was killed at the siege of Valenza, in Piedmont, on July 2, 1656. His son Victor Maurice (1646–1727), comte de Broglie, also served in Louis XIV's wars, becoming *maréchal de camp* (brigadier) in 1671, lieutenant general in 1688 and marshal of France in 1724. He died on Aug. 4, 1727.

The eldest son of Victor Maurice, François Marie (1671–1745), 1st duc de Broglie, was born on Jan. 11, 1671. He served continuously in the War of the Spanish Succession and again in Italy in 1733–35, being made marshal of France in 1734. In 1742, during the War of the Austrian Succession, he was appointed to command the French army in Germany, but he had always been the "man of small means," safe, cautious and lacking in daring. The only success that he obtained was in the action of Sahay in Bohemia on May 24–25, 1742, for which he was created duc de Broglie in the following June. He died on May 27, 1745.

His son Victor François (1718–1804), 2nd duc de Broglie, was born on Oct. 19, 1718. He served with his father in Italy and took part, during the War of the Austrian Succession, in the storming of Prague (1741) and in the campaigns on the Rhine (1744–45) and in the Netherlands (1747). During the Seven Years' War, his victory over Ferdinand of Brunswick at Bergen (near Frankfurt) in 1759 won him the rank of marshal of France from Louis XV and that of prince of the Holy Roman empire from the emperor Francis I. Early in July 1789, Louis XVI put him in command of the troops gathered around Versailles with a view to checking the disorders which were to develop into the Revolution and made him minister of war. This attempt was short-lived, and within a few days Broglie had to emigrate. He died at Münster in Westphalia on March 30, 1804.

Charles François (1719–81), comte de Broglie, a younger son of the 1st duc, was born on Aug. 20, 1719. He is chiefly remembered in connection with the *secret du Roi* (*i.e.,* the private, as distinct from the official, diplomacy of Louis XV). There is an edition of his dispatches by D. Ozanam and M. Antoine (1956–). He died at Saint-Jean d'Angély on Aug. 16, 1781.

The son of Victor François Charles Louis Victor (1756–94), prince de Broglie, was born on Sept. 22, 1756. He served with La Fayette and Rochambeau in America and sat in the Constituent Assembly, constantly voting for the reforms proposed. He served as chief of staff to the republican army on the Rhine, but in the Terror he was arrested and guillotined at Paris on June 27, 1794. His final admonition to his little son was to remain faithful to the principles of the Revolution, however unjust and ungrateful.

(Achille Charles Léonce) Victor (1785–1870), 3rd duc de Broglie, the son of Charles Louis Victor, was born in Paris on Nov. 28, 1785. He was added to the imperial council of state as *auditeur* in 1809 and was sent by Napoleon on diplomatic missions to various countries as attaché.

In June 1814, under the first Restoration, he was included in Louis XVIII's chamber of peers. There, after the Hundred Days, he distinguished himself by his courageous defense of Marshal Ney, for whose acquittal he, alone of all the peers, both spoke and voted. On Feb. 15, 1816, he was married at Leghorn to Madame de Staël's daughter Albertine. In politics under Louis XVIII and Charles X he identified himself with the Doctrinaires (*q.v.*), and in the chamber of peers he opposed all reactionary measures.

After the July revolution of 1830 the duc de Broglie was minister of education for a few months and later took office as minister for foreign affairs (Oct. 11, 1832). His main efforts were directed toward establishing closer relations between France and Great Britain and proved fruitful (1) in the final settlement of the Belgian question, (2) during the crisis of Mohammed Ali's first war against Turkey (*see* Eastern Question) and (3) in the negotiations about the troubles in Spain and Portugal. He retired from office in April 1834. In March 1835, however, he became prime minister. He passed strong repressive measures against seditious activities, but resigned in Feb. 1836. From then to 1848 he held himself almost completely aloof from politics, though in May 1847 he was ambassador in London.

The revolution of 1848 was a great blow to Broglie. However, he was elected deputy for Eure in May 1849 and, as a member of the conservative group known as the "Burgraves," did his best to stem the tide of socialism and to avert the reaction in favour of autocracy, which he foresaw. After the *coup d'état* of Dec. 2, 1851, he was one of the bitterest enemies of Napoleon III's regime, though he was heard to remark, with that caustic wit for which he was famous, that the empire was "the government which the poorer classes in France desired and the rich deserved." The last 20 years of his life were devoted chiefly to philosophical and literary pursuits. He died in Paris on Jan. 25, 1870. His writings include *Vues sur le gouvernement de la France* (1861), *Écrits et discours,* three volumes (1863), *Le Libre Échange et l'impôt* (1879) and *Souvenirs,* four volumes (1885–88).

(Jacques Victor) Albert (1821–1901), 4th duc de Broglie, the eldest son of the 3rd duc, was born in Paris on June 13, 1821. After a brief diplomatic career at Madrid and Rome, he withdrew from public life at the revolution of 1848. He had already published a translation of the religious system of Leibniz (1846). He contributed to the *Revue des deux mondes* and to the Orleanist and clerical organ *Le Correspondant.* He was elected to the Académie Française in 1862, while his *L'Église et l'empire romain au IV*^{e} *siècle,* six volumes (1856–66) was still incomplete.

In Feb. 1871 the duc de Broglie was elected to the national assembly as deputy for Eure. A few days later he was appointed ambassador in London. In March 1872, however, in consequence of criticisms of his negotiations on the commercial treaties between Great Britain and France, he resigned his post and took his seat in the national assembly, where he became the leading spirit of the conservative campaign against L. A. Thiers. On the replacement of the latter by Marshal MacMahon, Broglie became president of the council and minister for foreign affairs (May 1873) and later of the interior (Nov. 26). His tenure of office was marked by an extreme conservatism, which roused the bitter hatred of the republicans, while he alienated the legitimists by his friendly relations with the Bonapartists and the Bonapartists by an attempt to effect a compromise between the rival claimants to the monarchy. The result was the fall of the cabinet on May 18, 1874. Three years later (May 16, 1877) he was entrusted by MacMahon with the formation of a new cabinet, with the object of securing a new chamber more favourable to the reactionaries. The result, however, was a decisive republican majority. The duc de Broglie resigned office on Nov. 20. Not being re-elected in 1885, he abandoned politics for historical work. He died in Paris on Jan. 19, 1901. His *Memoires,* two volumes, were published in 1938–41. His son Victor (1846–1906) was the 5th duc.

See Jean de La Varende, *Les Broglie* (1951). (G. de B. de S.)

(Louis César Victor) Maurice (1875–1960), 6th duc de Broglie, the grandson of the 4th duc, was born in Paris on April 27, 1875. A distinguished physicist, he was elected to the Académie Française in 1934 and foreign member of the Royal society in 1946. He died at Neuilly on July 15, 1960.

Louis Victor Pierre Raymond (1892–), prince de Broglie, the physicist who was awarded the 1929 Nobel prize in physics for his discovery of the wave nature of the electron, was born at Dieppe on Aug. 15, 1892, the younger brother of the 6th duc.

Appointed professor of theoretical physics at the Henri Poincaré institute at the Sorbonne in 1928, he became titular professor in the faculty of sciences in 1932. He was a member of the Académie des Sciences from 1933 and its permanent secretary from 1942. He was elected a foreign member of the Royal society in 1953 and a member of the Académie Française in 1944.

When the prince de Broglie took up the study of theoretical physics there were two seemingly contradictory theories of light: the wave theory, according to which light behaves like a continuous train of waves; and the corpuscular theory, according to which it behaves like a hail of bullets. The revolutionary theories of Planck and Einstein led physicists to accept the dual character of light, but the prince de Broglie took a further step. In 1924 he arrived at the idea that matter, just as much as light, could behave either as a wave or as a corpuscle. He worked out formulas to establish the parallelism between the motion of a corpuscle and the propagation of a wave with which it is associated. In 1927 experimental confirmation of the wave theory of matter put forward by the prince de Broglie was provided by C. J. Davisson and L. H. Germer in New York and G. P. Thomson in Aberdeen. The conception of matter-waves has dominated all subsequent speculations about the ultimate elements of matter and light.

See *Jubilé scientifique de M. Maurice de Broglie* (1947); A. Georges, *Louis de Broglie, physicien et penseur* (1953). (W. J. Bp.)

BROKE (Brooke), **ARTHUR** (d. 1563), English poet and author of *The Tragicall Historye of Romeus and Juliet* (1562), the poem on which Shakespeare based *Romeo and Juliet*. It is written in rhymed verse and was taken from the French translation of one of Matteo Bandello's *Novelle* (1554–73; Fr. trans., 1564–82). Broke altered the original; for example, he developed the character of the nurse and changed various aspects of the last scene. Shakespeare followed him in these changes, which indicates that it was Broke's poem that he used as a source and not the original story of Bandello.

Broke died in a shipwreck in 1563 while crossing to join the English troops in France. Modern editions include P. A. Daniel, *Brooke's Romeus and Juliet and Painter's Rhomeo and Julietta* (1875); G. Bullough (ed.), *Narrative and Dramatic Sources of Shakespeare*, vol. i (1957).

BROKE, SIR PHILIP BOWES VERE, 1st Baronet (1776–1841), English sailor, famous for his capture of the "Chesapeake" during the War of 1812, was born at Broke hall, near Ipswich, Eng., on Sept. 9, 1776. He entered the navy in 1792, served as a lieutenant at the battle of St. Vincent (1797) and became a captain in command of a frigate in the channel fleet in 1801. He was appointed to the "Shannon," a 38-gun frigate, in 1806, proceeding in her in 1811 to Halifax, Nova Scotia, where he commanded the force in that area. On June 1, 1813, while cruising off Boston, Mass., he challenged Capt. James Lawrence of the "Chesapeake" to leave port and "try the fortunes of our respective flags." The "Chesapeake," also a frigate of 38 guns, had left port before the challenge was delivered. After the second broadside the U.S. ship fell afoul the British and Broke led a boarding party of 60 men over her side. After "a desperate but disorderly resistance," in which Broke himself was wounded, the "Chesapeake" was captured, the action lasting only 15 min.

Broke's success was due to his high standard of gunnery practice, the example of which had a salutary effect on the Royal Navy in subsequent years. Coming as it did after a series of frigate defeats, Broke's action won him the popular title of "Brave Broke," and he was made a baronet (1813). His wound incapacitated him from further active service. He died in London, Jan. 2, 1841. (C. C. L.)

BROKEN HILL (Zambia): *see* Kabwe.

BROKEN HILL, a mining city in the west of New South Wales, Austr. It is situated at a height of 1,000 ft. on the eastern flank of the Barrier range, 30 mi. from the South Australian border and about 700 mi. by rail from Sydney on the eastern seaboard. Pop. (1966) 30,023. The region is subarid, hot in summer and mild (with frost) in winter; mean annual temperatures range from 51° to 78° F., with absolute extremes of 27° and 116° F.; average annual rainfall is 9 in., but varies from 3.6 to 17.0 in. Proclaimed a city in 1907, Broken Hill has imposing public buildings, a technical college, a large hospital and modern shops and hotels. It is connected by daily air services with Sydney, Melbourne and Adelaide, South Australia and by triweekly passenger train services to Sydney and Adelaide. Economic and business relations are mainly with South Australia, largely because there was no direct rail connection with Sydney until 1927. Broken Hill is a base for the flying doctor services.

The mining field is one of Australia's greatest mineral assets. For its size, the ore body is the richest individual producer of lead, silver and zinc in the world. The main lode is a long, tightly folded lens which is curved in plan and arched in longitudinal section. Its known length is about 3¾ mi., over-all width up to 500 ft. and vertical dimension up to 2,000 ft. The crude ore is milled at Broken Hill by gravity and flotation processes into a lead concentrate containing 72%–77% lead and 16–40 oz. of silver per ton, and a zinc concentrate containing 51%–53% zinc. Most of the lead concentrate is smelted and refined at Port Pirie, South Australia, for the production of lead, silver and a little gold and copper, the remainder being shipped overseas. The zinc concentrate is shipped principally to Risdon, Tasmania, and to Avonmouth, Eng., or Swansea, Wales, for the production of zinc and cadmium. Both concentrates are a source of sulfur for the manufacture of sulfuric acid. Broken Hill is also the centre of a prosperous pastoral area.

The mining companies contribute to all welfare organizations in the city. One notable amenity is the regeneration area, a strip of country half a mile wide enclosed within a vermin-proof fence and encircling the city. Regeneration of native flora in this area was supplemented by the planting of trees and shrubs with the result that the drift-sand menace was arrested. Water supply problems were met by the construction of the Stephens creek and Umberumberka dams, 10 and 19 mi. distant respectively, and by 63 mi. of 24-in. welded steel pipeline from the Darling river. Annual evaporation is reduced by dusting powdered cetyl alcohol on the surfaces of the reservoirs to form a tenacious monomolecular film. (H. L. J. K.)

BROKER, an agent middleman who for a commission or fee (often referred to as brokerage) bargains or negotiates between his principal and a third party for the purchase or sale of goods, real estate, services, stocks and bonds, insurance and commodities without having title and usually without having possession of the property or rights involved. When he does have possession, the broker holds it as bailee or in a fiduciary capacity. The broker is an independent contractor, not a servant, and may be an individual, firm or corporation. Every broker is, in a sense, an agent, but every agent is not a broker since agency (*q.v.*) is a broader and more comprehensive term. A broker is often required by statute or ordinance to take out a licence and pay a tax or fee for the privilege of engaging in the brokerage business.

He typically is a specialist dealing in one type of product who makes available to his principals vital information about the conditions of the market such as current offering prices, available supply and demand, general market conditions and the best method of distribution. The arrangement between broker and principal is usually impersonal, is usually for a sole specified venture, and involves a minimum of control.

The broker has whatever authority he requires to carry out his duties, whether this authority is expressly conferred on him or implied as necessary. His acts are binding on his principal unless he exceeds his authority. A third person is not legally bound by secret instructions given by the principal to the broker but he is under obligation to ascertain the extent of the broker's authority. The broker, for example, may be given authority to warrant goods but usually has no such implied authority unless it is customary in his trade. He usually has no authority to buy and sell on credit unless such authority is expressly conferred or is customary in the trade. In the sale of merchandise, he has no authority to pass title and usually has no implied authority to receive payment unless the name of the principal is not disclosed. He usually has no authority to make contracts in his own name.

Brokers may have authority to fix or agree to prices and to bind their principals to sell or buy at such prices; they may be required to submit bids or offers to their principals for acceptance; or they may be limited to sales made at prices specified by their principals. A broker can neither purchase from nor sell to his principal unless the latter expressly assents thereto. The law does not permit a broker to act in his own personal interest to the detriment of his principal, as, for example, by making a secret profit for himself. This usually prevents a broker from representing opposite parties.

Brokers may have continuous relations with their principals or may act under a separate contract for each transaction. Contracts can usually be terminated at will unless granted for a definite period. If a broker is employed for a definite period and the principal revokes the contract earlier without cause he may be held liable for damages.

Merchandise Brokers.—There are three main classes of brokers selling goods: the free-lance broker, the manufacturer's agent and the selling or sales agent. Free-lance brokers are usually not limited to territory and may sell or buy at any place where opportunity offers. They are not permanently bound to any principal and may represent anyone who wants to sell or buy goods in their field. Manufacturer's agents sell part of the output of certain manufacturers with whom they maintain continuous relations and are limited as to territory, price and terms. They usually represent two or more manufacturers selling noncompeting equipment such as furniture and home furnishings or cloth and clothing. Selling agents usually sell the entire output of a given line of goods for one or more manufacturers with whom they maintain continuous relations. They often help to finance their clients or offer other sales and merchandise assistance, and, in essence, act as the sales department for their principals.

The chief functions of these three types of merchandise brokers are to sell goods, give information and advice to their principals, and, in the case of selling agents, sometimes to help to finance their principals. These brokers usually sell to industrial buyers, wholesalers, institutions, and some of the larger retailers. One broker may represent several producers and thus make it possible to spread sales expense. Commissions to merchandise brokers typically vary from a fraction of 1% to 10% or more depending upon the services rendered and the commodities handled.

Canners, farmers, and many food manufacturers find brokerage the most economical channel to dispose of their seasonal production and so merchandise brokers are relatively important in food and farm products lines where they earn a typical commission of 2%. Dry goods and machinery are also important merchandise brokerage lines. The seller has a completely flexible selling cost as the broker is paid only in proportion to the sales volume he develops. Since the broker handles a variety of products from different sources, originators of goods and services often chafe at the inability of the broker to devote his efforts to a particular single individual product and often prefer to set up individually controlled selling or buying systems when volume justifies the fixed expense.

Buying Brokers.—Brokers who specialize in buying merchandise for their principals are known as buying brokers and are found in lines such as hardware, groceries, produce, textiles and apparel. These brokers may locate goods for their principals, negotiate purchase contracts, sometimes secure quantity prices by combining the orders from several buyers, close the contracts and give their principals price information. There are some brokers who represent buyers but receive their commissions from sellers. The Robinson-Patman amendment to the Clayton Anti-Trust act prohibited U.S. brokers from rebating brokerage commissions to the buyers, but statutory prohibition of rebating is not commonly found in other parts of the world.

In the U.S. garment trade, most resident buyers are paid by their retail store clients by fees, commissions or a combination of the two. Their services consist of locating desirable goods for examination by store buyers, giving information on fashions and prices and making purchases. Many resident buyers are independent business concerns operating for profit; others are owned co-operatively by a number of stores. In the hardware trade, purchasing agents operate to give wholesale buyers information on prices and sources of goods and to make purchases for them. They obtain a large part of their income from the sale of information services to their subscribers.

Services allied to those performed by brokers are carried on by factors and commission merchants. Factors aid in financing and marketing, principally by assuming responsibility for credit transactions by purchasing or lending on accounts receivable and also by lending funds to business concerns. The factor can and often does act as a broker in finding purchasers for goods as well as acting as principal in the credit operations. Factors were originally found principally in the textile trades but have spread into other lines. Commission merchants typically offer for sale goods that are sent to them on consignment and receive as commission a percentage of the sales price. They are thus brokers and also agents in that they pass title to the buyer. Factors and commission merchants often have actual or constructive possession of the principal's goods, often have a special property interest in the goods, and often make contracts without disclosing the name of the principal. Their authority and powers are necessarily broad.

Real Estate Brokers.—The real estate broker or, as he is known in Great Britain, the estate agent, is the intermediary who brings parties together and assists them in negotiating a contract of sale or rental of real estate. He usually performs his services for a commission or fee. Many brokers also negotiate loans and mortgages incident to transfers of real estate. The powers of real estate brokers are limited as compared to those of real estate agents, and their duties and powers are to be found in the law of the locality and in specific agreements between parties. The real estate broker's authority is derived from the express act or word of his principal as well as being implied from the principal's conduct. If a broker exceeds his authority, his principal may repudiate the transaction and the broker will lose his commission. As in other brokerage situations, the broker's authority to act may be general or special. General authority gives the broker broad powers to represent and to bind the principal while special authority limits him to representing the principal for a specific purpose.

Insurance Brokers.—*United States.*—The insurance broker is one who performs brokerage activities in the field of insurance. He ordinarily represents the purchaser of insurance and is remunerated on a commission basis. Most of his income is derived from the insurance company, although it is not uncommon for him to charge the insured a fee for services performed not compensated by commission. The broker solicits the insurance from potential purchasers and assists them in selecting the type of insurance they desire.

The broker is customarily paid a commission on the premium by the insurer with whom he places the business, the commission being less than that paid an agent of the company. The broker is not the company's agent but is free to place his business with any insurance firm. In fire, marine and casualty insurance, the broker occupies an extensive and important position. Individuals or companies that have large and varied insurance programs often find it desirable to have a representative transact business for them. In these fields, brokers have substantial importance because of the many different policies that firms must buy and because the technicalities are such as to make the advice and knowledge of the expert broker valuable. Brokers place their business in domestic or foreign markets, depending upon its characteristics and the availability of coverage, and perform an indispensable function in the marketing and placement of insurance and in the distribution of insurable risks. Brokers can and do represent some companies as agents and act as brokers for other parts of their business. (O. R. G.)

Great Britain and Other Countries.—There are very early references to insurance brokers in England. As long ago as 1395 a statute referred to their office as one of antiquity and credit. In 1598, Stow's survey of London stated there were 30 in the City of London and described them as "such as are assistance to the merchants. . . . in the writing of insurance and policies and such like." The "assistance" thus given was the securing of personal guarantors to cover loss by perils of the sea. This task of assistance is the keynote of the insurance broker's function and has been considerably extended by a number of factors which have operated in the second half of the 19th century and during the present century. There is the vast economic expansion of this period which has made it necessary for insurance brokers to extend their activities beyond marine insurance (*q.v.*). This was coupled with the entry of Lloyd's (*q.v.*) into the nonmarine insurance market and the development of composite insurance companies, that is to say, companies transacting several classes of insurance business instead of specializing in one only. The development of workmen's compensation insurance also gave a great impetus to the broadening of activities.

There is no legal definition of an insurance broker but an old case, *Power* v. *Butcher* (1830) 10. B & C 329, refers to an insurance broker as one who arranges policies of insurance. Generally, the opinion is that the broker is agent to the insured. There are no specific legislative controls, such as licensing or registration, over brokers in England. Anyone can set up as a broker and describe himself as such. There are, however, three bodies which can exercise control over brokers. The committee of Lloyd's will elect a person or firm as a member once ability to comply with financial requirements and evidence of character and integrity have been shown. Such are known as Lloyd's brokers and a large proportion of the business of Lloyd's is derived from this source. Secondly, the Corporation of Insurance Brokers lays down qualifications as to suitability and rules of conduct by its members, who may be styled incorporated brokers. These are the two most influential bodies; many Lloyd's brokers are also incorporated brokers, and vice versa. In 1948 an Association of Insurance Brokers was formed to cater for the needs of those who are not members of either of the other two bodies. Most of the leading brokers in England are members of Lloyd's and of the corporation.

The Corporation of Insurance Brokers defined a broker, whether a person or firm, as one whose sole business is the placing and arranging of insurances on commission. It insists there shall be no preferential treatment in the placing of such business with any particular insurer. This is the key test, but it would be wrong to assume that to the modern broker this is the primary duty. The forms of insurance are so varied that a high level of technical knowledge is required. Competition demands a shrewd knowledge of the market so that the best terms, as measured by premium charged, breadth of coverage and policy conditions can be obtained for clients. At the top level, brokers provide not only these services but technical services to insurers such as surveying and policy drafting. On the nonmarine side of insurance, this is particularly important where Lloyd's is concerned and, although companies have their own survey departments, joint surveys by company and broker surveyors are by no means infrequent. In general brokers act in an advisory capacity, safeguarding the clients' interests while the terms are negotiated, at the renewal of the policy and throughout its life.

Although serving the insured in this way, their remuneration is received from the insurer by way of commission, usually called brokerage. The rate varies according to the class of business and, in a competitive market, between one insurer and another. It is understood that Lloyd's pay is a higher rate of brokerage than the companies.

Although insurance brokers play a dominant part in arranging insurance, their position regarding losses is less significant, though by no means unimportant. Both in marine and nonmarine insurance, brokers may submit claims on behalf of the insured. Losses are settled by average adjusters and loss assessors respectively and brokers will hold a watching brief for the insured. On the marine side, large brokers maintain a claims department, but this is not usual in the nonmarine branch. Any remuneration for services where claims are settled must be paid by the insured, and there is a marine custom to pay brokers for their service $\frac{1}{2}\%$ for total losses and 1% for partial losses on the amount of indemnity. No such practice exists in nonmarine insurance.

The foregoing relates to direct insurances; *i.e.*, the placing by the insured of their insurance direct with insurers. The volume of liabilities thus accumulated has made it imperative for insurers to effect reinsurance in order to limit their net liabilities to reasonable proportions. Such reinsurance arrangements are effected through reinsurance brokers, who may specialize in reinsurance as such, or may be a separate department or a subsidiary of a direct broker. The *expertise* required by the reinsurance broker is the capacity to view the merits of a block of insurance business rather than of any single contract. Reinsurance is arranged internationally and remuneration is on the basis of a commission on the net premium ceded, plus a profit commission calculated on the basis laid down in the reinsurance contract, commonly known as a treaty.

The most powerful and influential insurance market in the world is London, and the part played by insurance brokers there is clearly important. Elsewhere, the position varies. Thus, in the Scandinavian countries, there are no brokerage firms as such and business is obtained through general agencies. In the far east, brokers are little more than mere business getters, placing their business with those insurers who will pay the highest commission. In Greece and in some parts of the near and middle east, brokers are remunerated by agents or subagents from the latter's commission.

Registration and licensing practice varies. Thus in Quebec province, the distinction between agent and broker has been eliminated by statute and a licence can be obtained only on the recommendation of an insurance company. In South Africa, a broker must be licensed in accordance with the requirement of the department of revenue. Specific provision, however, as to Lloyd's brokers are made in the Insurance act of 1943. Licence is required by law in France, but none is required in Belgium. In South America, most of the states adopt the practice of statutory licensing.

As in England, the power of the broker varies with the size and the functions he can carry out. In the Netherlands, Belgium and France, the position is not dissimilar but is characterized by the bourse system. This is a form of exchange, possibly inspired by Lloyd's organization and operates notably at Rotterdam and Antwerp and to a lesser extent at Paris. Here again are highly competitive markets where brokers do considerable work by way of surveying, valuing property to be insured, drafting policies, and collecting and distributing premiums. To some degree they may be more influential than their counterpart in London in varying the insurance contract. They also take some part in loss settlements by submitting claims and eventually collecting the payments from the various insurers interested and paying the proceeds to the insured, for which they may receive a remuneration of 1% of the amount of the indemnity.

An unusual feature found in London is the combination of agent and broker whereby the same firm may be an agent to one company for some class of business, but a broker in every other respect. (*See* also INSURANCE.) (GA. S.)

Ship Brokers.—Another example of brokerage service is that provided by ship brokers who are so important in the buying, selling and chartering of ships and shares in ships, solicitation of cargoes for export, auctions of freight unloading, settlement of claims for lost cargoes and maritime disasters and providing ships' needs. Ship and maritime brokers operate in the principal ports of the world. Similar activities are performed by trucking brokers as well as by brokers specializing in air transportation or operating in all lines of transportations. (*See* also SHIPPING: *Ship Operation.*)

Future Contracts on Exchanges.—Brokers are important in executing contracts for the future purchase or sale of goods on the commodity or produce exchanges such as the Liverpool Corn Trade association, the Chicago Board of Trade, the New York Cotton exchange and the Chicago Mercantile exchange. They represent principals in buying and selling contracts, but on the exchanges they are principals and are liable for the fulfillment of their contracts. The rules of the exchanges require them to be men of financial responsibility and they must maintain margins with the exchange or its clearing association to cover their open contracts. The brokers, in turn, usually require their principals to keep sufficient margins with them to cover fluctuations in the prices of the commodities covered by the contracts. All contracts are presumed to be made in accordance with the rules of the exchange on which they are executed.

(*See* also COMMODITY MARKET; FUTURES.)

Stockbrokers.—Representatives of stock brokerage houses perform brokerage services in the distribution and sale of securities in the primary and secondary securities markets. In the primary markets, where bonds and stocks are offered by issuers to potential buyers, stockbrokers perform the service of bringing buyers and sellers together. Brokers may represent either buyers or sellers and their powers depend upon express or implied contracts. For example, they may agree to offer a security issue on a "best-efforts" basis, receiving a commission on each individual share or bond sold, or they may act as underwriters who guarantee a successful sale and agree to indemnify the issuer if they fail.

In the secondary markets, stockbrokers make possible the sale of stocks and bonds between investors, either on organized exchanges or in the "over-the-counter" market. They buy and sell the securities for the principals by effecting private sales or, on the floors of public stock and bond exchanges of which they are members, upon instructions from the customers. A stockbroker's powers are ordinarily much broader than those of ordinary brokers since they are often entrusted with the possession of securities and generally act in their own names.

The mechanics of trading are many and varied and provide a rich example of the middleman function of brokers. Service is a very important facet of brokerage activities and nowhere is this more apparent than in finance and insurance. The relation between the broker and his customer is ordinarily one of confidence, good will and service. Custom, law and good business policy combine to lay down accepted business practices. (*See* also STOCK EXCHANGE.)

Funds borrowed by members of a stock exchange or by factors in textile lines or by any of the many types of these varied and valuable middlemen are generally known as broker's loans and the monies received enable them to carry customers. Many lines of trades have broker's markets in which the public is not active but where members of an exchange trade with one another on their own behalf or on behalf of clients. They perform an indispensable function in their specialized lines of commerce. Probably their major stock in trade is that of experience and knowledge of their individual lines made available to many and varied potential clients. They are usually bound to only limited or no-agency contracts and are thus able to offer to new as well as to old potential traders expert middleman services that contribute to an economical, efficient and productive system of commerce.

See also references under "Broker" in the Index.

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(O. R. G.)

BROME, ALEXANDER (1620–1666), English Royalist poet who wrote drinking songs and satirical verses against the Rump parliament, was probably an attorney in the lord mayor's court or the court of the king's bench. Izaak Walton wrote an introductory eclogue to Brome's *Songs and Other Poems* (1661), a volume of songs, ballads, epistles, elegies and epitaphs. Brome's gaiety and wit won him the title of the "English Anacreon" in Edward Phillips' collection, *Theatrum Poetarum* (1675). Brome edited and contributed to a translation of Horace (1666), and was the author of a comedy, *The Cunning Lovers* (1654). He also edited two volumes of plays by Richard Brome, to whom he was not related.

Brome died in London on June 30, 1666.

BROME, RICHARD (d. 1652), English dramatist and the most considerable of the minor Jacobean playwrights, was originally Ben Jonson's servant. This does not necessarily imply a lack of education in Brome, since Jonson expected his servant to read "a piece of Virgil, Tacitus, Livy or some better book to his friends at supper," and Brome probably acted as his amanuensis. The relationship of master and servant developed into one of friendship, and knowledge of Brome's personal character is chiefly drawn from Jonson's sonnet to "my old faithful servant and by his continued virtue my loving friend . . . Mr. Richard Brome," prefixed to Brome's *The Northern Lasse* (published 1632).

Brome, together with Nathan Field, came under Jonson's personal tuition, and Jonson's influence is apparent in the way in which he develops his plots, his strongly marked characters and the amount of curious information to be found in his plays. Yet, although following the technique of his master, he lacks his greatness of mind. Brome was, however, a conscientious and able craftsman, continuing the Elizabethan dramatic tradition until the theatres were closed by order of parliament in 1642. His comedies are full of pictures of contemporary London and its life, which are of historical value and interest.

The Northern Lasse (produced 1629?) made Brome's reputation as a dramatist and was the most popular of his plays, although *A Joviall Crew* (acted 1641, published 1652) is considered to be his best work. There are 15 of his comedies extant; two volumes of his plays were edited by Alexander Brome (of whom he was no relation) in 1653 and 1659.

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BROME GRASS, the name applied to the species of the genus *Bromus*. They are annual or perennial, low or tall grasses, with closed sheaths, flat leaf blades, and open or contracted panicles of large spikelets. About 50 species occur in temperate regions; nearly half of the U.S. species are introductions, mostly from Europe.

B. catharticus, a native of Argentina, was introduced into the southern U.S. about mid-19th century and now appears spontaneously there. It is known as rescue grass or Schrader's brome grass, and is a short-lived perennial adapted to humid regions with mild winters. Growth starts in the fall, continues through the winter, and the plants mature in early summer. It supplies a good amount of forage and is relished by livestock. *B. inermis*, the smooth brome, also known as Hungarian brome grass and awnless brome grass, also a perennial, is extensively grown for pasture and hay in the northern portion of the Great Plains from northern Kansas to Montana and eastward to Pennsylvania. It is adapted especially to regions of moderate rainfall and low to moderate summer temperatures.

Two distinct types of smooth brome, differing in growth behaviour, are recognized; viz., the southern type which came originally from central Europe and is best adapted to the northern parts of the central Great Plains that have long dry periods and high summer temperatures, and the northern type, introduced from Siberia and adapted to Canada and the northern Great Plains.

As a pasture or hay grass, smooth brome, because of its palatability and high protein content, its good volume of leafy forage, and its tolerance to grazing and trampling, scarcely has an equal in the area of its best adaptation.

B. tectorum, known as downy chess, cheatgrass, or downy brome, is either an annual or summer annual, introduced from Europe, that has spread to some extent over portions of the 11 far western states, except Arizona and New Mexico, occupying chiefly plains, foothills, and intermountain valleys. Although it is one of the less palatable species of brome grasses, its local abundance where better plants are absent makes it a valuable early spring grazing plant for sheep, cattle, and horses. A number of other annual species, although they furnish good grazing when young, occupy large areas on the Pacific coast, but because their season is very short are often considered to be troublesome weeds.

(J. M. BL.)

BROMELIACEAE, the bromelia or pineapple family, plants with three-parted flowers like lilies, but with contrasting sepals and petals. Except for a single African member, *Pitcairnia feliciana*, the family is strictly American, consisting of 45–50 genera and about 1,800–2,000 species. It includes the pineapple (*q.v.*), the giant *Puya raimondii* of Peru and Bolivia, and the so-called Spanish moss, an air plant that grows down from trees and wires in long gray streamers, and that ranges from southeastern United States to Argentina. Bromeliads are mostly herbs with a rosette of leaves and a spike or panicle of flowers. They are remarkable for the development of scales that enable the leaves to absorb water and even food efficiently; roots, being unnecessary, are often aborted, as in the Spanish moss, and the various species are able to thrive from the coastal deserts of Peru and the treeless crests of the Andes to the treetops of the Brazilian rain forest.

Bromeliads of the rain forest also collect water in their tank-like rosettes, thus providing the normal abode for animal life varying from protozoa to frogs. *Anopheles* mosquitoes, responsible for much malaria in Trinidad and southern Brazil, sometimes breed in the rosettes, making the plants a hazard that needs control.

BY COURTESY OF THE NEW YORK BOTANICAL GARDEN; PHOTOGRAPH, BASSETT MAGUIRE

PUYA RAIMONDII, LARGEST KNOWN BROMELIAD, RISING 40 FT. FOUND IN THE SOUTH AMERICAN ANDES

Bibliography.—Lyman Bradford Smith, "Bromeliad Malaria," *Smithsonian Report*, pp. 385–398 (1952). For nontechnical articles, especially on horticultural genera such as *Vriesea, Aechmea, Billbergia,* and *Cryptanthus, see* the *Bromeliad Society Bulletin,* vol. i (1951). *See* also Jack Kramer, *Bromeliads, the Colorful House Plants* (1965).

(L. B. Sm.)

BROMIDE, in chemistry, a compound of bromine with an element or an organic radical, or a salt of hydrobromic acid, such as sodium bromide. Various bromides are of value in medicine, especially potassium bromide. *See* also Bromine.

BROMINE, a chemical element that is a deep-red fuming liquid. It is corrosive to metals, irritating to the skin, and as a result of its unpleasant odour was given the name bromine from the Greek *bromos*, meaning "stench." In nature, bromine is found only in compounds. Traditionally obtained from salt deposits, the element is now produced in commercial quantities by the processing of ocean water. The most important use of bromine is in the manufacture of ethylene bromide, one ingredient of "antiknock" fluid for motor fuels.

Bromine is designated by the chemical symbol Br. Its atomic number is 35 and the atomic weight is 79.904.

History and Occurrence.—A. J. Balard in France first isolated bromine from bitterns left after the evaporation of Mediterranean sea water, and recognized it as an element in 1826. In the United States, brines of Pennsylvania were worked for their bromine content as early as 1846; production from the salt deposits near Stassfurt, Ger., was reported in 1858 and dominated the market for about 50 years. Successful commercial recovery of bromine directly from ocean water was begun in 1934 near Wilmington, N.C.

In nature bromine occurs only in combination with metallic elements as bromides, and is distributed widely but very sparingly. Natural brines and saline deposits, particularly those containing much calcium chloride, are the richest sources. Their bromine contents vary from 0.02% to 0.5%. Ocean water contains 67 mg. per litre (0.0065%), and the proportion in the entire crust of the earth is about 0.0006%. By far the greatest part of the available bromine occurs in the ocean.

Production.—Much bromine has been recovered from brines or saline mother liquors in Michigan, Ohio, West Virginia, Arkansas and California, U.S., at Stassfurt and Alsace in Europe, and from the Dead sea. Other actual or potential sources of bromine have been reported in the Crimean region (Sivash sea) and in Italy, India, Siberia and north Africa. The processes employed generally involve the passage of chlorine and steam upward through a ceramic tower, at the top of which a spray of hot brine is introduced. Bromine is liberated, passed out with the steam and condensed. The condensate is separated into aqueous and halogen layers, the former of which is returned to the tower while the latter is subjected to purification by fractional distillation. Bromine about 99.8% pure can be obtained, the impurities being chlorine, moisture and organic matter.

After mid-20th century most of the bromine produced in the United States was extracted from ocean water. Other ocean-water plants were operating in Amlwch, Anglesey, Wales, in Hayle, Cornwall, Eng., and at Marseilles, France. In ocean-water processes, air is used in place of steam and the halogen-laden air is mixed with sulfur dioxide so that hydrobromic and sulfuric acids are formed. These are absorbed in water from which the bromine is recovered by steaming out with chlorine as described.

Uses.—Most of the bromine produced after 1928 has been used in the manufacture of ethylene bromide, an ingredient of antiknock fluid for motor fuel.

This compound is also used in soil sterilization to destroy nematodes and other pests. Other major uses of bromine are in the manufacture of methyl bromide, a fumigant employed for insect control in the food industries, and of various dyes, particularly the bromo-indigos. Methylene chlorobromide has been found useful as a fire extinguisher fluid. Certain compounds such as bromoform and acetylene tetrabromide find application as gauge liquids because of their high specific gravity. Others are added to plastics (polymeric organic materials) to impart fire retardancy. Elemental bromine has relatively few uses, and it is generally converted into other compounds by the producer. Some is used as a laboratory reagent, for syntheses and as an oxidant in analytical chemistry.

Bromides of potassium, sodium, calcium, strontium, lithium and ammonium, as well as a number of organic bromides, have been used widely in medical practice. Their sedative action has been found to be a useful adjunct in the treatment of many conditions involving nervous hyperexcitability such as hysteria and nervous insomnia. Silver bromide is of great importance in photography. In common with silver chloride and iodide, it is light sensitive. Modern photographic emulsions contain one or more of these halides, the combination of silver bromide and a small amount of silver iodide being used in negative films.

Lithium and calcium bromides are useful as desiccants in air conditioning, while ferric and aluminum bromides serve as catalysts in bromination reactions. The alkali bromates are used as oxidizing agents. The baking characteristics of wheat flour are improved by the addition of a trace of potassium bromate.

Physical Properties (*see* accompanying table).—Bromine is the only nonmetallic chemical element that is liquid under ordinary conditions. It is classed in Group VIIA of the periodic system between chlorine and iodine in the halogen family. Bromine has two stable isotopes, Br^{79} and Br^{81}, and radioactive isotopes with mass numbers of 74–78, 80, 82–85 and 87–89 have been prepared. The electron arrangement in the outer (N) orbit is: $4s^2$, $4p^5$. Bromine liquid and vapour are diatomic over a wide range of temperatures. The vapour is amber in colour, the liquid a dark amber-red and the solid almost black. A saturated solution in water is

Physical Properties of Bromine

Freezing point	−7.2° C.
Boiling point	58.8° C.
Critical temperature	311° C.
Critical pressure	102 atm.
Specific heat of liquid	0.113 cal./g.
Heat of fusion at m.p.	15.8 cal./g.
Heat of vaporization at b.p.	44.8 cal./g.
Density, 25° C.	3.105 g./ml.
Coefficient of expansion	0.0011
Viscosity, 20° C.	0.99 centipoise
Surface tension, 20° C.	41.8 dynes/cm.
Refractive index, 25/D	1.6475
Dielectric constant	3.2

orange-red and on cooling yields a red crystalline hydrate of composition $Br_2.10H_2O$. The solubility in water at 25° C. is 3.35 g. per 100 g. of solution but in the presence of bromide ions it is greatly increased through formation of the complexes Br_3^- and Br_5^-. Bromine is very soluble in all organic solvents but reacts with many. The electrode potential for the reaction $2Br^- \rightarrow Br_2 + 2e$ is -1.065 v. The covalent radius of bromine in its molecule is 1.11×10^{-8} cm. and the ionic radius of bromide ion is 1.96×10^{-8} cm. Liquid bromine is a poor conductor of electricity, having a resistance of about 1.1×10^{11} ohms per centimetre at 20° C.

Chemical Properties.—The properties of bromine are intermediate between those of chlorine and iodine. It is a strong oxidizing agent and combines violently with certain elements, such as phosphorus, aluminum and potassium, giving off light. Sodium, on the contrary, reacts only in the vapour state with dry bromine. Hydrogen and bromine unite explosively when heated; light and catalysts also bring about their reaction. In the presence of moisture bromine attacks many metals to produce bromides. The most stable valence state of bromine is -1, but positive valences of 1, 3 and 5 are known, compounds of bromine in pentavalent form (bromates) being especially easy to prepare. Aqueous solutions of bromine possess a strong bleaching and oxidizing action attributed to the formation and decomposition of hypobromite ion:

$$Br_2 + H_2O \rightarrow Br^- + BrO^- + 2H^+,$$
$$BrO^- \rightarrow Br^- + \tfrac{1}{2}O_2.$$

In the presence of alkalies, bromate and bromide are formed:

$$3Br_2 + 6\,OH^- \rightarrow BrO_3^- + 5Br^- + 3H_2O.$$

The latter reaction is reversed upon addition of an acid and furnishes a convenient laboratory method for preparing bromine solution.

Organic compounds react with bromine in three major ways: (1) unsaturated hydrocarbons form addition products; (2) compounds with replaceable atoms or groups yield substitution products; and (3) some substances such as aldehydes may be oxidized. The nature of the solvent used and the reaction conditions (temperature, light, catalysts) exert much influence on the reaction.

$$RCH{:}CH_2 + Br_2 \rightarrow RCHBr.CH_2Br \qquad \text{(addition)} \quad (1)$$
$$RCH_2CH_3 + Br_2 \rightarrow RCHBrCH_3 + HBr \qquad \text{(substitution)} \quad (2)$$
$$RCHO + Br_2 + H_2O \rightarrow RCOOH + 2HBr \qquad \text{(oxidation)} \quad (3)$$

Compounds.—By burning bromine vapour in a stream of hydrogen one obtains hydrogen bromide (HBr), a very irritating, toxic gas which under atmospheric pressure condenses to a liquid at −67° C. and freezes at −87° C. The gas is colourless but fumes strongly in moist air, having a great affinity for water. The aqueous solution (hydrobromic acid), which may also be obtained by the hydrolysis of phosphorus tribromide, forms constant-boiling mixtures whose composition depends upon the pressure; at 760 mm. the mixture contains 47.6% HBr and boils at 124.3° C. Hydrobromic acid resembles hydrochloric acid closely but is somewhat more easily oxidized. It is one of the strongest acids. Upon treating the hydroxides, oxides or carbonates of many metallic elements with hydrobromic acid, or with bromine and a reducing agent, bromides are obtained. Their properties in general are similar to those of the corresponding chlorides, and they can be converted to chlorides by the action of chlorine. Several nonmetallic and amphoteric elements react with bromine to form liquid bromides which decompose in water.

Hypobromous acid (HBrO) and the hypobromites are unstable, decomposing easily to oxygen and hydrobromic acid or to bromates and bromides (*see* above). Bromic acid ($HBrO_3$) exists only in aqueous solutions, which may be obtained by adding the calculated quantity of diluted sulfuric acid to a solution of barium bromate. The acid is a strong oxidizing agent and it decomposes to oxygen and bromine when heated. Alkali bromates are produced by the auto-oxidation and reduction of bromine in alkaline solution and may be crystallized from a concentrated solution since they are less soluble than the bromides which are formed simultaneously.

Bromine does not react with oxygen under ordinary conditions but the oxides Br_2O, BrO_2 and Br_3O_8 have been prepared by special methods. They are all unstable and must be kept at low temperatures. Other compounds of bromine include the fluorides, BrF, BrF_3 and BrF_5; iodine bromide, IBr; cyanogen bromide, CNBr; sulfur bromide, S_2Br_2; and phosphorus oxybromide, $POBr_3$. At low temperatures bromine forms a series of mixed crystals with chlorine, but there is evidence for the existence of the compound BrCl in the liquid and vapour states. (*See* HALOGENS.)

Many thousands of organic bromine compounds have been synthesized and studied. Bromine can be introduced conveniently into most organic molecules and can be replaced by other groups more readily than can chlorine. A bromo compound resembles the corresponding chloro derivative but is usually more dense, less volatile, less combustible and less stable.

Analytical.—Inorganic bromides may be detected and determined by their reaction with silver nitrate in dilute nitric acid, producing a pale yellow precipitate of silver bromide which is sparingly soluble in ammonia. They may also be oxidized to bromates, which can be titrated iodometrically (J. H. van der Meulen, 1931), or to free bromine, which can be distilled from a chromic acid solution.

See also references under "Bromine" in the Index.

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BROMLEY, one of the 32 London boroughs constituting Greater London, Eng., lies on its southeastern perimeter bordered (west) by Croydon, (north) by Lewisham, Greenwich, and Bexley, and (south and east) by Kent County. This outer London borough was established on April 1, 1965, under the London Government Act 1963 (*see* LONDON), through the amalgamation of the former boroughs of Beckenham and Bromley, and the urban districts of Orpington, Penge and part of Chislehurst and Sidcup (all of which were in Kent). Its parliamentary constituencies comprise Beckenham, Bromley, Chislehurst (part), and Orpington. With an area of 61.3 sq.mi. (159 sq.km.), it is the largest London borough. Pop. (1967 est.) 302,660. Bromley is mainly residential with a large area of the Metropolitan Green Belt to the south and more than 1,500 ac. (600 ha.) of open spaces, including the commons at Hayes, Keston, Chislehurst, St. Paul's Cray, and Farnborough.

The Crystal Palace, an exposition hall built in 1851 and destroyed by fire in 1936, stood on Sydenham Hill; the grounds now contain the National Recreation Centre and a Concert Bowl (opened 1964). The former palace of the bishops of Rochester (rebuilt 1775) is now the Stockwell College of Education. Wickham Court, a Tudor manor house, is the Coloma College of Education. The Bromley parish church, destroyed by bombing in 1941 (restored 1957) retains its 14th-century tower and Norman font; it contained the tomb of Samuel Johnson's wife, Tetty (d. 1752). Bromley College, founded in 1666 under the will of Bishop John Warner to provide a home for 40 widows of "loyal and orthodox" Anglican clergy, is a cloistered red brick building with fine wrought-iron gates. The priory at Orpington, a pre-Reformation rectory probably dating from 1270, houses a museum. The earl of Chatham (the elder William Pitt) lived at Hayes Place (now demolished) and William Pitt the Younger was born there in 1759. Charles Darwin lived and worked at Down House, Downe, now a museum of Darwin relics, and there wrote the *Origin of Species*. St. Nicholas' Church, Chislehurst, contains tombs of the Walsinghams, Bettensons, and Sydneys. Camden Place, built by William Camden, the antiquary, in 1609, was the home of the exiled Napoleon III and the empress Eugénie. A memorial cross to Eugène, the prince imperial, who was killed in the Zulu War (1879), stands on Chislehurst Common. H. G. Wells was born at 57 High Street, Bromley, in 1866; a plaque marks the site. Pett's Wood was vested in the National Trust in 1927 as a memorial to William Willett, the promoter of daylight saving, who lived in Chislehurst until his death in 1915. Educational institutions include Bromley Technical College (opened 1959), the Ravensbourne College of Art and Design (1962), Eltham College for boys, and Farrington's School for girls (at Chislehurst).

Charters dated 862 and 955 deal with a tract of land that became the Manor of Bromley. The bishops of Rochester were lords of the manor, and they resided at Bromley Palace until 1845. In 1205 King John granted a charter to hold a Tuesday market; in 1477, a further charter changed the market day to Thursday and granted the right to hold two annual fairs (discontinued 1865). The railway reached Penge in 1839 and had crossed the district by 1860, resulting in its growth as a residential area. The Chislehurst Caves, chalk mines developed in the 18th and 19th centuries, were used as air-raid shelters during World War II.

Bromley is served by the Southern Region of British Rail and by London Transport buses and coaches. Light industry (chiefly papermaking, mechanical engineering, and the manufacture of electrical goods, scientific instruments, and office supplies) is sited mainly at Elmers End and in the Cray Valley. The British Scientific Instruments Research Association Laboratories are at Elmstead Woods, and the Wellcome Research Laboratories at Langley Court. Bromley has a considerable shopping and business centre with large office blocks. (AL. H. W.)

BRONCHIECTASIS is a dilatation of one or more of the bronchi, or larger air passages of the lungs. Usually it is of a cylindrical or saccular type, the latter being more serious because the cavity cannot empty itself as readily. The causative factors may be congenital, although diseases (often inflammatory) of the lungs may cause a narrowing of the branches with a gradually developing distention beyond the narrowed portion. It is most commonly secondary to some form of bronchitis and may date back to infancy as the result of inflammatory measles, whooping cough, tuberculosis, etc. Pressure on the wall of a bronchus by a tumour, enlarged glands, etc., also may cause this condition. The symptoms are cough and copious expectoration, and diagnosis is made by the clinical history, physical findings and X-ray examination. The principles of treatment are symptomatic relief, postural drainage and in some instances surgery. *See* LUNG, DISEASES OF: *Bronchiectasis;* HEART AND LUNG, SURGERY OF: *Bronchiectasis.* (F. L. A.)

BRONCHITIS is the often vaguely used term for an inflammation of all or part of the bronchial tree, through which the air passes into the lungs (*see* RESPIRATORY SYSTEM, ANATOMY OF). During the passage through the bronchi, microorganisms and other foreign bodies are removed from the air by tiny hairlike structures called cilia, which project from the cells that line the bronchial wall. These cilia exhibit a wavelike motion and sweep the foreign material upward toward the trachea and larynx. Because of this irritation a thick mucous and a thinner serous secretion are produced by glands in the bronchial wall and aid in the elimination of the foreign material.

Such material and the secreted mucus stimulate nerve endings in the bronchial wall and initiate the cough reflex. Coughing then completes the expulsion of the foreign material and of the secreted mucus from the bronchial tree. All these factors together, and often in a vicious circle, cause an inflammation of the bronchi, which is called bronchitis. This can be caused either by a sudden and rapid attack upon the bronchi by infectious, physical, or chemical agents, resulting usually in a relatively short disease, called acute bronchitis, or by long-standing, repetitive injury that results in protracted and often permanent damage to the bronchial mucosa, called chronic bronchitis.

Acute Bronchitis is defined by some as a symptom caused by a great number of agents, and not as a specific disease. It is most frequently caused by viruses responsible for upper respiratory infections and is, therefore, often part of what is called the common cold. It is also a common sequel to influenza, whooping cough, and measles, as well as to infections by pyogenic (pus producing) organisms, such as streptococci and staphylococci. Acute bronchitis can also be precipitated by a variety of physical and chemical agents, such as hot and/or toxic gases inhaled by fire victims; war gases, such as mustard and chlorine; fumes of strong acids, ammonia, organic solvents; and dusts containing silica and beryllium.

The first sign of acute bronchitis is usually an irritating unproductive cough, often accompanied by anterior chest pain. With the ensuing secretion, the cough becomes productive of more or less viscous material, which, depending on the causative agent, may or may not be purulent. If the damage to the lining of the bronchi is severe enough to cause tissue destruction and rupture of small engorged blood vessels, the expectoration may be blood streaked. In severe cases the swelling of the bronchial mucosa and the presence of the sticky secretion in the bronchi cause obstruction to the airflow with shortness of breath and wheezing. The condition is then called asthmatic bronchitis (in contrast to bronchial asthma, where the obstruction to the airflow is caused mostly by bronchial muscle spasm on an allergic, noninflammatory basis). Fever is present in acute bronchitis whenever the causative agent produces a general systemic reaction.

Treatment has to be both symptomatic and specific. Steam inhalation, bronchodilators, and expectorants will usually relieve the symptoms, while specific chemotherapy (according to the sensitivity of the infecting organisms) and removal of or from the noxious physical or chemical agent will take care of the underlying cause.

The course of the disease is commonly short, two to four days, if the specific treatment is successful. Main complications are the development of pneumonia in untreated or drug-resistant infectious cases and the precipitation of cardiac or pulmonary failure in the aged, very young, or debilitated persons, particularly those with previous cardiac or respiratory problems. Untreated or unmitigated acute bronchitis may develop into chronic bronchitis.

Chronic Bronchitis refers to long-standing inflammation of the bronchial tree. The continuous injury to the lining has destroyed many of the cells, the cilia are absent, and the defense mechanism against invading foreign material is lost. Scarring has produced narrowing, rigidity, and distortion of the bronchial tubes, predisposing to chronic infection and hypersecretion of viscous mucous material.

A chronic, deep, and productive cough is the main symptom. It is difficult to suppress and actually should not be suppressed, since the abundant secretion has to be eliminated to avoid the ever present danger of severe superimposed infection.

Excessive and prolonged smoking may be one of the causes and is certainly the most aggravating factor of chronic bronchitis. Sudden changes in temperature, cold and damp climate, and dusty surroundings increase the severity of the symptoms.

Chronic bronchitis predisposes to the development of pulmonary fibrosis and emphysema, and episodes of acute bronchitis and pneumonia are frequent, since the respiratory tract is more susceptible to invasion by pathogenic microorganisms.

Since the damage to the bronchial tree is largely irreversible, the treatment has to be symptomatic, consisting of expectorants and bronchodilators. Occasionally, drugs to suppress paroxysmal coughing may be necessary but should be used sparingly, because they are addictive and because expectoration is necessary. Of primary importance is the prevention of superimposed infections either by careful watching for early signs or by using prophylactic antibiotics. An adjustment of the patient's living and working conditions to the largely irreversible condition is an essential factor in treatment.

See S. Davidson, *The Principles and Practice of Medicine,* 7th ed. (1964); P. B. Beeson and W. McDermott (eds.), *Cecil-Loeb Textbook of Medicine,* 11th ed. (1963). (R. H. E.; D. K.-W.)

BRONG-AHAFO REGION stretches across the west African Republic of Ghana from the western border to the Volta region, its chief boundary on the north and east being the Black Volta and Volta rivers. Pop. (1960) 587,920. Area 15,273 sq.mi. Created in 1959 from the western and northern parts of the original Ashanti (*q.v.*) region, the Brong-Ahafo region has three principal physical divisions: (1) in the centre, a westward continuation of the Kwahu plateau of Voltaian sandstones, rising to 2,000 ft. and forming the watershed between south-flowing rivers (Bia, Tano) and right-bank tributaries of the Volta; (2) south of this divide a dissected peneplain of Pre-Cambrian metamorphic and intrusive rocks averaging 1,000 ft. elevation; (3) a fairly steep descent northward from the plateau to a plain of Voltaian sandstones mostly below 500 ft. Near Bui in the northwest resistant rocks along the Black Volta cause rapids potentially useful for hydroelectricity.

South of Wenchi the annual rainfall generally exceeds 50 in.; vegetation and soils resemble those in the adjoining part of the Western region. North of Wenchi the rainfall is in places less than 45 in. and the thin sandy soils, exposed to dry harmattan winds, support savanna woodland.

The forested southwestern section, especially around Sunyani, is economically the best developed (cocoa, timber). In marginal areas coffee is of increasing importance but the prospects for food crops are limited by remoteness and lack of communications. In the northern savanna section the long dry season (Nov. to March) precludes cultivation of the usual forest crops and yams predominate, especially around Atebubu; maize (corn) and cassava are also grown. Nevertheless, much of this section is uninhabited because of tsetse diseases, poor soil and communications, and perhaps from the former prevalence of slave raiding in this zone between Ashanti and the north.

Throughout the region large settlements are the exception; most places have 500–1,000 inhabitants or less. The chief concentrations are along the three main roads leading from Kumasi northward through Wenchi, Nkoranza and Atebubu, and along the road leading from Kumasi through Sunyani and Dormaa-Ahenkro to the Ivory Coast. Even the east-west secondary road between Kete-Krachi and Atebubu in the northeast savanna tract forms an active farming zone, largely for immigrant communities from northern Ghana.

The regional capital is Sunyani (pop. *c.* 12,000). Former administration of this widespread region as part of Ashanti tended to make Kumasi the main focus of routeways, and new links with transverse lines of communication are needed to make Sunyani an effective administrative centre. The headquarters of the administrative centre are Sunyani, Goaso, Wenchi and Atebubu.

(Er. A. B.)

BRONGNIART, ADOLPHE THÉODORE (1801–1876), French botanist best known for his work on fossil plants, was the son of the geologist Alexandre Brongniart. He was born in Paris on Jan. 14, 1801. In 1831 he became assistant to R. L. Desfontaines at the Muséum d'Histoire Naturelle, and two years later succeeded him as professor, a position he continued to hold until his death on Feb. 18, 1876.

Brongniart's paper on the classification and distribution of fossil plants (1822) was followed by others bearing chiefly upon the relation between extinct and existing forms. His important *Prodrome* (contributed to the *Grand dictionnaire d'histoire naturelle*, 1828) brought order into chaos by a classification in which the fossil plants were arranged, with remarkably correct insight, along with their nearest living allies; it formed the basis of all subsequent progress in that direction. It is of special botanical interest because, in accordance with Robert Brown's discoveries, the Cycadeae and Coniferae were placed in the new group *Phanérogames gymnospermes*. In this book attention was also directed to the succession of forms in the various geological periods.

Brongniart's great *Histoire des végétaux fossiles*, which itself was not destined to be more than a colossal fragment, was published in successive parts from 1828 to 1837. His other important palaeontological contributions are his observations on the structure of *Sigillaria* (*Arch. Mus. Hist. Nat.*, vol. i, 1839) and his researches on fossil seeds, of which a full account was published posthumously in 1880.

His memoir "Recherches sur la génération et le développement de l'embryon des Phanérogames" (*Ann. Sci. Nat.*, vol. xii, 1827) contains the first valuable account of the development of the pollen; as well as a description of the structure of the pollen grain, the confirmation of G. B. Amici's (1823) discovery of the pollen tube, the confirmation of R. Brown's views as to the structure of the unimpregnated ovule (with the introduction of the term *sac embryonnaire*). It shows how nearly Brongniart anticipated Amici's subsequent (1846) discovery of the entrance of the pollen tube into the micropyle, fertilizing the female cell.

Brongniart's systematic work is represented by a large number of papers and monographs, many of which relate to the flora of New Caledonia, and by his *Énumération des genres de plantes cultivées au Muséum d'histoire naturelle de Paris* (1843; 2nd ed., 1850), which is a landmark in the history of classification in that it formed the starting-point of the system, modified successively by A. Braun, A. W. Eichler and A. Engler, later adopted in Germany.

With J. V. Audouin and J. B. A. Dumas, his future brothers-in-law, he established the *Annales des sciences naturelles* in 1824; he also founded the Société botanique de France in 1854, and was its first president.

For accounts of his life and work see *Bull. de la Soc. géol. de France* (1876), and *La Nature* (1876); the *Bulletin de la Soc. bot. de France* for 1876, vol. xxiii, contains a list of his works.

BRONGNIART, ALEXANDRE (1770–1847), French mineralogist and geologist, whose work as director of the Sèvres porcelain factory and the researches of an able band of assistants enabled him to lay the foundations of ceramic chemistry. The son of the eminent architect who designed the Bourse and other public buildings of Paris, he was born in that city on Feb. 5, 1770, and became professor of natural history in the Collège des Quatre Nations. In 1800 he was made director of the Sèvres factory, a post which he retained to his death, and in his hands it became the leading factory in Europe.

He succeeded René Just Haüy as professor of mineralogy in the Museum of Natural History; but he did not confine himself to mineralogy, for among his contributions is the division of reptiles into the four orders of Saurians, Batrachians, Chelonians and Ophidians. Brongniart died in Paris on Oct. 7, 1847. His *Traité des arts céramiques* (1844) is a classic.

BRONSART VON SCHELLENDORF, PAUL (1832–1891). Prussian soldier and general staff officer, was born at Danzig on Jan. 25, 1832. He entered the Prussian guards in 1849. During the war of 1870 he was chief of a section on the great general staff, and conducted the preliminary negotiations for the surrender of the French at Sedan. As minister for war (1883–89) he carried out many important reforms in the Prussian army, in particular the introduction of the magazine rifle. He was appointed in 1889 to command the 1st army corps at Königsberg, and died on June 23, 1891, at his estate near Braunsberg. Bronsart's military writings include two important works: *Ein Rückblick auf die taktischen Rückblicke* (2nd ed., 1870); and *Der Dienst des Generalstabs im Frieden und im Kriege* (1st ed., 1876; 3rd ed., revised by General Meckel, 1893; new ed. by the author's son, 1904), a comprehensive treatise on the duties of the general staff. Of the latter, the edition of 1893 was translated into English and issued officially to the British army as *The Duties of the General Staff*; the edition of 1904 was reissued in English by the general staff, under the same title, in 1905.

BRÖNSTED, JOHANNES NICOLAUS (1879–1947), Danish physical chemist, is best known for his theory of acids and bases. He was born Feb. 22, 1879, at Varde, West Jutland. After receiving degrees in chemical engineering (1899) and chemistry (1902) from the University of Copenhagen, and after brief employment in an electro-technical concern, Brönsted became professor of physical chemistry at the university and professor of inorganic chemistry at the Polytechnic institute (1908). In 1930 he became director of the Physico-Chemical institute in Copenhagen. His contributions comprise studies in general thermodynamics, including a new system dealing with the relation between heat and work, chemical affinity, interaction theory of electrolytes, separation of isotopes (with G. Hevesy), reaction kinetics, thermodynamic properties in relation to molecular size and colloidal and high molecular weight phenomena. A proponent of an acid-base theory and an authority on the catalytic properties and strengths of acids and bases, he considered it possible to write all reactions of acids with bases in the familiar symmetrical form:

$$\text{Acid}_1 + \text{Base}_2 \rightleftharpoons \text{Base}_1 + \text{Acid}_2$$

His career and honours included the Oersted medal in 1928;

visiting professor at Yale in 1929; honorary member of the British Academy of Arts and Sciences in 1929; fellow of the Royal society in 1935; and election to the Danish parliament in 1947. He wrote texts in inorganic and physical chemistry. He died December 17, 1947, in Copenhagen. *See* ACIDS AND BASES: *Brönsted-Lowry Definition.* (V. Bw.)

BRONTË, CHARLOTTE (1816–1855), **EMILY** (1818–1848) and **ANNE** (1820–1849), English novelists, were all three distinguished for the regional quality of their work and Charlotte and Emily for passion and imaginative power. The personalities of women in conflict with their natural desires and their social condition were presented by Charlotte with a frankness and ardour that marked a new stage in the 19th-century novel, while Emily's fierce and tragic *Wuthering Heights* was unparalleled in her time both in its primitive power and its intricate dramatic form. They were the children of Patrick Brontë, an Irishman, who was born at Emdale, County Down, March 17, 1777. His paternal name was Brunty, but he changed the spelling in England, apparently to conform with that in Nelson's title of duke of Brontë. Although humbly born, he was able to enter St. John's college, Cambridge, in 1802. Apart from his own savings, he was helped by the Wesleyan Methodists, who were strong in County Down and not yet wholly detached from the established church. Methodist connections and influences pervade the Brontë background and allusions to Methodism make sparse but significant appearances in the sisters' writings. Their passion has been interpreted as a Methodist passion transferred to secular objects. Patrick Brontë took his degree in 1806 and became curate in succession at Wethersfield, Essex; at Hartshead, Yorkshire, where he met and married in 1812 Maria, daughter of Thomas Branwell of Penzance, a Methodist, and where his elder daughters Maria (1813–25) and Elizabeth (1814–25) were born; and at Thornton, Yorkshire, where Charlotte was born on April 21, 1816, Patrick Branwell on June 26, 1817, Emily Jane on July 30, 1818 and Anne on Jan. 17, 1820. Three months after Anne's birth, her father became rector of Haworth, nine miles from Bradford, where he remained for the rest of his life. There Mrs. Brontë, a delicate woman, died of cancer on Sept. 15, 1821.

After Mrs. Brontë's death her sister Elizabeth Branwell joined the household at Haworth. Branwell was her favourite, but she instructed the girls, especially in needlework, and did her duty by them. She had no sympathetic intimacy with them, however, and her austere Methodism oppressed them, especially Anne. Branwell was educated by his father, a man of marked intelligence (he published books and stimulated his children's intellectual interests), fond of his family but eccentric and unsocial in his habits, though a conscientious parson. Thus the children were left very much to themselves. They read whatever they could lay hands on, including newspapers, and rambled on the moors. They were happy and very precocious, but this sequestered upbringing left the girls with a crippling shyness and deprived Branwell of the companionship of his equals, which might have proved steadying.

In 1824 Mr. Brontë sent Maria and Elizabeth to school at Wakefield but soon transferred them to the recently opened Clergy Daughters' school at Cowan Bridge, near Kirkby Lonsdale, Lancashire, where Charlotte and then Emily joined them. The fees were very low, the food unattractive and the discipline harsh. When Charlotte recorded her memories of this school in the "Lowood" of *Jane Eyre* she was unaware of exaggerating. Her description was challenged, however, and the subject has been much debated. It is agreed that, during the months the Brontë sisters were there, the school was badly run and the girls sickly. What exaggeration there was derived from the keen sensibilities of a highly intelligent and passionate child, who saw her two elder sisters sicken and taken home to die, an experience that left deep traces on both Charlotte and Branwell.

Charlotte and Emily returned home in June 1825 and for over five years the children learned and played there. Here belongs the inception of those sustained imaginative games, issuing in an enormous output of midget books, written in minute script, which have attracted much attention. The four children invented the Kingdom of Angria and jointly elaborated its wars, its politics, its aristocracy and their feuds and loves. At some time, probably in 1831 when Charlotte was sent to Miss Wooler's school at Roe Head, near Huddersfield, Emily and Anne seceded and founded their own Kingdom of Gondal, leaving Charlotte and Branwell to conduct the affairs of Angria. These complex romantic sagas were kept going by the sisters well into their twenties. Negligible as literature, they were the training ground of the Brontë genuis. Themes and situations in their published work were first adumbrated here and worked on at all stages from adolescence to maturity. Many Angrian chronicles are extant, but all the Gondal prose has been destroyed. It is, however, plain from the manuscripts that many of Emily's poems are dramatic utterances of Gondal characters, and from them it has proved possible to draw a dubious outline of the lost corpus. The Angrian and Gondal daydreams have a deep psychological interest. Charlotte early recognized the compensatory nature of her dream and was troubled by guilt at the discrepancy between it and the sober, restricted life before her. There is no sign that Emily felt this division. She filled Gondal with the growing weight of her own thoughts and emotions until the fantastic husk fell off and Gondal was revealed as Yorkshire. Anne wrote Gondal verse and prose but her novels are strictly and responsibly realistic, bearing no trace of the dream, which may have become, for her, chiefly a medium of communication with Emily. Branwell's tragedy seems to have been that he ceased to be able to distinguish between obsessive daydream and reality.

At Roe Head, where she stayed a year, Charlotte made lasting friendships with Mary Taylor and Ellen Nussey; her correspondence with Ellen, which continued till her death, has provided much of our knowledge of her. In 1832 she came home to teach her sisters and for three years they lived, studied and wrote together at Haworth. The whole family delighted in drawing and all except Charlotte were musical. The moors, with their changes of weather and season, were their exhilarating playground. In all their books the Brontës show themselves countrywomen. In 1835 Charlotte returned to Roe Head as a teacher. She wished to improve her family's position and this was the only outlet that was offered to her unsatisfied energies. Branwell, moreover, was to be started on his career as an artist, and it was needful to supplement the family resources. Emily accompanied her as a pupil but was too wretched with homesickness to remain, and her place was taken by Anne. The work with its inevitable restrictions was uncongenial to Charlotte. She fell into ill-health and melancholia and took fright at the state of health of the always delicate Anne, who left at the end of 1837. In the summer of 1838 Charlotte terminated her engagement. Emily, who had spent six exhausting months as teacher in Miss Patchett's school at Law Hill near Halifax, had likewise resigned her post, and the sisters were at home again.

In 1839 Charlotte declined a proposal from the Rev. Henry Nussey, her friend's brother, and some months later one from another young clergyman. In the same year she and Anne made brief and unsuccessful experiments as governesses. The hardships and anomalies of the position are reflected in their novels and impressed public opinion, but it is doubtful if Charlotte, touchy and inhibited by her duties from imaginative creation, could ever have been contented in such a post. Anne endured better and presently established herself with the Robinsons at Thorpe Green, near Boroughbridge, Yorkshire, where she stayed for four years (1841–45). At the same time Charlotte's ambition to make the practical best of her talents and the need to pay Branwell's debts urged her to spend some months as governess with the Whites at Upperwood House, Rawdon. Branwell's talents for writing and painting, his good classical scholarship and his social charm had engendered high hopes of him. He had sent specimens of his writing to Wordsworth but had received no encouragement; Charlotte, at about the same time (Jan. 1837), had had a similar experience with Robert Southey. At the end of 1837 Branwell had set up as a portrait painter in Bradford and had worked steadily for a year, but he was fundamentally unstable, weak willed and intemperate, and the venture collapsed. After six months as tutor in Broughton-in-Furness, he was working as clerk-in-charge at Sowerby Bridge on the Leeds and Manchester railway by Sept. 1840 and from there was transferred to Luddenden Foot, but was dismissed in Jan. 1842 for culpable negligence.

Meanwhile his sisters had planned to open a school together, which their aunt had agreed to finance, and in Feb. 1842 Charlotte and Emily went to Brussels as pupils in the Pensionnat Heger to improve their qualifications in French and acquire some German. Emily also studied and later taught the piano. The talent displayed by both brought them to the notice of M. Constantin Heger, a fine teacher and a man of unusual perception. Charlotte was on the whole happy, though as a staunch Protestant she despised her Catholic surroundings. Emily, while working with stubborn resolution, pined for the liberty of home. The death of Miss Branwell in October summoned them to Haworth. She had bequeathed each of her nieces a sum that may have amounted to £300—specification is lacking—but they put their money aside for a greater need. Emily remained at Haworth to keep house while Branwell joined Anne as tutor at Thorpe Green and Charlotte returned to Brussels as pupil-teacher. She stayed there during 1843 but was lonely and depressed. Her friends had left Brussels and Mme. Heger appears to have become jealous of her. The nature of Charlotte's attachment to M. Heger and the degree to which she understood herself have been much discussed. His was the most interesting mind she had yet met and he had perceived and evoked her latent talents. His strong and eccentric personality appealed both to her sense of humour and to her affections. She offered him an innocent but ardent devotion, and he tried to repress her emotions. The letters she wrote to him after her return may well be called love letters. When, however, he suggested that they were open to misapprehension, she stopped writing and applied herself, in silence, to discipline her feelings. Shirley's indignation at Moore's assumption that she loves him (in her novel, *Shirley*) may well reflect part of her reaction. However we interpret them, her experiences at Brussels were cardinal to her. She received a strict literary training, became aware of the resources of her own nature and gathered material that served her, in various shapes, for all her novels.

In 1844 Charlotte endeavoured to start a school she had envisaged in the parsonage itself, as her father, whose sight was failing, could not be left. Prospectuses were issued, but no pupils were attracted to distant Haworth. In 1845 Anne left the Robinsons, and soon afterward Branwell was dismissed, charged with making love to his employer's wife. The sisters believed the fault lay with Mrs. Robinson and Charlotte transmitted this view to Mrs. Gaskell, who embodied it in the first edition of her *Life of Charlotte Brontë*, but was forced by Mrs. Robinson's representatives to withdraw and apologize for the passages in question. Whatever happened, it finished Branwell. He spent the last three years of his life at Haworth, incurring debts, drinking, taking opium, alternately blaspheming and repenting, until he died of his excesses, a profound grief to his father and sisters, an obstacle to his sisters' hopes and a great and tragic stimulus to their genius.

In autumn 1845 Charlotte came across some poems by Emily and this led to the publication in 1846 of a joint volume of *Poems by Currer, Ellis and Acton Bell;* the pseudonyms were assumed to preserve secrecy and avoid the special treatment they believed reviewers accorded to women. The book was issued at their own expense. It received few reviews and only two copies were sold. Nevertheless, a way had opened to them and they were already trying to place the three novels they had written. By midsummer 1847 Emily's *Wuthering Heights* and Anne's *Agnes Grey* had been accepted by Newby, but Charlotte had failed to place *The Professor*. She had, however, nearly finished *Jane Eyre,* begun in Aug. 1846 in Manchester where she was staying with her father for an operation to his eyes; and when Smith, Elder and Co., declining *The Professor,* declared themselves willing to consider a three-volume novel with more action and excitement in it, she completed and submitted it at once. It was accepted, published less than eight weeks later, on Oct. 16, 1847, and had an immediate success. In December Newby brought out *Wuthering Heights* and *Agnes Grey,* and in June 1848 Anne's *Tenant of Wildfell Hall,* which sold well. Reviewers had already suggested that *Wuthering Heights* was an earlier work by Currer Bell and now Newby offered the American rights of *The Tenant* as by the author of the successful *Jane Eyre,* and in July Charlotte and Anne were forced to go to London to acknowledge their identities to their publisher.

The year that followed was a tragic one. On Sept. 24 Branwell died. Emily caught cold at his funeral, fell into rapid consumption, refused all medical help and died on Dec. 19. Immediately afterward, Anne, Emily's closest friend, sickened of the same disease; Charlotte put aside *Shirley,* on which she was working, to nurse her. Anne submitted dutifully to treatment but died on May 20, 1849, at Scarborough. Charlotte completed *Shirley* in the empty parsonage and it appeared in October. In 1850 Smith, Elder and Co. republished *Wuthering Heights* and *Agnes Grey* with Charlotte's "Biographical Notice" of her sisters. In the following years Charlotte went three times to London as the guest of her publisher, George Smith, and his mother; met Thackeray and other literary men and women; and sat for her portrait by George Richmond. She went twice to the Lakes, where she stayed in 1851 with Harriet Martineau, went to Scotland, visited Mrs. Gaskell in Manchester and entertained her at Haworth. *Villette* came out in Jan. 1853. Meanwhile, in 1851, she had declined a third offer of marriage from James Taylor, a member of Smith, Elder and Co. Her father's curate, Arthur Bell Nicholls (1817–1906), an Irishman, was her fourth suitor. It took some months to win her father's consent, but they were married on June 29, 1854, in Haworth church. They spent their honeymoon in Ireland and then returned to Haworth, where her husband had pledged himself to continue as curate to her father. He did not share his wife's intellectual life, but she was happy to be loved for herself and to take up her duties as his wife. She began another book, *Emma,* of which some pages remain. Her pregnancy, however, was accompanied by exhausting sickness and she died on March 31, 1855. Nicholls stayed in Haworth until Brontë's death in 1861, when he went back to Ireland.

The absorbing personal history of the Brontë family has stimulated many writers. Haworth is a place of pilgrimage and Haworth parsonage a Brontë museum. Plays and novels have been written about them and the Brontës have become living figures in popular imagination. Each of the family has had partisans and, in the attempt to define their distinct natures, the close bonds of temperament, conviction, imagination and pooled experience have sometimes been undervalued. Emily, the least known and praised in her lifetime, has proved the most interesting for modern biographers and critics. There has been a corresponding tendency to withhold justice from Charlotte as a writer and a woman. Without Charlotte's ambition we should not have had Emily's writings. Her editing of them, now under censure, aimed at removing obstacles between the contemporary reading public and work that she deeply admired. In what she wrote of her sisters she had it in mind to defend their "dear names" against the charges of coarseness and brutality that had been launched at their novels.

As a poet Emily far exceeded her sisters. Her poems, often unfinished and very unequal, show the influence of Scott and the Border ballads, but at their rare best transmit the flavour of a unique and powerful personality. That some of the finest rise out of a Gondal setting confirms the dramatic bent that distinguishes *Wuthering Heights* but does not shelve the enigma of Emily. If the experience in the long Gondal poem "Julian M. and A. G. Rochelle" (excerpted by Charlotte as "The Prisoner") is a mystical one, then it was Emily's experience and that section of the poem is as personal as "The Old Stoic" and "No Coward Soul is Mine," which are not Gondal poems. She had a strong lyrical note, a beautifully spontaneous and flexible metre, and, at her best, a powerful and precise though limited diction. Her work on *Wuthering Heights* cannot be dated and she may well have spent a long time on this intense, solidly imagined novel. It is distinguished from other novels of the period by its dramatic and poetic presentation, its abstention from all comment by the author and its unusual structure. It recounts in the retrospective narrative of an onlooker, which in turn includes shorter narratives, the impact of the waif Heathcliffe on the two families of Earnshaw and Linton in a remote Yorkshire district at the end of the 18th century. Embittered by abuse and by the marriage of Cathie Earnshaw, who shares his stormy nature and whom he loves, to the gentle and prosperous Edgar Linton, Heathcliffe plans a revenge on both families, extending into the second generation. Cathie's death in childbirth fails to set him free from his love-hate relationship with her and the obsessive haunting persists for years until the driven man lets fall his revenge in the hour of triumph and dies; the union of the surviving heirs of Earnshaw and Linton restores peace.

The 11th-hour entry into the tale may derive from French classical tragedies, read in Brussels. The method of direct narrative, heard in oral storytellers, is used with deliberate effect to recount an action that culminates through two generations, for which the model may have been Shakespeare's later romantic plays. There is no confusion, though some awkwardness. Everything is thoroughly wrought out. Sharing her sisters' dry humour and Charlotte's violent imagination, she diverges from them in making no use of the events of her own life and showing no preoccupation with a spinster's state or a governess's position. Working, like them, within a confined scene and with a small group of characters, she constructs an action, based on profound and primitive energies of love and hate, which proceeds logically and economically, making no use of such coincidences as Charlotte relies on, requiring no rich romantic similes or rhetorical patterns and confining the superb dialogue to what is immediately relevant to the subject. The sombre power of the book and the elements of brutality in the characters affronted some 19th-century opinion. Its supposed masculine quality was adduced to support the claim, based on the memories of Branwell's friends long after his death, that he was author or part author of it. While it is not possible to clear up all the minor puzzles in the case, neither the external nor the internal evidence offered is substantial enough to weigh against Charlotte's plain statement or a reference to Branwell's extant writings. Modern interest in myth and symbol has stimulated fresh approaches. Lord David Cecil (*Early Victorian Novelists*, ch. v., 1935) regards Emily's characters as types of the cosmic forces of storm and calm, which replace the principles of good and evil; both are good in their proper relations, but tragedy results from their mismating. A widely different approach has been made by David Wilson ("Emily Brontë: First of the Moderns," *Modern Quarterly Miscellany*, no. 1, 1947) who interprets the story of Heathcliff and Catherine Earnshaw as a metaphor of the social struggle going on in the turbulent Pennine districts under Emily's eyes, a struggle in which she saw evil and degradation on both sides. This illuminating suggestion has been carried further by other writers who insist on Emily's conscious social passion. These studies give a welcome new dimension to the book, but should not obscure the depth of her imaginative response to the wild and remote nor the fact that what matters most to her is the freedom and energy, in love and hate, of the individual human spirit. *Wuthering Heights* masters the reader by its passion and fulness of meaning; its rapid, concrete presentation; its resonant, concise dialogue; and the courage, unparalleled in the contemporary novel, with which it accepts the tragic logic of its assumptions. It is not a flawless masterpiece, but it is unexhausted.

Anne, commonly described as gentle and pious, with none of her sisters' fire, has found champions to insist on her quiet strength and the integrity and realism of her work. In chaste and shapely verse she examines her thoughts and feelings in the light of moral and religious truth. *Agnes Grey*, probably begun at Thorpe Green, records with limpidity and some humour the life of a governess. George Moore called it "simple and beautiful as a muslin dress." *The Tenant of Wildfell Hall* presents an unsoftened picture of a young man's debauchery and degradation and sets against it her Arminian belief that no soul shall be ultimately lost. Her outspokenness raised some scandal and Charlotte deplored the subject as morbid and incongruous with her sister's nature, but the vigorous writing indicates that Anne found in it not only a moral obligation but an opportunity of artistic development.

Charlotte's first novel *The Professor* (published posthumously, 1857) shows her extreme reaction from her Angrian indulgences. Sober in colouring and discreet in action, it is nevertheless satirically lively and, like all her fiction, prickles with personality. Told in the first person by an English tutor in Brussels, it is based on Charlotte's experiences there, with a reversal of sexes and roles. The necessity of her genius, reinforced by reading her sister's *Wuthering Heights*, modified this restrictive self-discipline and, though there is plenty of satire and dry, direct phrasing in *Jane Eyre*, what carried it to success was the fiery conviction with which it presented a thinking, feeling woman, craving for love, but able to renounce it at the call of impassioned self-respect and moral conviction. Jane Eyre, an orphan and governess to the ward of Mr. Rochester, falls in love with her Byronic and enigmatic employer. Her love is reciprocated, but on the wedding morning it comes out that Rochester is a married man and keeps a mad and depraved wife in the attics of his mansion. Jane leaves him, suffers hardship and finds work as a village schoolmistress. When Jane learns, however, that Rochester has been maimed and blinded, trying vainly to rescue his wife from the burning house she herself had set afire, Jane seeks him out and marries him. There are melodramatic naïveties in the story and Charlotte's elevated rhetorical passages, though genuine and powerful in their kind, do not much appeal to modern taste, but she maintains her hold on the reader. The novel is subtitled "An Autobiography" and Charlotte follows Anne in putting her tale in the mouth of a governess, but, except in Jane's impressions of "Lowood," the autobiography is not Charlotte's. Personal experience is fused with suggestions from widely different sources and the "Cinderella" theme may well come from Richardson's *Pamela*. The action is carefully motivated and apparently episodic sections, like the return to Gateshead hall, are seen to be necessary to the full expression of Jane's character and the working-out of the threefold moral theme of love, independence and forgiveness. The landscape background, geared closely to the phases of the action, carries into the novel a lyricism only partially anticipated by Mrs. Radcliffe and Scott.

Charlotte intended *Shirley* to be "real, cool and solid," avoided melodrama and coincidences and widened her scope. Setting aside Miss Edgworth and Scott as national novelists, *Shirley* is the first regional novel in English, full of shrewdly depicted local material—Yorkshire characters, church and chapel, the cloth workers and machine-breakers of her father's early manhood and a sturdy but rather embittered feminism. It is not, however, easy to elicit a dominant theme. Of her two heroines, Shirley, on Mrs. Gaskell's authority, was a "representation" of Emily in ampler circumstances and Caroline, at least in some parts, approximates to Anne. While Charlotte was writing, both sisters died and it is arguable that the course of the novel was diverted. Caroline, who in the earlier chapters seems marked for the spinsterhood that was so much in Charlotte's and Anne's minds, is dismissed to married happiness, while Louis Moore, abruptly introduced in the last third of the book, carries out with Shirley the master-pupil love relationship which occurs in all Charlotte's novels.

In *Villette* she recurs to the Brussels setting and the first-person narrative, disused in *Shirley;* the characters and incidents are largely variants of the personnel and life at the Pensionnat Heger. Against this background she sets the ardent heart, deprived of its object, contrasted with the woman happily fulfilled in love. The action is seen through the personality of the sober-seeming governess Lucy Snowe, and the vision varies from daylight to hallucination, as her humour, suspicious reserve or melancholia prevails. Her struggle for detachment stimulates the reader to attain it. Charlotte said her heroine was morbid and unamiable and refused to divert tragedy from her, but allowed her to achieve a useful and honourable independence. The "Long Vacation" chapter and the character of M. Paul Emmanuel (M. Heger) illustrate the two extremes of her art.

The influence of Charlotte's novels was much more immediate than that of *Wuthering Heights*, which was described for many years as without posterity. (It is now acclaimed both as the first socio-revolutionary novel and the predecessor of the novel of flux and sensation.) Her combination of romance and satiric realism had been the mode of nearly all the women novelists for a century. Her fruitful innovations were the presentation of a tale through the sensibility of a child or young woman—in which Dickens followed her; her lyricism—in which the genius of romantic poetry entered the novel; and the picture of love from a woman's standpoint—with which she unwittingly startled a section of Victorian opinion. The two sides of her nature were never fully harmonized and this results in what Virginia Woolf called the "jerking of the planes." Her special mastery lies in her intense participation in her story and the transmission of this to the reader.

Bibliography.—Mrs. Gaskell's *Life of Charlotte Brontë*, 2 vol. (1857) raised controversy and was modified in the third edition. It is indispensable. The Haworth edition (1902) was annotated by C. K. Shorter, who had access to material in the hands of Mr. Nicholls and published all Charlotte's available letters in *The Brontës' Life and Letters* (1908). The first supplement, however, was provided by T. Wemyss Reid in *Charlotte Brontë: a Monograph* (1877). In 1912 her four letters to M. Heger were given to the British museum, London, by the Heger family. During the 20th century a formidable body of biographical and critical investigation and assessment has appeared. The publication *in extenso* of the early writings began with *Legends of Angria* (ed. by Fannie E. Ratchford and W. Clyde de Vere, 1933) and Miss Ratchford has studied them in *The Brontës' Web of Childhood* (1941) and *Gondal's Queen* (1955). The Brontë mss. have yielded fresh verse by Emily and Anne and their complete poems have been published. The first biography of Emily by A. M. F. Robinson (1883), to which Ellen Nussey contributed information but did not approve the conclusions, has been followed by Romer Wilson's *All Alone: the Life of Emily Brontë* (1928), Muriel Spark and Derek Stanford's *Emily Brontë: Her Life and Work* (1953) and Jacques Blondel's *Emily Brontë* (1955). Winifred Gérin's *Anne Brontë* appeared in 1959, together with Ada Harrison's and Derek Stanford's *Anne Brontë: Her Life and Work*; her *Branwell Brontë* followed in 1961 and her *Charlotte Brontë: the Evolution of Genius* in 1967. R. B. Martin's *The Accents of Persuasion: Charlotte Brontë's Novels* (1966) is one of the few serious critical studies. *The Clue to the Brontës* by G. Elizabeth Harrison (1948) follows up the Brontës' Methodist connections. The Brontë Society publications (1895–) include biographical, topographical and critical contributions. The following studies are important: May Sinclair, *The Three Brontës* (1912); E. Dimnet, *Les Soeurs Brontë* (1910; Eng. trans. *The Brontë Sisters*, 1928); Irene Cooper Willis, *The Authorship of Wuthering Heights* (1936); Laura L. Hinkley, *The Brontës* (1945); Phyllis Bentley, *The Brontës* (1947) and *The Brontë Sisters* (1950); and Laurence and E. M. Hanson, *The Four Brontës* (1949). The last four provide good select bibliographies. Inga Stina Ewbank's *Their Proper Sphere* (1966) studies the Brontës as early-Victorian female novelists. The *Shakespeare Head Brontë*, 19 vol. (1931–38), though not complete, is the best working edition. (J. M. S. T.)

BRONTOSAURUS, a large plant-eating amphibious dinosaur that flourished in western North America. *See* Dinosaur.

BRONX, THE, one of the five boroughs of New York City, U.S., and the only mainland borough, being separated from Manhattan Island by the Harlem River. It was a part of Westchester County until 1898 when it was incorporated in the city of New York. It is primarily a residential area, with some of its waterfront of over 80 mi. used for shipping, warehouses, and industry. Pop. (1970) 1,472,216.

The Bronx is named for Jonas Bronck, its first settler, who purchased the area from the Indians in 1639. New Englanders moved in early, trespassing on Dutch territory.

Among the numerous points of interest in the Bronx are its many parks, including Bronx Park, well known for its zoological parks and botanical gardens, Van Cortlandt Park, and Pelham Bay Park on Long Island Sound. The Bronx is also the site of Yankee Stadium and the location of many institutions of higher learning, such as Fordham University, a Roman Catholic university founded in 1841; Hunter College in the Bronx, a division of the City University of New York; the University Heights Centre of New York University, a private institution founded in 1831; Manhattan College, a Roman Catholic college founded in 1853; and the Albert Einstein College of Medicine of Yeshiva University. The Bronx is associated with the life of Edgar Allan Poe, who lived there with his child wife and wrote *Ulalume* and *Annabel Lee*.

For the government of the Bronx, the public education system, taxation, and finance, etc., *see* New York (City). (D. L. D.)

BRONZE, an alloy formed wholly or chiefly of copper and tin (*qq.v.*) in variable proportions. A Greek manuscript of about the 11th century in the library of St. Mark's, Venice, gives the composition of the alloy as 1 lb. of copper with 2 oz. of tin. The product obtained by adding tin to copper is more fusible than copper and thus better suited for casting; it is also harder and less malleable. A soft bronze or gun metal is formed with 16 parts of copper to 1 of tin, and a harder gun metal, such as was used for bronze ordnance, when the proportion of tin is about doubled.

The steel bronze of Col. Franz Uchatius (1811–81) consisted of copper alloyed with 8% of tin, the tenacity and hardness being increased by cold rolling. Bronze containing about 7 parts of copper to 1 of tin is hard, brittle and sonorous, and can be tempered to take a fine edge. Bell metal varies considerably in composition, from about 3 to 5 parts of copper to 1 of tin. In speculum metal there are 2 to 2½ parts of copper to 1 of tin. Statuary bronze may have from 80% to 90% copper, the rest tin, or tin with zinc and lead.

Bronze in British and French copper coinage is 95% copper, 4% tin and 1% zinc. The U.S. cent is 95% copper (45.6 gr.) and 5% tin and zinc (2.4 gr.).

Many copper-tin alloys employed for machinery bearings contain a small proportion of zinc, which gives increased hardness. "Antifriction metals," also used in bearings, are copper-tin alloys in which the amount of copper is small and there is antimony in addition. Of this class an example is Babbitt's metal, invented by Isaac Babbitt (1799–1862); it originally consisted of 24 parts of tin, 8 parts of antimony and 4 parts of copper, but in later compositions for the same purpose the proportion of tin is often considerably higher. *See* Bearing Metals.

Phosphor Bronze.—Bronze is improved in quality and strength when fluxed with phosphorus. Alloys prepared in this way, and known as phosphor bronze, may contain only about 1% of phosphorus in the ingot, reduced to a mere trace after casting but their value is nevertheless enhanced for purposes in which a hard strong metal is required, as for pump plungers, valves, the bushes of bearings, etc.

Bronze again is improved by the presence of manganese in small quantity, and various grades of manganese bronze, in some of which there is little or no tin but a considerable percentage of zinc, are used in mechanical engineering.

Alloys of copper with aluminum, though often nearly or completely destitute of tin, are known as aluminium bronze, and are valuable for their strength and the resistance they offer to corrosion. By the addition of a small quantity of silicon the tensile strength of copper is much increased; a sample of such silicon bronze, used for telegraph wires, on analysis was found to consist of 99.94% of copper, 0.03% of tin and traces of iron and silicon. (*See* also Alloys.)

The bronze (Gr. *chalcos*, Lat. *aes*) of classical antiquity consisted chiefly of copper, alloyed with one or more of the metals, zinc, tin, lead and silver, in proportions that varied as times changed, or according to the purposes for which the alloy was required. Among bronze remains, the copper is found to vary from 67% to 95%. From the analysis of coins it appears that for their bronze coins the Greeks adhered to an alloy of copper and tin till 400 B.C., after which time they used also lead with increasing frequency. Silver is rare in their bronze coins. The Romans also used lead as an alloy in their bronze coins, but gradually reduced the quantity, and, under Caligula, Nero, Vespasian and Domitian, coined pure copper coins; afterward they reverted to the mixture of lead. So far the words *chalcos* and *aes* may be translated as bronze. Originally, no doubt, *chalcos* was the name for pure copper. It is so employed by Homer, who calls it *erythros* (red), *aithops* (glittering), *phaennos* (shining), terms which apply only to copper. But instead of its following from this that the process of alloying copper with other metals was not practised in the time of the poet, or was unknown to him, the contrary would seem to be the case from the passage in the *Iliad* where he describes Hephaestus as throwing into his furnace copper, tin, silver and gold to make the shield of Achilles, so that it is not always possible to know whether when he uses the word *chalcos* he means copper pure or alloyed. Still more difficult is it to make this distinction regarding the mythical Dactyls of Ida in Crete or the Telchines or Cyclopes being acquainted with the smelting of *chalcos*. It is not, however, likely that later Greek writers, who knew bronze in its true sense, and called it *chalcos*, would have employed this word without qualification for objects which they had seen unless they had meant it to be taken as bronze. When Pausanias speaks of a statue, one of the oldest figures he had seen of this material, made of separate pieces fastened together with nails, it is understood he means literally bronze, the more readily since there exist very early figures and utensils of bronze so made.

For the use of bronze in art, *see* METALWORK, DECORATIVE. *See* also references under "Bronze" in the Index volume.

BRONZE AGE. The term "Bronze Age" refers to the third phase in the development of man's material culture, following the Paleolithic (Old Stone) Age and the Neolithic (New Stone) Age, and the first period in which metal was used. The beginning of this phase is sometimes called the Chalcolithic (Copper-Stone) Age, referring to the initial use of pure copper. Scarce at first, copper was used only for small or precious objects; its use was known in east Anatolia in the aceramic Neolithic period by 6500 B.C., and soon after in widespread Neolithic and Chalcolithic cultures. By the middle of the 4th millennium a rapidly developing metallurgy, with cast tools and weapons, was a factor leading to urbanization in Mesopotamia. By 3000 B.C. the use of copper was widespread in the near east, had extended westward into the Mediterranean area and was soon to infiltrate the still Neolithic cultures of Europe. While sometimes termed the Copper Age, all this early phase of the use of metal is commonly thought of as part of the Bronze Age, though true bronze, an alloy of copper and tin, cannot be traced back much before 3000 B.C. and was used only rarely for the next few centuries. Natural alloys may account for some of the earliest occurrences of bronze. Tin deposits discovered during the 3rd millennium were apparently few and small, and only late in this millennium were more considerable deposits located. Anatolian bronzes are among the most common at this early date. Just how early the Cornwall tin deposits were exploited is not known with certainty, but they were much used in the 2nd millennium B.C. and were responsible for a considerable part of the large production of bronze objects in the second half of the 2nd millennium, as well as later. Thus, for almost 3,000 years copper and then bronze were the main metals used for making implements, weapons, vessels, etc.; stone continued to be used in decreasing amounts for these purposes as the availability of metals increased. From the end of the 2nd millennium the greater availability and use of another metal, iron, brought the Bronze Age to an end as the Iron Age began.

See ARCHAEOLOGY; *see* also references under "Bronze Age" in the Index volume. (S. S. WE.)

BRONZE AND BRASS WORK. A general history of the use of bronze and brass in the arts is given in the article METALWORK, DECORATIVE. The chemistry and metallurgy of these two alloys are discussed in BRASS and BRONZE. The technique of bronze casting, and the subject of patina, are dealt with in SCULPTURE TECHNIQUES.

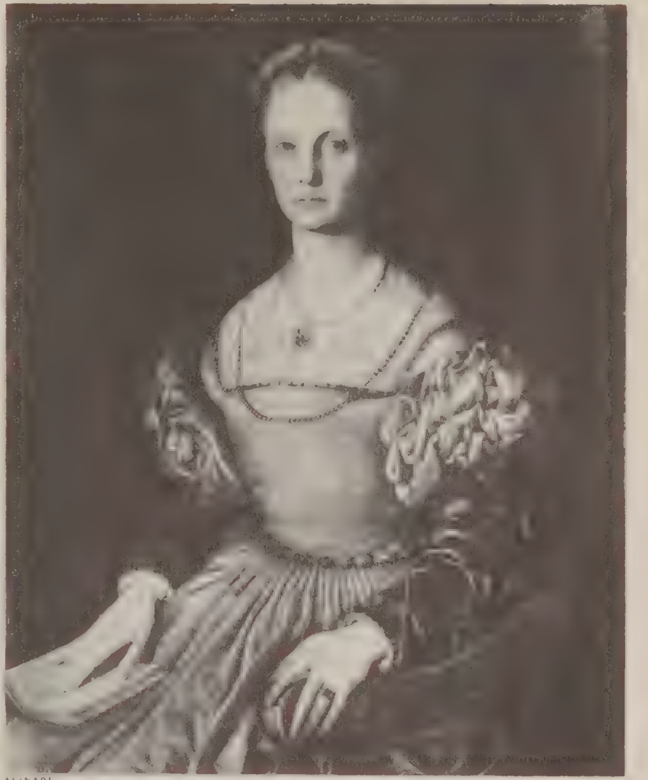
References to art objects in bronze and brass are found in numerous articles on sculpture and in such articles as CHINESE BRONZE; SEALS and NUMISMATICS.

BRONZING, a process of imparting a metallic surface to objects of wood, plaster, clay, etc. The material used is Dutch metal, an alloy of 80% copper and 20% zinc. It is prepared as a thin foil and then powdered.

The metallic powder may be applied directly, if the object to be covered is first sized with a spirit lacquer or with gold-size. If the powdered metal is combined with spirit lacquer thinned with amyl acetate, the mixture can be painted on with a brush.

A number of colouring effects can be produced chemically. For example, treatment with a solution of arsenious acid in hydrochloric acid imparts an appearance of true bronze, while a water solution of copper nitrate, ammonium chloride and calcium chloride gives an antique bronze finish. Application of nitric acid results in a pale gold color. The alloy's own natural gold effect can be heightened by applying spirit lacquer coloured with dragon's blood. The colours can be preserved by a finishing coat of clear spirit lacquer.

Gun barrels can be bronzed by treatment with a strong solution of antimony trichloride. (E. L. Y.)



ALINARI

PORTRAIT OF LUCREZIA PANCIATICHI BY BRONZINO. IN THE UFFIZI GALLERY, FLORENCE

BRONZINO, IL (AGNOLO or ANGIOLO DI COSIMO) (1503–1572), Florentine painter and poet, renowned especially for his portraits, which are the classic embodiments of the courtly ideal under the Medici dukes, Alessandro and Cosimo I. Bronzino was born in the Florentine suburb Monticelli, Nov. 17, 1503. Allessandro Allori, his adopted son and pupil, also used "Bronzino" as his last name. Bronzino's principal teachers were Raffaellino del Garbo and Jacopo da Pontormo. Beginning in Pontormo's eccentric, expressive style (exemplifying what is now called early Mannerism) he created a brilliantly precise, clear style of his own, partly influenced by Michelangelo and the Raphael school. He is rightly classified as a Mannerist since after the middle 1530s he was a prime exponent of Mannerist stylization; *e.g.*, "Allegory of Luxury," National gallery, London, or "Resurrection," SS. Annunziata, Florence. His portraits are pre-eminent examples of Mannerist portraiture: stiff, flat, reserved and noncommittal, yet arrestingly elegant and decorative; *e.g.*, "Duchess Eleanora and Son," Uffizi gallery, Florence. Bronzino did sacred and allegorical works of influence and distinction, including fresco decorations and tapestry designs, and represents the local Florentine tradition toward the mid-16th century at its clearest. He was court artist to Cosimo. Bronzino died in Florence on Nov. 23, 1572. *See* also MANNERIST ART AND ARCHITECTURE.

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BRONZITE: *see* PYROXENE.

BROOCH: *see* JEWELRY.

BROOKE, FULKE GREVILLE, 1ST BARON (1554–1628), English writer who, on his tomb, styled himself "Servant to Queen Elizabeth, Counsellor to King James, and Friend of Sir Philip Sidney," but who is best remembered as a powerful philosophical poet and exponent of a plain style of writing. He was born at Beauchamp court, Warwickshire, on Oct. 3, 1554, entered Shrewsbury school with Philip Sidney in 1564 and matriculated at Jesus college, Cambridge, in 1568. Sir Henry Sidney, president of

Wales, gave him a post in the court of the Marches in 1576, but next year he accompanied Sidney on an embassy to the Holy Roman emperor and to the Palatinate. This was the first of several diplomatic missions undertaken for Elizabeth I, who favoured him greatly but refused to let him travel as often as he wished. However, he visited the Low Countries, Ireland and France. With Sidney and Sir Edward Dyer he practised poetry, but the legend that they formed an "Areopagus," a literary classicizing club, is now exploded. He grew rich by grants of land and minor offices, and in 1598 became treasurer of the navy. He tried to stay the impetuous descent of the earl of Essex and he befriended Francis Bacon, but he alienated Sir Robert Cecil. Consequently, although he was made a knight of the Bath at James I's coronation, he obtained no major office. Instead he managed his estates, restored the ruined Warwick castle (which the king had bestowed on him in 1605) and wrote his verse treatises and plays. Noted for his tact and business ability, Greville was made chancellor of the exchequer in 1614 and was created a baron in 1621. He was stabbed at Warwick by his manservant on Sept. 1, 1628, and died on Sept. 30. He never married, though Sir Robert Naunton in his *Fragmenta Regalia* (1641) called him "a constant courtier of the ladies." He proved a kindly patron to William Camden, John Speed and Samuel Daniel.

Greville's *Life of the Renowned Sir Philip Sidney* (1652), though inadequate biographically, is a valuable commentary on Elizabethan politics. It was probably intended as a dedication for an edition of Sidney's poems, the corrected manuscripts of which are at Warwick castle. The only other works which can certainly be ascribed to Greville were published in *Certaine Learned and Elegant Workes* (1633) and *Remains* (1670). The tragedy *Mustapha* was printed (probably piratically) in 1609 and a few songs were set to music. His sonnet collection *Caelica* differs in tone from most Elizabethan cycles: the themes often resemble Sidney's, but the treatment is realistic and ironic. Greville's mind was melancholy, Calvinistic, deeply philosophical; obsessed with the incapacity of fallen human nature deprived of grace, he emphasizes the "wearisome condition of humanity," torn between this world and God's commands. The Senecan tragedies on oriental themes trace the political results of this division. In his verse treatises, such as "Monarchy," he is an Elizabethan Machiavelli showing how statesmen should behave to keep order in a naughty world. His poem "Humane Learning" is skeptical about the instruments and aims of earthly knowledge. In stressing practical improvements it probably owes something to Bacon.

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BROOKE, HENRY (*c.* 1703–1783), Irish novelist and dramatist best known for his novel *The Fool of Quality,* was born near Virginia, County Cavan, Ire., and educated at Trinity college, Dublin. In 1724 he went to London to read law and became friendly with Alexander Pope and Lord Lyttleton; he had already met Jonathan Swift in Ireland. In 1728 he wrote a philosophical poem, *Universal Beauty,* a statement of the idea that "the beauty of the universe is the expression of the Divine order immanent in all creation." A poem of the same kind as Pope's *Essay on Man,* it is spoiled by a style which attempts to combine the rhyme pattern of the couplet with the syntactical elaboration of Miltonic blank verse. Brooke translated the first and second books of Tasso's *Gerusalemme liberata* in 1738, and in 1739 produced a celebrated drama, *Gustavus Vasa, the Deliverer of His Country,* performance of which was forbidden under the new Licensing act because of the supposition that Sir Robert Walpole was depicted in the part of the villain Trollio. The play was printed, and later performed in Dublin as *The Patriot.* It deals with conflicts of loyalty and, although the situations are artificially contrived, it is not without rhetorical power and can be read with pleasure.

Following the ban on *Gustavus Vasa* Brooke returned to Ireland. During the Jacobite rebellion of 1745 he published *Farmer's Six Letters to the Protestants of Ireland,* in form an imitation of Swift's *Drapier's Letters,* pointing to the threat of rebellion provided by the Catholic majority in Ireland, and suggesting a more enlightened policy to forestall the danger. For this he received the post of barrack master at Mullingar, County Westmeath, which he held until his death, in Dublin, on Oct. 10, 1783.

Brooke's novel, *The Fool of Quality* (1764–70), is a rambling and digressive narrative which has as its central thread the education of an ideal nobleman. It oscillates between hectic incident and pathetic reflection and owes its reputation largely to its "passionate and tearful sensibility." In date and feeling it may be linked with Laurence Sterne's *Sentimental Journey* (and the more pathetic passages of *Tristram Shandy*) and Henry Mackenzie's *Man of Feeling.* Its humanity and religious temper recommended it to John Wesley, who edited an abridged version in 1780, and to Charles Kingsley, who published it with an enthusiastic biographical preface in 1859.

See H. M. Scurr, *Henry Brooke* (1927). (Jn. C.)

BROOKE, SIR JAMES (1803–1868), English soldier and explorer, who became raja of Sarawak and founded a dynasty there, was born in India on April 29, 1803, at Secrore, near Benares, where his father, a descendant of the Cromwellian lord mayor of London, Sir Thomas Vyner (1588–1665), was a high court judge. Educated in England at Norwich grammar school, James joined the 6th Madras native infantry and sailed for India in 1819. He did not see action until 1825, in the first Burmese War, when he was critically wounded and returned to England, a pensioner of the British East India company. Expecting dismissal from the company for overstaying his leave, he resigned (1830) and traveled through the islands of the East Indies as far as China, showing a keen interest in the problems of European settlement in the far east. Restless and bored when he returned to England, in 1834 he helped to organize an unsuccessful trading expedition to the Indian archipelago. However, on his father's death in 1835, Brooke inherited a considerable fortune and settled down to a serious study of the political and economic problems of settlement, publishing, in Oct. 1838, a long and controversial article on the subject in the *Athenaeum.* That year he sailed from Devonport in his armed yacht "Royalist," vaguely planning a settlement in Borneo or Celebes.

On reaching Singapore, Brooke learned that the raja Muda Hassim of Sarawak was kindly disposed toward the English, possessed rich resources of antimony and was facing a rebellion. Brooke sailed for Kuching, capital of Sarawak, and offered his services against the rebels. After lengthy intrigues, the rebellion was quashed with his aid, and he was rewarded with the title of raja, subject to the approval of the sultan of Brunei. He visited Brunei in 1842, the title was confirmed and in 1843 the sultan, impressed by Brooke's connection with the British fleet, granted it in perpetuity. From 1843 the fleet was virtually at Brooke's orders, helping to stamp out piracy.

With no more than a handful of English assistants, Brooke made expeditions into the interior, partially suppressed head-hunting and established a secure government. Little interested in commercial profit, he had difficulty at first in gaining financial backing, but the foundation of the Borneo company in 1856 and the help of his friend Baroness Burdett-Coutts later solved this problem. Brooke wanted to make Sarawak a British protectorate, but on his visits to England he gained little support, although he was given official status in 1845 and made governor of Labuan and consul general for Borneo in 1847. He was knighted in 1848. In 1851 grave charges were brought against him in the house of commons on the grounds that he had employed unnecessary severity during a battle against Sea Dayaks off Tanjong Marau (1849). He replied that severity was necessary in combating pirates, and defended himself during a protracted visit to England (1851–53). Although a royal commission which met in Singapore in 1854 declared the charges "not proven," it is said that he never recovered from the strain of those proceedings.

In 1857 Chinese tin miners in Bau sailed up the Sarawak river and sacked Kuching, which Brooke recovered a few days later with the help of the Borneo company's armed yacht, "Sir James Brooke." The same year he returned to England, staying until 1861 and leaving the government in the hands of his nephew Brooke Johnson, with whom he quarreled intermittently. He contemplated making Baroness Burdett-Coutts his successor, but finally appointed another nephew, Charles Johnson, who changed his surname to Brooke and became the second English-born raja of Sarawak. Sir James Brooke died at Burrator in Devon on June 11, 1868. He displayed unusual courage in his dealings with the Malay princes and showed throughout his life a penetrating understanding of the ways of Malays and Dayaks. He was less successful in dealing with his adversaries in England.

Bibliography.—*The Private Letters of Sir J. Brooke*, 3 vol., ed. by J. C. Templer (1853); Gertrude Jacob, *The Raja of Sarawak* (1876); S. B. St. John, *Life of Sir James Brooke* (1879); E. Hahn, *James Brooke of Sarawak* (1953); Robert Payne, *The White Rajahs of Sarawak* (1960); Steven Runciman, *The White Rajahs* (1960). (R. Pa.)

BROOKE, RUPERT (1887–1915), English poet who will be remembered as the author of the sonnet-series *1914*, and as typical of the poets who died in World War I, was born at Rugby, Warwickshire, on Aug. 3, 1887. Brooke began his education at Rugby, going on to King's college, Cambridge, with a scholarship in 1906. He played a leading part in university life; and there, as throughout his career, the charm of his personality, in which his remarkable good looks were only one element, gained him innumerable friends. In 1911 he published his first volume, *Poems*, and in 1913 became a fellow of King's college. During 1913–14 he traveled in North America and the South seas. In Sept. 1914 he received a commission in the Royal Naval division, with which he took part in the Antwerp expedition and sailed for the Dardanelles. He died on the Greek island of Skiros, April 23, 1915.

In his earlier poems (1905–08) Brooke is still a boy; he writes with a sense of verbal and metrical beauty, but the general effect is a little turgid. The later section (1908–11) shows an advance: though there is still an immaturity of exuberance and bravado, the beauties are more abundant. His wartime sonnets, *1914* (1915), won him immediate fame. The sonnets are in strong contrast with the later poetry of trench warfare, and in them his contemporaries recognized, in the words of Winston Churchill, "a voice . . . more true, more thrilling, more able to do justice to the nobility of our youth in arms than any other . . ." The collection of his poems edited by his friend and patron Edward Marsh (1918), and the memoir prefixed to it, created a permanent (if somewhat idealized) image of the poet, and changing tastes hardly diminished its popularity. *Poetical Works of Rupert Brooke* edited by G. Keynes (1946) added about 30 *juvenilia* of little worth. (E. Mar.; J. Sp.)

BROOK FARM, an institute of agriculture and education from 1841 to 1847, situated on 160 ac. at West Roxbury, Mass., 9 mi. from Boston. It was organized and throughout its existence virtually directed by the Rev. George Ripley, a former Unitarian minister, an editor of *The Dial* (a critical literary monthly) and a leader in the Transcendental club, an informal gathering of the intellectuals of the period and vicinity (*see* Transcendentalism: *The New England Transcendentalists*). He was aided by his wife, Sophia Dana Ripley, a woman of wide culture and academic experience. According to the articles of agreement, their desire was to combine the thinker and the worker, to guarantee the highest mental freedom and to prepare a society of liberal, intelligent and cultivated persons whose relations with each other would permit a more wholesome and simple life than could be led amid the pressure of competitive institutions.

The project was financed by the sale of stock, a purchaser of one share becoming automatically a member of the institute. It was governed by a board of directors. The profits, if any, after all payments and improvements, were divided into a number of shares corresponding with the number of days' labour, every member entitled to one share for each day's labour performed. Among the original shareholders were Charles A. Dana and Nathaniel Hawthorne (*qq.v.*), who served together as the first directors of agriculture. Ralph Waldo Emerson, Amos Bronson Alcott, Margaret Fuller, Theodore Parker and Orestes A. Brownson were interested visitors. Brook Farm attracted not only intellectuals—though teachers remained ever in excess of farmers—but carpenters, shoemakers and printers. It paid a dollar a day for work (physical or mental) to men and to women, and provided to all members, their children and family dependents, housing, fuel, clothing and food at approximately actual cost. For four years it published *The Harbinger*, a weekly magazine devoted to social and political problems, to which James Russell Lowell, John Greenleaf Whittier and Horace Greeley occasionally contributed.

Brook Farm was noted particularly for its excellent school, which in educational theory was modern, desiring "perfect freedom of intercourse between students and teaching body." Disciplinary measures consisted in the attempt to arouse a sense of personal responsibility and to communicate a passion for intellectual work. There were no prescribed study hours, and each student was required to give a few hours a day to manual labour—the girls to kitchen and laundry work, the boys to hoeing and chopping. There was an infant school, a primary school and a college preparatory course covering six years. George William Curtis, Father Isaac Thomas Hecker and Gen. Francis C. Barlow were early students there.

Although communal living proved to have disadvantages (Hawthorne found that he was unable to write there and left after six months), for a while it looked as though the ideal of the founders would have something of a practical realization. Within three years the community—or "Phalanx" as it was called after 1844 when Brook Farm adopted some of the theories of the French socialist Charles Fourier (*q.v.*)—had added four houses, workrooms and dormitories to its original farmhouse and school. It then put all available funds into the construction of a large central building to be known as the Phalanstery, which burned to the ground as its completion was being celebrated on the night of March 2, 1846.

Though the colony struggled on for a while, "the enterprise faded, flickered, died down, and expired," and the land and buildings were sold at auction on April 13, 1849. Ripley went to New York and in 1849 became literary critic on Greeley's *Tribune*, a position he held until his death in 1880.

Brook Farm was one of many experiments in communal living that took place in the United States during the first half of the 19th century; it is better known than most—and has a secure place in U.S. social history—because of the distinguished literary figures and intellectual leaders associated with it.

Bibliography.—J. T. Codman, *Brook Farm* (1894); L. Swift, *Brook Farm* (1900); M. Hillquit, *History of Socialism in the United States* (1903); M. D. Orvis, *Letters From Brook Farm, 1844–1847* (1928); K. Burton, *Paradise Planters: the Story of Brook Farm* (1939); V. W. Brooks, *The Flowering of New England, 1815–1865*, pp. 237–260 (1936). Hawthorne's *Blithedale Romance* (1852) is a fictional treatment of the Brook Farm setting.

BROOKFIELD, a village in Cook county, Ill., U.S., about 14 mi. S.W. of the Chicago loop. Founded in 1892 by Eberly Gross, a land promoter, it has remained largely residential. The village has a council-manager form of government, adopted in 1947. A tax-supported recreation program is carried on in cooperation with the schools and private groups.

A major attraction, drawing 2,000,000 persons a year, is the Chicago zoological park or Brookfield zoo, where an outstanding collection of birds and animals is kept in open exhibits in simulated natural habitat.

For comparative population figures *see* table in Illinois: *Population.* (Wa. B. H.)

BROOKINGS, ROBERT SOMERS (1850–1932), U.S. businessman and philanthropist who helped establish the Brookings institution at Washington, D.C., for research and graduate training in economics and government, was born in Cecil county, Md., on Jan. 22, 1850. Brookings entered a St. Louis, Mo., woodenware company at the age of 17. Four years later he and his brother opened their own woodenware firm and during the next 25 years extended their interests into real estate and the lumbering and transportation industries. Following his retirement in 1896, Brookings devoted his time to the development of Washington university in St. Louis. As president of the university corporation

(1897–1928) he helped relocate the school, induced wealthy St. Louis citizens to contribute money for buildings and endowments and helped raise the medical school to a position of academic excellence. He was one of the original trustees of the Carnegie Endowment for International Peace and during World War I served as chairman of the price-fixing committee of the war industries board. After the war he became the first board chairman of the Institute for Government Research and helped found the Institute of Economics and the Brookings Graduate School of Economics and Government. In 1928 these three organizations were merged and named the Brookings institution in his honour.

Brookings died at Washington, D.C., on Nov. 15, 1932, and was buried at St. Louis.

BROOKITE, one of the three modifications in which titanium dioxide (TiO_2) occurs in nature; the other minerals with the same chemical composition, but with different physical and crystallographic characters, being rutile (*q.v.*) and anatase. The two latter are tetragonal in crystallization while brookite is orthorhombic. The name was given in honour of the English mineralogist H. J. Brooke (1771–1857). Two types of brookite crystals may be distinguished. The commoner type of crystals are thin and tabular, and often terminated by numerous small and brilliant faces. These crystals are of a rich reddish-brown colour and are often translucent. Crystals of the second type have the appearance of six-sided bipyramids; these crystals are black and opaque, and constitute the variety known as arkansite, so named from its occurrence at Magnet Cove, Ark.

Brookite occurs only as crystals, never in compact masses, and is usually associated with either anatase or rutile, a major ore of titanium (*q.v.*) with which it is mined. The crystals are found attached to the walls of cavities in decomposed igneous rocks and crystalline schists; brookite is also found as minute isolated crystals in many sedimentary rocks. The best-known locality is Fronolen, near Tremadoc, in north Wales, where crystals of the thin tabular habit occur with crystallized quartz, albite and anatase on the walls of crevices in diabase. Similar crystals of relatively large size are found attached to gneiss at several places in the Swiss and Tirolese Alps.

The lustre of brookite is metallic-adamantine. There is no distinct cleavage (rutile and anatase have cleavages); hardness is 5.5 to 6; specific gravity 4.0. The optical characters are interesting: the optic axes for red and for blue light lie in planes at right angles to each other, while for yellow-green light the crystals are uniaxial. The acute bisectrix, a line bisecting the angle between the optic axes, is perpendicular to the orthopinacoid for all colours, so that this phenomenon of the crossing of the optic axial planes may be readily observed in the thin tabular crystals of the first-mentioned type. (L. J. S.)

BROOKLIME, known botanically as *Veronica beccabunga* (family Scrophulariaceae, *q.v.*), a succulent herb growing on margins of brooks and ditches in the British Isles, a native of Europe, north Africa and northwestern Asia and naturalized in eastern North America.

Brooklime has smooth spreading branches, blunt oblong leaves and small blue or pink flowers.

BROOKLINE, a residential town of Norfolk county, Mass., U.S., almost surrounded by Boston and separated from the rest of Norfolk county by parts of Suffolk and Middlesex counties. As is the case in many New England towns, it contains a number of unincorporated village communities, including Brookline village, Cottage Farms, Longwood, Beaconsfield and Chestnut Hill. It has the largest population of any municipality classified as a town in New England. Its government is known as a representative or limited town meeting form; the town meeting consists of 240 members elected by 12 precincts (wards).

Brookline was originally a part of Boston but became a separate town in Suffolk county in 1705. It was separated from Suffolk county in 1793. It has been a residential community from its earliest days; the only manufacturing is furniture and scientific apparatus. The town is also the birthplace of John F. Kennedy, 35th president of the United States. Cardinal Cushing College (1952) and the Hebrew Teachers College (1921) are there.

Gov. John Winthrop first referred to that part of Boston which is now Brookline as "the hamlet of Muddy River." For many years the area was designated as "Boston's back cow pasture." According to the Rev. John Pierce, Brookline got its name from a brook which ran along the line of Samuel Sewall's property. Some of the early settlers who owned property in the area were the Rev. John Cotton, William Colborne, Thomas Leveritt, Thomas Savage and Capt. John Underhill. In the earliest days sailing vessels could proceed up the Muddy river to what is now Longwood Avenue bridge. Land fills during the late 18th and early 19th centuries made the river no longer navigable. Throughout its history as a suburb Brookline has fought successfully to retain its identity as a separate community beyond the boundaries of Boston.

Pop. (1970) 58,886. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (L. G. H.)

BROOKLYN, a borough of the city of New York, U.S., is situated at the southwest extremity of Long Island. First settled in 1636, it was chartered as a city in 1834 and gradually absorbed the towns of Bushwick and Williamsburg (1855), New Lots (1886), Flatbush, New Utrecht and Gravesend (1894), and Flatlands (1896). In 1898 it became a borough of New York City. Pop. (1960) 2,627,319, (1970) 2,601,852. Three bridges, one vehicular tunnel, and several rapid transit tubes connect Brooklyn with Manhattan. Known as a city of homes and churches, it has a widespread business area. An important manufacturing centre, the city handles a vast amount of ocean-going traffic and is a western terminal of the Long Island Railroad. Parkways connect it with Queens and Long Island areas, and the Verrazano-Narrows Bridge, with a span of 4,260 ft., completed in November 1964 at a cost of $325,000,000, connects it with Staten Island.

Brooklyn's numerous parks and recreation centres include Prospect Park, site of the Battle of Long Island during the American Revolution. In addition to an excellent public school system, its advanced educational facilities include Pratt Institute, a school of engineering and applied arts founded in 1887; Polytechnic Institute of Brooklyn, a private college founded in 1854; Brooklyn College of the City University of New York (1930); Kingsborough Community College (1964); the Downstate Medical Center of the State University of New York; St. Francis College (1858), Brooklyn Center of St. John's University (1870), and St. Joseph's College for Women (1916), all three Roman Catholic. There are also Brooklyn Law School (private, 1901); Brooklyn College of Pharmacy and the Brooklyn Center of Long Island University; and several schools of music.

Among the better-known libraries are the Brooklyn Public Library, the Long Island Historical Society, Pratt Institute Free Library, Kings County Medical Society, and the Brooklyn Museum. The Brooklyn Institute of Arts and Sciences, the Brooklyn Philharmonia, the Brooklyn Academy of Music, the Botanic Garden, and the Children's Museum in Bedford Park attract nationwide attention. For the government, public school system, etc., *see* NEW YORK (CITY). (M. H. LE.)

History.—The first settlement within the present limits of Brooklyn was made when some Dutch farmers took up their residence along the shore of Gowanus Bay in 1636. About the same time other Dutch farmers founded Flatlands (at first called Amersfoort), on Jamaica Bay, and a few Walloons founded Wallabout, later the site of the navy yard. In 1642 a ferry was established across East River from the present foot of Fulton Street, and a settlement grew up there which was known as The Ferry. The next year Lady Deborah Moody with some followers from New England founded Gravesend, near the southern extremity of the borough. In 1645 a settlement was established near the site of the present borough hall, and was called Breuckelen (also spelled Breucklyn, Breuckland, Brucklyn, Broucklyn, Brookland, and Brookline) until about the close of the 18th century, when its orthography became fixed as Brooklyn. The name Breuckelen, meaning marshland, seems to have been suggested by the resemblance of the situation of the settlement to that of Breuckelen, Holland. Of the other towns which were later united to form the borough, New Utrecht was settled about 1650, Flatbush (at first called Medwoud, Midwout or Midwood) about 1651, and Bushwick and Williamsburg in 1660. During the American Revolution the chief event was the Battle of Long Island, fought on Aug. 27, 1776. In 1816, when the population of the town of Brooklyn was about 4,500, its most populous section was incorporated as a village; and in 1834, when the population had increased to 23,310, the whole town was incorporated as a city. By 1850 the population had increased to 138,882. In 1855 Williamsburg, which had been incorporated as a city in 1851, and the town of Bushwick were annexed. Other annexations followed until the city of Brooklyn was conterminous with Kings County; on Jan. 1, 1898, the city of Brooklyn became a borough of New York City. (E. B. Wn.; L. Gu.)

BROOKS, PHILLIPS (1835–1893), U.S. Episcopal clergyman who gained an international reputation as a preacher during a 22-year ministry at Trinity Protestant Episcopal church in Boston, Mass., was born in Boston on Dec. 13, 1835. He graduated from Harvard university in 1855, spent a brief period as a teacher in the Boston Latin school and then studied for the ministry at the Episcopal theological school in Alexandria, Va. In 1859 he became minister of the Church of the Advent in Philadelphia, and three years later was called to Holy Trinity church in the same city. He began his ministry at Trinity church, Boston, in 1869. He preached Sunday after Sunday to great congregations. In 1891 Brooks was consecrated bishop of Massachusetts, but after a brief episcopate of 15 months he died, unmarried, on Jan. 23, 1893. Although he declined the professorship of Christian ethics at Harvard, he was for many years an overseer of the university and the university preacher.

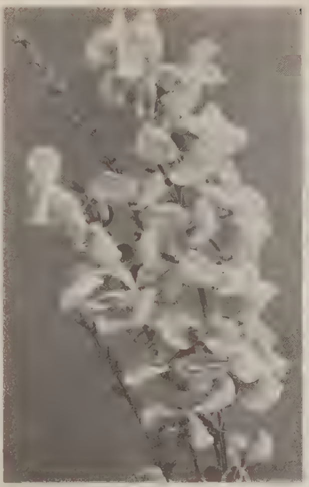
Endowed with a commanding stature, a compelling personality and great eloquence, Brooks was by far the most attractive and most widely loved preacher of his day. An abundance of natural vigour coupled with an innate gentleness of spirit and cheerfulness of temper gave to his preaching a quality of winsomeness and serenity, which was tremendously appealing to the comfortable and enlightened folk of Back Bay Boston, Harvard yard and the cultural oases of the east and middle west. He was a broad churchman who regarded humanity itself rather than the organized church as the instrument through which God effects his purposes. "The spirit of man is the candle of the Lord" was the theme of his most famous sermon; it aptly expressed his theology. He never bothered to refute the doctrines he quietly discarded, refusing always to be drawn into controversy. Even when charges of heresy were leveled against him, his only answer was calm and unruffled silence. He published numerous volumes of sermons, and his verse included the well-known Christmas hymn "O Little Town of Bethlehem." Speaking of his death, James Bryce noted that not since Abraham Lincoln had there been a man so widely mourned.

See W. Lawrence, *Life of Phillips Brooks* (1930). (W. S. H.)

BROOKS, WILLIAM KEITH (1848–1908), U.S. zoologist, who made extensive and valuable researches on the morphology of various groups of marine animals, especially the tunicates, crustaceans and the oyster, was born in Cleveland, O., on March 25, 1848. He graduated from Williams college, Williamstown, Mass., n 1870 and later studied with Louis Agassiz at Harvard university Ph.D., 1875). In 1876 he was made associate in natural history at Johns Hopkins university, Baltimore, Md., where he became professor of animal morphology in 1891, head of the biological laboratory in 1893 and also professor of zoology. He established a marine laboratory. Among his more important works are *Provisional Hypothesis of Pangenesis* (1877), *Heredity* (1883), *Monograph of the Genus Salpa* (1893), *Foundations of Zoology* (1899–1907), and a popular book on *The Oyster* (1891). He died at Baltimore, Md., on Nov. 12, 1908.

BROOM (*Cytisus scoparius*), a shrub of the pea family (Leguminosae, *q.v.*), is native to the temperate parts of Europe and Asia and naturalized in North America. The leaves are small and usually fall away early; their function is shared by the green stems. The bright yellow flowers scatter their pollen by an explosive mechanism; the weight of a bee alighting on the flower auses the keel to split and the pollen to be shot out onto the inect's body. When ripe the black pods explode with a sudden wisting of the valves and scatter the seeds. The twigs have a bitter, nauseous taste and have long had a reputation as a diuretic; the seeds have similar properties.

Butcher's broom, a very different plant, known botanically as *Ruscus aculeatus*, is a member of the lily family. It is a small evergreen shrub found in copses and woods. The stout angular stems bear leaves reduced to small scales, which subtend flattened leaflike branches (cladodes) with a sharp apex. The small whitish flowers are borne on the face of the cladodes; the berry is bright red.



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BROOM (CYTISUS SCOPARIUS)

BROOM: *see* Brush.

BROOME, WILLIAM (1689–1745), English scholar and poet, and collaborator with Alexander Pope in his translation of Homer, was born at Haslington, Cheshire, in 1689. He was educated at Eton and St. John's college, Cambridge, and became rector of Sturston, Norfolk. When Pope undertook the translation of the *Odyssey* (1725–26) he engaged Elijah Fenton and Broome, who had contributed to the notes for Pope's translation of the *Iliad* (1715–20), to help him. Broome translated the 2nd, 6th, 8th, 11th, 12th, 16th, 18th and 23rd books, and provided almost all the notes. The financial arrangements were vague, and Pope has often been accused of treating Broome shabbily, but research has shown that Pope acted with greater generosity than was at one time supposed. He gave his collaborators virtually all the copy money and something more (amounting to about £800) and kept for himself the proceeds from subscribers that he had solicited (amounting to about £5,000). Fenton and Broome were free to solicit for subscriptions on their own account but did not in fact do so to any considerable extent. Broome seems to have undertaken the work largely in order to increase his own reputation, and it was only when he found that little fame was coming his way that he complained of underpayment. Broome also made translations from Anacreon, printed in the *Gentleman's Magazine*, and wrote *Poems on Several Occasions* (1727). He died at Bath on Nov. 16, 1745.

See George Sherburn, *The Early Career of Alexander Pope* (1934). (Jn. C.)

BROOMRAPE (*Orobanche*), a genus of brown, leafless, parasitic herbs (family Orobanchaceae) growing attached to the roots of other plants. The usually stout stem bears brownish scales and ends in a spike of yellow, reddish-brown or purplish flowers, with a gaping two-lipped corolla. There are about 90 to 100 species of broomrape, natives of temperate and subtropical regions; many occur in North America. Eleven species are found in the British Isles; the largest, *Orobanche major*, is parasitic on roots of shrubby leguminous plants, and has a stout stem one to two feet high. *O. minor* is sometimes troublesome on clover crops.

BROQUEVILLE, CHARLES, Comte de (1860–1940), Belgian statesman who headed the Belgian government-in-exile during World War I, was born at Postel, near Moll, on Dec. 4, 1860. From 1885 to 1910 he was successively town councilor of Moll, provincial councilor of Antwerp, deputy for Turnhout (1892) and minister of railways, posts and telegraphs. He became prime minister in a Catholic cabinet on June 18, 1911. After the elections of 1912 he formed a new cabinet, in which he was also minister of war until Aug. 1917. His army bill making military service compulsory for all males (instead of one male only per family) became law in 1913. In July 1914, on the eve of World War I, he was responsible for the mobilization of the Belgian army. While at Ste. Adresse, near Le Havre in France, after the battle of the Yser, he undertook the reorganization of the army. He resigned in Dec. 1917 when it became known that, without informing the members of his cabinet, he had taken part in a secret negotiation aiming at the conclusion of a separate peace treaty with Austria-Hungary. Nevertheless he became minister of state on May 31, 1918, and was minister of the interior in Léon Delacroix's coalition from Nov. 1918 until Nov. 1919. He endeavoured to make the Catholic party accept the suppression of the plural vote and prepared a revision of the constitution. He was elected senator for the province of Namur in 1919. From 1926 until 1930 he was minister of war. He fought for the maintenance of the term of military service against the Socialist members of Henri Jaspar's coalition and brought into being a new system of defense centred on the fort of Eben Emaël. He was again prime minister from Oct. 1932 until Nov. 1934 and retired from political life in 1936. He died in Brussels on Sept. 5, 1940.

See F. Marre, *Le Baron de Broqueville . . .* (1918); Comte L. de Lichtervelde, *Le Comte de Broqueville* (1946). (J. D.-V. L.)

BRORSON, HANS ADOLPH (1694–1764), Danish poet and bishop, author of hymns influenced by German Pietism, was born at the village of Randerup, southern Jutland, on June 20, 1694. He became pastor there in 1721, and was transferred in 1729 to Tönder and in 1737 to Ribe, where he was elected bishop in 1741. He died at Ribe on June 3, 1764.

Brorson was influenced in his youth by German Pietism (*q.v.*) and while at Tönder began to translate German Pietist hymns. From 1732 onward he published also hymns of his own, and in 1739 appeared *Troens rare Klenodie* ("The Rare Jewel of Faith") which contained many translations and 82 original hymns, among them the famous "The loveliest rose is found." *Svanesangen* ("Swan Songs"), a collection of hymns expressing his longing for the life hereafter, was published a year after his death.

Brorson's hymns are intimate expressions of the soul, and are meant for personal and family use. His frequent use of flower symbols, and his emphasis on the mystical marriage between the soul and Jesus, are Pietist. His hymns are often in aria form, and their language and rhythm show the subtlety of rococo.

Brorson's *Samlede Skrifter* were published in 3 vol. (1951). (O. A. F.)

BROSCHI, CARLO: *see* FARINELLI.

BROSSE, SALOMON DE (1571–1626), French architect, whose work prepared the way for the restrained baroque architecture of Louis XIV, was born at Verneuil and died in Paris. Son of an architect, grandson and follower of Jacques Androuet du Cerceau the elder, he was among the most distinguished architects of his age. After the Edict of Nantes, De Brosse, a Protestant, moved to Paris where in 1615 he began the Luxembourg palace for Marie de' Medici. By 1619 Blérancourt, his finest and most influential château, was completed.

De Brosse also designed the first monumental French Protestant temple at Charenton (1623) and the *palais de justice* at Rennes (1618; built posthumously). His architecture is particularly noteworthy for its simplicity, dignity and monumentality.

See J. Pannier, *Un architecte français au commencement du XVII^e^ siècle: Salomon de Brosse* (1911); L. Hautecoeur, *Histoire de l'architecture classique en France,* i, part 2 (1943). (H. MN.)

BROSSES, CHARLES DE (1709–1777), French scholar and writer known as *le Président de Brosses* because he was president of the parliament of Burgundy from 1740 until his death. He was born at Dijon, Feb. 7, 1709. After a visit to Italy in 1739 he published (1750) the first work on the ruins of Herculaneum and wrote his famous *Lettres sur l'Italie,* posthumously published in 1799 (best edition by Y. Bezard, 1931). His *Histoire des navigations aux terres australes* (1756), in which he first laid down the geographical divisions of Australasia and Polynesia adopted by succeeding geographers, helped to stimulate the voyages of L. A. de Bougainville and James Cook. He also wrote on the origin of language, on Roman history and on Sallust, the translation of whose work occupied much of his time. He died in Paris, May 7, 1777.

See H. Mamet, *Le Président de Brosses, sa vie et ses ouvrages* (1874); A. C. Taylor, *Le Président de Brosses et l'Australie* (1937). (A. C. T.)

BROSSOLETTE, PIERRE (1902–1943), a leading member of the French resistance movement during the German occupation in World War II, was born at Angoulême on June 15, 1902, and graduated at the faculty of letters in the University of Paris. A journalist and member of the Socialist party, he was appointed chief foreign commentator for the French radio in 1936, but lost his post in 1939 because of his critical commentaries on the foreign policy of Édouard Daladier, particularly the Munich agreement. He became foreign editor of the Socialist party's newspaper, *Le Populaire,* and the acuteness and vigour of his commentaries brought him to the front rank both in journalism and among the new generation of the party. After serving in the infantry in the campaign of 1940 he was among the first organizers of the resistance in the German-occupied zone after the armistice. In Sept. 1942 he joined General de Gaulle in London but soon returned for further work in France itself. He was captured by the Germans and tortured. He died in prison on March 22, 1943. His widow, Gilberte, who had served with him in the resistance, was a Socialist senator from 1946 to 1959. (P. W. C.)

BROSTROM, AXEL LUDVIG (1838–1905), the founder of the largest shipping group in Sweden, can be regarded as the father of the modern Swedish mercantile marine. Born at Kristinehamn, Swed., May 21, 1838, as a young man he joined a shipping company and later became an owner-captain in the lake shipping trade. In 1870 he converted a sailing ship, "Aactiv," into a steamship, which proved so successful that he acquired other steamships.

Brostrom founded the "Ferm" steamship company and built vessels for transporting iron ore, the predecessors of the special ore-carrying vessels later in world-wide use. He died at Göteborg on Sept. 21, 1905. (P. DF.)

BROTHERS, RICHARD (1757–1824), a religious fanatic who believed himself to be a descendant of David, "the nephew of the Almighty, the prince of Hebrews," and was the first to preach the theory of British Israel, was born in Newfoundland on Dec. 25, 1757. As a naval officer, he was retired on half pay after the peace of Versailles (1783) and was several times imprisoned as a debtor, having refused his pay on conscientious grounds. The publication of *A Revealed Knowledge of the Prophecies and Times* (1794), containing prophecy of the end of George III's reign and of the re-establishment of a Jewish kingdom composed of the lost tribes of Israel who were believed now to be in England, resulted in his confinement as a criminal lunatic. He continued to write prophetic pamphlets and gathered several followers, among them the engraver William Sharp, who afterward deserted him for Joanna Southcott (*q.v.*). Brothers died in London on Jan. 25, 1824. He was a favourite subject for contemporary caricaturists and satirists including J. Gillray and G. Cruikshank.

BROUGHAM, JOHN (1814–1880), British actor and author of nearly 100 plays, was born in Dublin, Ire., on May 9, 1814, and died in New York on June 7, 1880. He made his first stage appearance in London at the Tottenham street (later Scala) theatre in 1830, playing six small parts in *Tom and Jerry.* He joined the company of Madame Vestris in 1831.

Brougham collaborated with Dion Boucicault in writing *London Assurance* in which he played Dazzle. He went to the United States in 1842 and thereafter spent his time between the two countries. He is said to have been the original of Harry Lorrequer in Charles Lever's novel. (W. J. M.-P.)

BROUGHAM: *see* CARRIAGE.

BROUGHAM AND VAUX, HENRY PETER BROUGHAM, 1ST BARON (1778–1868), was lord chancellor of England from 1830 to 1834, in the ministries of Earl Grey and Viscount Melbourne. Brougham's place in history, however, is not dependent upon his accomplishments as occupant of the woolsack; a prominent figure in British political life for more than 30 years, he played an important role in the improvement of education, law reform, the abolition of slavery and other reforms.

Edinburgh.—Henry Brougham was a Scot, born in Edinburgh on Sept. 19, 1778, to parents of modest means and no connections. Except for visits to his father's estate in Westmorland, Brougham grew up amid the genteel poverty of Edinburgh society which had retained its arch-conservatism if not its wealth. As a precocious youth of 13, he matriculated at Edinburgh university, then in one of its golden periods with teachers such as Dugald Stewart inspiring students to independent thought rather than indoctrinating them in the fashion of the major universities south of the border. Before he was 20 years of age, Brougham had published three scientific papers which had won wide critical acclaim, including that of the Royal society, to which he was elected shortly after he went to London. Though the physical sciences attracted him, Brougham's primary interests were politics, good talk and fine oratory, which he developed at Edinburgh's famed Speculative society as well as in the taverns and rooms of his friends.

After receiving his degree, Brougham studied law and was called to the Scots bar in 1800. That bar, which afforded some promise to conforming young men, held little hope for so iconoclastic a nature as Brougham's. He kept busy defending impecunious prisoners and baiting the senile and reactionary judge who presided on his circuit. But cash briefs were few and far between. The sparsity of legal work afforded him ample time—a commodity which he always used well—to assist in the promulgation of the *Edinburgh Review*, for which he wrote 35 articles in two years; thus displaying characteristic depth and shallowness, ingeniousness and ingenuousness, astonishing versatility and a facile, venomous pen. At the same time, he prepared a lengthy book on the colonial policies of all the European powers—the first of many books which he published during his long life—which, though full of half-truths and not a best seller, brought him some measure of fame and the plaudits of William Wilberforce's antislavery group. After this, the Scots bar was too confining for Brougham.

London.—Late in 1803, Brougham went to London, entered Lincoln's Inn and studied law under Nicholas Tindal, later chief justice of the common pleas. Brougham continued to support himself largely by his writings for the *Edinburgh Review*. Always ambitious for recognition and hoping for place, he moved into the political arena. At first he associated with Wilberforce's Tories, for whom he wrote a pamphlet which was most effective in securing the passage of the antislave trade bill through commons. He also undertook a dangerous mission to Holland, where he unsuccessfully sought to convince the Dutch to ban the slave trade. But the Whigs seemed to offer a more congenial association, both in terms of social connection with the great Whig aristocracy and in terms of a program for badly needed social reforms which was sponsored by the Mountain, the left wing of the Whig party. Party lines were not then clearly drawn in terms of principles and it was ambition for office which led Brougham into the Holland house camp. Brougham's attraction for the Whigs was his great capacity as a publicist, exhibiting methods far in advance of his time. This is not to say that he did not cut an excellent figure in the Whig drawing rooms and at the dinner tables where his charm and wit and learning secured acceptance which his background and family connections could not have obtained.

His pamphleteering often drew blood from the Tories. In his role as public relations director for the 1807 campaign he exhibited a magnificent talent for using the newspapers and periodicals to aid the cause. He brought the *Edinburgh Review* to the Whig banner in so effective a manner that the Tories were compelled to sponsor a competitor in the form of the *Quarterly Review*. By these and other services, such as attendance on a mission to Portugal headed by Lords St. Vincent and Rosslyn, he earned the enmity of the Tories and the debt of the Whigs, though the latter were too aware of his individualism to trust him with a seat in parliament until the threat of his desertion led Lord Holland to prevail on the duke of Bedford to make available to Brougham the pocket borough of Camelford in 1810.

The Bar.—Brougham's first success as a lawyer came even before he was called to the English bar in 1808. As a member of the Scots bar, he was qualified to represent in the house of commons the commercial interests of Liverpool on their petition to withdraw the orders in council. For six weeks he kept the house hanging on his words, though ordinarily such presentations served but to empty that chamber. The failure of the house to accede to his demands did not dim the brilliance of the performance nor mar the reputation as an advocate which resulted from this pyrotechnic display. After his admission to the English bar, he had a remarkable financial success, though the Tories kept him from his silk gown long after he had earned it. His success was not attributed to great legal learning and he was at his best only when he was arguing a cause which aroused his emotions as well as his intellect. It was thus that he successfully defended John and Leigh Hunt against a charge of seditious libel for publishing criticisms of the government for the inhuman corporal punishment which prevailed in the armed forces.

His other great forensic triumph as a lawyer was at the trial of Queen Caroline accused by her husband of infidelities as a ground for annulment of the royal marriage, a charge which ill-became the profligate George IV, especially in light of his earlier illegal marriage to Mrs. Fitzherbert. Here, as in the earlier causes, Brougham represented the popular side of the controversy, though it was he who helped immensely to make the cause a popular one. Brougham had become legal adviser to the unfortunate Princess Caroline some time before 1811. He had much earlier learned to despise her husband, who was to become his sovereign as George IV. And if he had no feelings of warmth for Caroline, he was most affectionate toward Princess Charlotte, the ill-starred offspring of the unhappy marriage. When Caroline became queen, Brougham was made her attorney general, and with Thomas Denman, later lord chief justice, who was her solicitor general, tried the annulment suit in the house of lords. Brougham's cross-examination of the crown's unsavoury witnesses and his magnificent summation, which lasted two days, turned the cause in favour of his client. He became the most popular figure in England, representing a woman who had no claim on him or the people except, perhaps, by reason of the fact that she was less despicable than her husband.

The House of Commons.—From the very beginning of his parliamentary career, Brougham was the best speaker available to the Whig benches: a worthy successor to Charles James Fox. If this made him valuable it did not endear him to the lesser men who were in control of that party. There were no issues on which Brougham was not prepared to speak and, generally, to speak well. But it was on the subjects of slavery, public education and law reform, where personal persuasion was combined with oratorical capacity, that he revealed his greatest talents. Strangely, in these areas of personal predilection, he succeeded in avoiding the lapses of judgment and good taste which not infrequently marred his other forensic displays.

In 1812 he succeeded in causing Lord Castlereagh to withdraw the orders in council, for which he had earlier fought as a barrister. Despite the appeal which such action had for the commercial interests, he was unsuccessful in standing for Liverpool after losing his seat for Camelford, which the duke of Bedford had "sold." The Whigs again were unwilling to find a place for him until 1816, when he flirted with the idea of standing for Westminster against Richard Brinsley Sheridan. They then offered him the earl of Darlington's pocket borough of Winchelsea. In 1818 Brougham succeeded in revitalizing the committee on education which turned up scandalous abuses by the church, the public schools and the universities in their administration of charitable funds donated for educational purposes but perverted to private uses. He sponsored the Public Education bill of 1820, worked assiduously in the implementation of the mechanics' institutes, and helped found the Society for the Diffusion of Useful Knowledge to publish books at prices within the reach of artisans. In 1825 he was elected rector of Glasgow university and was at a later date made titular head of Edinburgh university. In 1828 he succeeded in creating a university in London, a nondenominational school which incurred the displeasure both of the established church and the dissenters.

On Feb. 7, 1828, Brougham delivered his great speech on law reform, which proved to be the foundation for the revision of civil procedure which took place in England during the 19th century. His bankruptcy bill and plan for local courts also came to fruition some time after his departure from effective political life. His antislavery speeches dated back to an address to the crown delivered within four months of his first coming into the house of commons. But the high point was reached in his speech in 1830 which won him the opportunity to stand for Yorkshire, a popular constituency. In his successful election campaign he pledged himself to parliamentary reform, a position which he could not very well take so long as he represented one of the Whig's rotten pocket boroughs. Immediately upon his return to commons from Yorkshire, he noticed a bill for parliamentary reform. Before it could be acted upon, Lord Grey was asked to form the ministry which resulted in Brougham's removal from commons to the lords.

Throughout his career in commons, Brougham used his position to further popular causes, thus winning himself the support of a large if unenfranchised following, and the enmity of many of the vested interests. Even so, his position was such that the government could not be formed without him, much as the Whigs would have liked to do so.

Brougham as Lord Chancellor.—On the accession of Grey, the Whigs offered Brougham the attorney general's post, a noncabinet position, which he cursorily rejected. He wanted to be master of the rolls, a judicial post which would permit him to remain in commons. But the king and Althorp (Lord Spencer), who was to be leader in commons, wanted him elsewhere. Brougham was prevailed upon to accept the woolsack with the result that he was created a peer and removed to the lords. The newspapers reflected the appointment in terms of Samson's haircut. In the cabinet Brougham continued to prove his versatility and energy, to the chagrin and displeasure of his colleagues, whose jealousies and mistrust were heightened. The fact that those with whom he interfered would have been unable to do their jobs without his assistance did not add to his attraction. But his lack of tact and certain improprieties with the press are not to be denied. In the lords, Brougham was the party's leader in fact as well as in name. Much of the credit for forcing the Reform bill of 1832 through that antediluvian body properly belongs to him. To him too must be attributed the reform of the privy council and the creation of the central criminal court in London.

In the chancery, Brougham proved the validity of his earlier charges against Lord Eldon by clearing a docket and revising the rules of procedure. His temperament did not, however, endear him to the lawyers practising before him, especially in light of the fact that he was taking money out of their pockets by his reforms.

Decline and Fall.—When Melbourne was called upon to form his second ministry, he would not find a place in it for so impolitic a politician as Brougham. Deprived of the forum of the commons, Brougham lost his power. From that point forward he was a "political Ishmael" both to the Whigs and the Tories. He continued to champion his favourite causes both in the house of lords and in the many organizations to which he subscribed. But he withdrew more and more often to his villa at Cannes, France, which he managed to establish as a favourite watering place for English society.

Brougham died at Cannes on May 7, 1868. His autobiography, *Life and Times of Henry Lord Brougham*, in three volumes, was published posthumously in 1871.

Brougham's was the unhappy role of the political liberal, unable to subordinate either himself or his principles to the demands of party. He was accused by his contemporaries of using his power for his own exaltation. Ego there was, but only occasionally was it not subordinated to principle. He made enemies by his principles and friends by his charm. Those who knew him found him gay and melancholy, charming and vexing, energetic and enervated, ambitious and self-denying, wise and foolish: the best of men and the worst of men. Whatever burdens he placed on his contemporaries, history must acknowledge that he was a man who made England a better place to live for all who followed him.

Bibliography.—Excellent bibliographies are in F. Hawes, *Henry Brougham* (1957); A. Aspinall, *Lord Brougham and the Whig Party* (1927); *see* also G. T. Garratt, *Lord Brougham* (1935); Lord Campbell, *Lives of the Lord Chancellors*, vol. 8 (1857). (P. B. K.)

BROUGHTON, JOHN CAM HOBHOUSE, Baron (1786–1869), English statesman and littérateur, is probably best known as the alleged coiner of the phrase "His Majesty's Opposition," and as the friend and confidant of Lord Byron, the poet, whose memoirs were destroyed by the publisher John Murray on his advice. He was born near Bristol on June 27, 1786, and educated at Westminster school and at Trinity college, Cambridge, where he became Byron's intimate friend. Member of a well-established merchant family, known for its political and intellectual interests, Hobhouse traveled widely with Byron in 1809–10 and again in 1816–17. In 1813–15 he followed the concluding campaigns of the Napoleonic wars, being present at the entry into Paris and again during the Hundred Days. First attracting attention in 1815 by an attack on the restored Bourbons, Hobhouse soon became prominent in literary and parliamentary circles as a radical of cosmopolitan tastes, and as a fluent and forceful pamphleteer, one of whose onslaughts upon the unreformed house of commons led to his imprisonment for breach of privilege in 1819, in which year he also unsuccessfully contested Westminster. Elected for the constituency in the following year as the colleague of his friend Sir Francis Burdett, Hobhouse proved a lively and assiduous member, active in promoting every type of reform, and fully sharing Byron's enthusiasm for the cause of Greek independence. He inherited his father's baronetcy in 1831.

In 1832, at the height of the crisis over the Reform bill, Hobhouse joined Lord Grey's administration as secretary at war, and a year later he became chief secretary for Ireland for a few weeks. However, he was by now less popular among radicals and he lost his seat at Westminster. Returned to parliament for Nottingham in 1834. Hobhouse attained cabinet rank as first commissioner for woods and forests under Lord Melbourne. In Melbourne's second ministry between 1835 and 1841, he was president of the board of control for India, and from 1846 to 1852 held the same appointment under Lord John Russell. Strongly anti-Russian, Hobhouse maintained a "forward" policy in India, favouring the plan to secure the northwest frontier by advance into Afghanistan, and was an ardent supporter of Lord Palmerston's diplomacy, especially over the eastern question. Raised to the peerage as Baron Broughton de Gyfford in 1851, he virtually withdrew from public life when the government fell in the following year; he died in London on June 3, 1869. In old age Broughton wrote his *Recollections of a Long Life*, printed privately in 1865 and later edited by his daughter and published (1909–11). These memoirs are a valuable source of information on his times by a man of unusually wide interests, which ranged from partnership in Whitbread's brewery to fellowship of the Royal society.

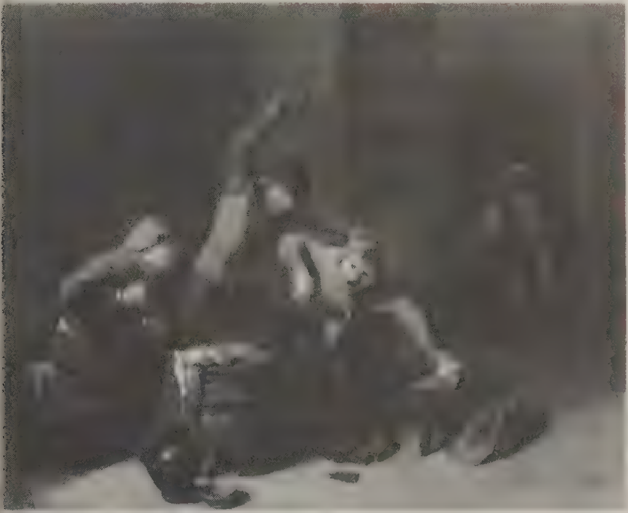
An effective propagandist and vigorous debater, Hobhouse entered politics as an uncompromising radical. With age and the achievement of many of his favourite reforms, his opinions mellowed; and he came to be regarded as deeply conservative, an exemplar of those Whigs whose attitude by the end of the 1830s was described as "rest and be thankful." In this respect, he was typical of many men of position, whose zeal for change reached its zenith between 1815 and the Reform act of 1832, declining rapidly thereafter. Keeping in close contact both with the inner group of cultivated Whig aristocrats and with more raffish and left-wing literary circles, Hobhouse was a respected figure of the second rank, who became an adequate administrator and trusted adviser. He always retained his interest in intellectual and artistic pursuits, and was well liked in society. (A. F. T.)

BROUSSAIS, FRANÇOIS JOSEPH VICTOR (1772–1838), French physician, one of the most active proponents of leech medicine, was born at Saint-Malo on Dec. 17, 1772, the son of a physician. After service in the wars of the Revolution he returned in 1814 to Paris, and was appointed assistant professor to the military hospital of the Val-de-Grâce. He believed that all diseases were local and that they passed from one organ to another "sympathetically" or through irritation of the gastrointestinal tract; that nature had no healing power; and that starvation and leeches would cure everything. He died at Vitry-sur-Seine on Nov. 17, 1838.

Broussais's best-known works are *L'Histoire des phlegmasies ou inflammations chroniques* (1808) and *L'Examen des doctrines médicales* (1816).

See J. D. Rolleston, "F. J. V. Broussais, 1772–1838; His Life and Doctrines," *Proc. Roy. Soc. Med.*, 30:405–13 (1939).

BROUWER, ADRIAEN (*c.* 1605/06–1638), Flemish painter, influenced in his short life the artists of both Flanders and Holland. Few facts concerning his career are established beyond question, but it is reasonably certain that he was born in Oudenaarde, that he made his way to Haarlem about 1621 and entered the studio of Frans Hals, that after gaining a high reputation in Holland he returned in 1631 to the South Netherlands, and that he was imprisoned by the Spaniards in Antwerp as a suspected spy until Sept. 1633. He then settled in Antwerp and was buried there on Feb. 1, 1638. Almost all authorities agree that he was a man of reckless and dissolute habits, although perhaps his profligacy (like the saintliness of Fra Angelico) has been exaggerated by those who knew the pictures but not the artist. Except for a handful of landscapes, which apparently belong to his last years, all Brouwer's pictures are genre subjects, drawn from the poorer, coarser and more painful aspects of common life—peasants smoking, drinking or brawling in taverns, quack surgeons operating on grimacing patients, and so on. Most of the pictures are small, and are painted on panel. The coarseness of his subjects is offset by the delicacy of his style, which combines a brisk, expressive brushstroke with a fastidious sense of colour and design. His mature style shows an unusual mastery of tonal values, expressed in a scale of grays and browns that are relieved sometimes by only a single note of more positive local colour.



BY COURTESY OF DEUTSCHE FOTOTHEK

"PEASANTS BRAWLING OVER A GAME OF CARDS," BY ADRIAEN BROUWER. IN THE DRESDEN GEMÄLDEGALERIE

(R. E. W. J.)

BROWDER, EARL (RUSSELL) (1891–), U.S. Communist party leader, was born in Wichita, Kan., on May 20, 1891. He left school at the age of 10 and worked at a variety of jobs. Through the influence of his father he attended Socialist meetings and met the Socialist leader Eugene Debs. As a result of his opposition to the entrance of the U.S. into World War I he was imprisoned (1919–20). He became a member of the U.S. Communist party in 1921. In China (1927–28) at Hankow and Shanghai he served as director of the Pan-Pacific Trade Union Secretariat. From 1930 to 1945 he held the post of general secretary of the U.S. Communist party and was that party's candidate for president of the United States in 1936 and 1940. In the latter year he was sentenced to prison for four years for passport irregularities but was released after serving 14 months. In 1945 he was removed from his position as secretary of the party for having declared that capitalism and socialism had begun to find means of peaceful coexistence. He was expelled from the Communist party in 1946 and three years later was named in "treason trials" in Budapest and Prague as originator of the heresy of "Browderism" which flowered in Titoism.

Among his many published works are *The People's Front* (1938), *War or Peace With Russia* (1947) and *Marx and America* (1958). He was for a time editor in chief of *The Daily Worker.*

(B. Mi.)

BROWN, SIR ARTHUR WHITTEN (1886–1948), British aviator, who with Capt. J. W. Alcock (*q.v.*) made the first direct airplane crossing of the Atlantic, was born in Glasgow, the only son of U.S. parents, on July 23, 1886. He was trained as an engineer in the Westinghouse company in Manchester and went to South Africa in 1912. In World War I he served in the Manchester regiment and later in the Royal Flying Corps and in the Royal Air Force as a pilot. In 1919, as navigator to Alcock, he made the record crossing of the Atlantic in a Vickers Vimy twin-engined biplane at an average speed of about 120 m.p.h. Taking off from St. John's, Nfd., at 4:13 P.M. on June 14, they landed 16 hr. 27 min. later in a bog at Clifden, County Galway, Ire. For this performance Alcock and Brown shared the £10,000 prize offered by the *London Daily Mail* and both were awarded knighthoods. Brown later returned to engineering and was general manager of the Metropolitan Vickers company in Swansea, Wales, for some years. He died at Swansea on Oct. 4, 1948.

See G. Wallace, *The Flight of Alcock and Brown* (1955). (D. Cr.)

BROWN, CHARLES BROCKDEN (1771–1810), United States novelist who pioneered in the Gothic manner later employed by Nathaniel Hawthorne and Edgar Allan Poe and earned the title "father of the American novel," was born of Quaker parents in Philadelphia, Jan. 17, 1771. Of delicate constitution, he early devoted himself to study, reading widely in geography and political theory. To Quaker concepts of equality and social justice he added the utopian ideas of William Godwin and the marquis de Condorcet. These views, as well as a deep insight into abnormal psychology, give vigour to his four best novels. He called himself a "story-telling moralist"; his writings reflect a thoughtful liberalism, and he adapted contemporary English and German terror and horror motifs to the American scene.

His first novel, *Wieland* (1798), a minor masterpiece in American fiction, shows the ease with which mental balance is lost when the test of common sense is not applied to strange experiences. The story concerns Theodore Wieland, whose father died by spontaneous combustion apparently for violating a vow to God. Theodore, also a religious enthusiast seeking direct communication with divinity, misguidedly assumes that a ventriloquist's utterances are supernatural in origin; driven insane, Theodore acts upon the prompting of an inner voice and murders his wife and four children. When apprised of his error, he commits suicide. *Ormond* (1799) portrays a high-minded rationalist, Constantia Dudley, whose dignity and courage guide her safely through many dangers and finally lead her to kill the villain, Ormond. *Edgar Huntly* (1799) pictures incidents of Indian bloodthirstiness in the wilderness of the upper reaches of the Delaware river valley; the story concerns a sleepwalker's attempts to discover the murderer of a friend. *Arthur Mervyn* (1799–1800) describes a young farmer boy's perilous adventures in Philadelphia during the yellow fever epidemic of 1793; he avoids moral stain and ultimately marries a wealthy Jewess.

Brown's other writings included *The Dialogue of Alcuin* (1798), on the rights of women; *Memoirs of Stephen Calvert* (1799–1800), a novel of a young man's vacillation in love; *Clara Howard* (1801) and *Jane Talbot* (1801), novels of love in letter form; *Carwin, the Biloquist* (1805), a fragmentary account of the early life of Wieland's ventriloquist; and the semiannual *American Register* (1806–09), an analytical interpretation and chronology of contemporary events. He died on Feb. 21, 1810.

For the fullest biography and critical evaluation, *see* Harry R. Warfel's *Charles Brockden Brown: American Gothic Novelist* (1949). *See* also David Lee Clark, *Charles Brockden Brown, Pioneer Voice of America* (1952); Alexander Cowie, *The Rise of the American Novel* (1948). (H. R. Wl.)

BROWN, ERNEST WILLIAM (1866–1938), British mathematician and astronomer, devoted many years of his life to a theory of the motion of the moon. Born at Hull, Yorkshire, Nov. 29, 1866, he went to Christ's college, Cambridge, where he greatly distinguished himself. He received the doctor of science degree in 1897 and became a fellow and, in 1911, an honorary fellow of his college. Although Brown retained throughout his life a great attachment for his college and returned to Cambridge almost every summer, his professional life was spent in the United States. He accepted an appointment at Haverford college, Haverford, Pa., in 1891 and he was professor of mathematics at Yale from 1907 until his retirement in 1932. He died at New Haven, Conn., on July 22, 1938. At Cambridge Brown began to study the motion of the moon by a method devised by G. W. Hill. The latter had carried the subject far enough to show its suitability for solving the problem and Brown completed the theory and constructed tables. The theory in its entirety was published by 1908 and the tables, which are many times more accurate than earlier ones, have been used in calculating the positions of the moon since 1923. For a description of Brown's theory and tables, *see* MOON: *Lunar Theory*. (J. JN.)

BROWN, FORD MADOX (1821–1893), English painter whose work resembled in feeling and technique that of the Pre-Raphaelites, though he was never a member of the Brotherhood. Born at Calais, April 16, 1821, he studied art, 1837–39, at Bruges under Albertus Gregorius, and at Antwerp under Baron Gustaf Wappers, from whom he learned a sound technique. His early work is characterized by sombre colour and dramatic feeling suited to the Byronic subjects executed in Paris during 1840–43; *e.g.*, "Manfred on the Jungfrau" and "Parisina's Sleep." Already concerned with the accurate representation of natural phenomena, he drew from corpses in University College hospital, London, when painting his "Prisoner of Chillon" (1843). Between 1844 and 1845 he contributed three cartoons to the competition for the houses of parliament decorations, but did not gain a prize. After a visit to Italy in 1845, his palette gained in richness and variety of colour, and in 1848 he met Peter von Cornelius, a member of the former Nazarenerbund which was a precursor to the Pre-Raphaelite Brotherhood. This combined interest in brilliant, clear colour and neomedievalism appears first in the "Wyclif Reading His Translation of the Scriptures to John of Gaunt" (1847). Brown contributed to the Pre-Raphaelites' magazine *Germ* in 1850, and Rosetti worked in his studio. Like Holman Hunt, Brown painted *en plein air* to obtain naturalistic accuracy of, for example, blue flesh tones in winter, for his "The Last of England" (1852–55, Birmingham Art gallery).

His most famous picture, "Work" (1852–63, Manchester Art gallery), which is a didactic social document, was first exhibited at Brown's retrospective exhibition held in London, 1865, for which he wrote the catalogue. He also worked as a book illustrator with William Morris; produced stained glass, for example, at St. Oswald's, Durham (1864–65); and between 1879–March 1893 completed a series of 12 "frescoes" in Manchester Town hall depicting scenes from the city's history. Some were executed in oil on canvas glued to the wall.

He died in London, Oct. 6, 1893.

See Ford M. Hueffer (Ford Madox Ford), *Ford Madox Brown* (1896); W. M. Rossetti (ed.), *Ruskin, Rossetti, Pre-Raphaelitism* (1899), *Pre-Raphaelite Diaries and Letters* (1899). (D. L. FR.)

BROWN, FRANCIS (1849–1916), U.S. Semitic scholar and president of Union Theological seminary, was born in Hanover, N.H., Dec. 26, 1849, the son of Samuel Gilman Brown (1813–85), president of Hamilton college from 1867 to 1881, and the grandson of Francis Brown (1784–1820), a president of Dartmouth involved in the famous "Dartmouth college case." The younger Francis graduated from Dartmouth and from the Union Theological seminary and then studied in Berlin. In 1879 he became instructor in biblical philology at the Union Theological seminary, in 1881 an associate professor, in 1890 professor of Hebrew and cognate languages and in 1908 president of the seminary. Brown's published works, which won him honorary degrees in both Great Britain and the U.S., were, with the exception of *The Christian Point of View* (1902; with A. C. McGiffert and G. W. Knox), almost purely linguistic and lexical, and include *Assyriology: its Use and Abuse in Old Testament Study* (1885), and the important revision of Gesenius, undertaken with S. R. Driver and C. A. Briggs, *A Hebrew and English Lexicon of the Old Testament* (1891–1905). In 1911 he was tried for heresy before the Presbyterian General Board but was exonerated. He died in New York on Oct. 15, 1916.

BROWN, GEORGE (1818–1880), Canadian journalist and statesman, was born in Edinburgh, Scot., on Nov. 29, 1818, and was educated in his native city. With his father, Peter Brown, he emigrated to New York in 1837. In 1843 they moved to Toronto and established *The Banner*, which supported the newly formed Free Church of Scotland. In 1844, at first with his father's help, he began to issue a Reform political journal, the weekly *Toronto Globe*. This became a daily in 1853 and through Brown's ability and energy came to possess an almost dictatorial influence over political opinion. In 1851 he entered the Canadian parliament as an independent Liberal member for Kent county. His vehement opposition to the presumed political power of the Roman Catholic Church and the "domination" in parliament of the French Canadian section made him very unpopular in Lower Canada, but in Upper Canada his power grew great. Largely owing to his campaign for separating church and state, the clergy reserves were secularized in 1854 and he championed the complete secularization of Upper Canada's schools, but unsuccessfully. He also fought for the representation by population of the two Canadas in parliament, the act of union (1840) having granted an equal number of representatives to each. His principle would be recognized in the British North America act (1867). He rebuilt the Upper Canada Liberal party behind "representation by population" and briefly won office in 1858 (the two-day Brown-Dorion administration).

He was one of the early advocates of a confederation of British North America, and in June 1864, to accomplish this end, entered into a coalition with his bitter personal and political opponent, Conservative premier John (later Sir John) A. Macdonald. Largely because of Brown's efforts, federation was carried through the house. In Dec. 1865, disapproving terms proposed for renewal of the reciprocity treaty with the United States, he resigned from the government, though continuing to support its federation policy. In 1867 he was defeated in South Ontario and never again sat in the house. In great measure because of his powerful advocacy, the Northwest Territories were acquired by the new dominion. In Dec. 1873 he was called to the Canadian senate, and in 1874 was appointed joint plenipotentiary with Sir Edward Thornton to negotiate a new reciprocity treaty with the United States. The negotiations were successful, but the draft treaty failed to pass the United States senate. Soon afterward Brown refused the lieutenant governorship of Ontario, and on two subsequent occasions the offer of knighthood, devoting himself to the *Globe*. On March 25, 1880, he was shot by a discharged employee and died at Toronto on May 9.

See J. M. S. Careless, *Brown of the Globe* (1960). (W. L. G.; J. M. S. C.)

BROWN, HENRY KIRKE (1814–1886), U.S. sculptor whose equestrian statues are his most famous works, was born in Leyden, Mass., on Feb. 24, 1814. He began to paint portraits while a boy, studied painting in Boston under Chester Harding, learned a little about modeling, and from 1836 to 1839 spent his summers working as a railroad engineer to earn enough to study further. He spent four years (1842–46) in Italy, but, returning to New York, he remained distinctively American, never being dominated, as were so many of the early U.S. sculptors, by Italian influence. He died on July 10, 1886, at Newburgh, N.Y. His equestrian statues are excellent, notably that of Gen. Winfield Scott (1874) in Washington, D.C., and one of George Washington (1856) in Union square, New York city, which was the second equestrian statue made in the United States. Brown was one of the first sculptors in America to cast his own bronzes. Among his other works are: Abraham Lincoln (Union square, New York city); Nathanael Greene, George Clinton, Philip Kearny and Richard Stockton (all in the National Statuary hall of the Capitol, Washington, D.C.); De Witt Clinton and "The Angel of the Resurrection," both in Greenwood cemetery, New York city; and an "Aboriginal Hunter."

Brown's nephew and pupil, HENRY KIRKE BUSH-BROWN (1857–1935), also became prominent among U.S. sculptors, his "Buffalo

Hunt," equestrian statues of Generals Meade and Reynolds at Gettysburg and "Justinian" in the New York appellate courthouse being his chief works. He completed also a portrait-bust of Henry Kirke Brown for the Hall of Fame of New York university.

BROWN, JACOB JENNINGS (1775–1828), U.S. army officer, was born of Quaker parents in Bucks county, Pa., on May 9, 1775. He served for a time (1798–1800) as military secretary to Alexander Hamilton, became a successful farmer in western New York and in 1810 was made a brigadier general in the New York state militia. At the outbreak of war with Great Britain in 1812, he was in command of the New York state frontier and was successful in repelling attacks of the enemy at Ogdensburg, Oct. 3, 1812, and at Sackets Harbor, May 29, 1813. In the following July he was commissioned a brigadier general in the U.S. army and placed in command at Niagara. From there he took the offensive and after preliminary successes fought an indecisive battle on July 25 at Lundy's Lane. He became the commanding general of the U.S. army in 1821 and served in that capacity until his death, Feb. 24, 1828. (E. E. R.)

BROWN, JOHN (1715–1766), English clergyman, poet and playwright, was born at Rothbury, Northumberland, on Nov. 5, 1715, and educated at St. John's college, Cambridge. He was senior wrangler in 1735 and then took holy orders. His poem entitled *Honour* (1743) was followed by the *Essay on Satire,* written on the death of Alexander Pope, which gained for him the friendship of Bishop William Warburton. In 1751 he wrote his *Essay on the Characteristics of the Earl of Shaftesbury,* containing an able defense of the new utilitarian philosophy, and particularly emphasizing the advantages of state-controlled education. In 1756 he received the living of Great Horkesley, in Essex, and five years ater became vicar of Newcastle upon Tyne. Garrick appeared in his two plays *Barbarossa* (1754) and *Athelstan* (1756). His *Estimate of the Manners and Principles of the Times* (1757–58), a bitter satire, was very popular. Invited by Catherine II of Russia to advise her on education, he prepared for the journey but was prevented by illness from setting out. In one of the fits of madness that had often before attacked him, Brown committed uicide on Sept. 23, 1766.

See his poetical works, ed. by Anderson (1794); and *Biographia Britannica,* ed. by A. Kippis (1780). (G. Hu.)

BROWN, JOHN (1800–1859), U.S. abolitionist, leader of the attack on Harpers Ferry in 1859, was born on May 9, 1800, at Torrington, Conn. He was one of the 16 children of Owen Brown, whose father had served as a captain in the Revolutionary War. n 1805 Owen Brown moved with his family to the Western Reerve district of Ohio. John Brown, at 18, intended to prepare for he Congregational ministry, and he studied briefly at schools in Massachusetts and Connecticut.

THE GRANGER COLLECTION

JOHN BROWN, FROM DAGUERREOTYPE MADE ABOUT 1850

Two years later he married Dianthe Lusk, who bore him 7 hildren; after her death he maried Mary Anne Day, who bore im 13 more. He moved about a reat deal, living from time to ime in Ohio, Pennsylvania and Massachusetts, and working as a rover, tanner, stock grower, wool merchant and farmer. In 849 he settled with his family in Negro community founded at North Elba, N.Y., on land doated by the antislavery philanhropist Gerrit Smith of Peterboro, N.Y. Long a foe of slavery, rown henceforth was to act like monomaniac on the subject.

In 1855 Brown went to Kansas, hither five of his sons already had gone. Kansas was then the scene of violent conflict between ree-state and proslavery groups. Settling near Osawatomie, rown soon became conspicuous as a guerrilla leader, especially ecause of the so-called Pottawatomie massacre. Brooding over the killing of five free-soilers, he concluded that he had a divine mission to take vengeance. On the night of May 24–25, 1856, he led four of his sons and three other men to the cabins of suspected proslavery settlers living along Pottawatomie creek. His followers dragged five men out and hacked them to death.

In the spring of 1858 Brown held a remarkable convention of Negroes and whites at Chatham, Can. There he announced his intention to set up in the Maryland and Virginia mountains a stronghold where escaping slaves might gather and defend themselves. He proposed, and the convention adopted, a "provisional constitution and ordinance for the people of the United States." He was elected commander in chief of this paper government. For his visionary enterprise he gained the moral and financial support of Gerrit Smith and the prominent Bostonians, Theodore Parker, G. L. Stearns, T. W. Higginson, S. G. Howe, and F. B. Sanborn (the "secret six"). In the summer of 1859, with an armed and disciplined band of 16 white men and 5 Negroes, Brown set up a kind of military headquarters in a rented farmhouse near Harpers Ferry, the site of a federal armory. He planned to seize the armory as the first step in carrying out his program. Launching his attack on the night of Oct. 16, he quickly took the armory and then rounded up some 60 leading men of the area, whom he meant to hold as hostages. Throughout the next day and night he and his men held out against the local militia, but on the following morning he surrendered to a small force of U.S. marines, under Col. Robert E. Lee, after they had broken in and overpowered him. He himself had been seriously wounded, and 10 of his followers, among them two of his sons, had been killed. Six were captured (and later executed) and five escaped. On the other side the losses were five dead and nine wounded.

Jailed in Charlestown, Va. (now Charles Town, W.Va.), Brown was tried for murder, slave insurrection and "treason to the Commonwealth," that is, to the state of Virginia. At the trial, evidence was produced to show that many of his ancestors and relatives had been emotionally disturbed and that he himself probably suffered from mental illness. He refused, however, to permit a plea of insanity. In a speech to the court he denied all the charges against him and admitted only that he had intended to free the slaves. "I say," he added, "I am yet too young to understand that God is any respecter of persons. I believe that to have interfered as I have done—as I have always freely admitted I have done—in behalf of His despised poor, was not wrong, but right." He was convicted and, on Dec. 2, hanged. He was buried at North Elba.

The Harpers Ferry raid failed utterly to do what Brown apparently had had in mind, that is, to start a general movement toward escape and freedom on the part of the slaves. Nevertheless, the raid had important consequences, for it immeasurably heightened the sectional feelings that soon were to eventuate in the Civil War. In the South little attention was paid to the views of responsible Republican leaders like Abraham Lincoln who disapproved of the raid. More attention was given to the statements of such New England intellectuals as Ralph Waldo Emerson and Henry David Thoreau who looked upon Brown as a hero and a saint. Once the war had come, Union soldiers took up the song "John Brown's Body," and his soul went "marching on." Thus he became a legendary martyr to the cause of freedom.

Bibliography.—F. B. Sanborn, *Life and Letters of John Brown* (1885); O. G. Villard, *John Brown, 1800–1859* (1910; rev. ed., 1943); J. C. Malin, *John Brown and the Legend of Fifty-Six* (1942); J. C. Furnas, *The Road to Harpers Ferry* (1959); Louis Ruchames (ed.), *A John Brown Reader* (1959). (R. N. Ct.)

BROWN, SIR JOHN (1816–1896), English armour-plate manufacturer, was born at Sheffield on Dec. 6, 1816, the son of a slater, and began work at a cutlery firm. Brown invented in 1848 the conical steel spring buffer for railway cars. In 1856 he started the Atlas iron works in Sheffield, which covered 30 ac. and employed eventually more than 4,000 workmen. Besides supplying iron to the Sheffield steel trade, Brown himself successfully developed the Bessemer process. In 1860, after seeing the French ship "La Gloire" armoured with hammered plate, he determined to attempt the production of armour for the British navy by a rolling process. The experiment was successful and led to orders for armour plate sufficient to protect about three-quarters of the navy. Brown died at Bromley, Kent, on Dec. 27, 1896.

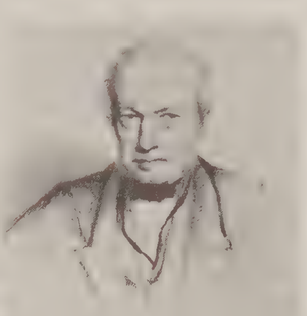
See obituary notice in the *Engineer* (Jan. 1, 1897).

BROWN, JOHN GEORGE (1831–1913), U.S. painter whose representations of bootblacks, newsboys and urchins had great popularity in his time, was born in Durham, Eng., Nov. 11, 1831. He studied at Newcastle upon Tyne, at Edinburgh academy, and, after removing to New York city in 1853, at the schools of the National Academy of Design, of which he afterward became a member. In 1866 he became one of the charter members of the Water Color society, of which he was president from 1887 to 1904. His "Passing Show" (Paris Salon, 1877) and "Street Boys at Play" (Paris exhibition, 1900) are good examples of his popular talent. He died in New York city, Feb. 8, 1913.

BROWN, LANCELOT ("CAPABILITY" BROWN) (1716–1783), English landscape gardener and architect to whose work and influence a great part of the English countryside owes its appearance, was born at Kirkharle, Northumberland. His nickname resulted from his habit of saying that he could see "capabilities" in the estates he was called upon to improve. He started his career as a gardener in his native village, and in 1740 became Lord Cobham's gardener at Stowe, Buckinghamshire, where he met William Kent (*q.v.*). In 1751 he started a practice at Hammersmith, meeting with immediate and lasting success. More than 140 estates received Brown's attention. He modified Kent's style of gardening to make it suitable for extensive tracts of park and farmland instead of the smaller areas Kent laid out. Structures alluding to classical antiquity were allotted minor roles or dropped altogether; the main elements in the typical Brown landscape were isolated clumps of trees, undulating greensward and a surrounding belt of woodland. He died on Feb. 6, 1783.

See D. Stroud, *Capability Brown* (1950). (Ms. W.)

BROWN, ROBERT (1773–1858), British botanist probably best known for his very important discovery of "Brownian movement" (*q.v.*), was born at Montrose, Scot., on Dec. 21, 1773. He is also noted for his *Prodromus florae novae Hollandiae et insulae Van Diemen*, which did much to further the general adoption of A. L. de Jussieu's natural system of plant classification. Brown was the foremost botanist of his time, and was a great figure in the history of British botany; he was the first to describe the cell nucleus in plants.



THE GRANGER COLLECTION

ROBERT BROWN, PENCIL DRAWING BY WILLIAM BROCKEDON, 1849

Educated at Montrose and at Marischal college, Aberdeen, he began to study medicine at Edinburgh in 1789, but did not take a medical degree. In 1800, on the recommendation of Sir Joseph Banks, he was offered the post of naturalist to the expedition of Capt. Matthew Flinders for the survey of the then almost unknown coast of Australia. In December 1801 Brown and Flinders arrived at Australia and immediately began the survey of the flora of the coast. Australia's isolation, which resulted in the greatest diversity of flora native only to the island continent, presented special problems of classification and morphology; Brown's solutions proved to be of great influence in the science of taxonomy. In 1805 the expedition returned to England, having obtained, among other acquisitions, nearly 4,000 species of plants, many of which were new.

Brown was almost immediately appointed librarian of the Linnean society, a post that he filled until 1822. He remained in the service of the admiralty until 1810 to work at his collections under Banks's supervision, and in that year published, in Latin, the first volume of his great work, the *Prodromus*. With the exception of a supplement published in 1830, no more of the work appeared. On the death of J. Dryander in 1810, Brown became librarian-botanist to Banks, who, on his death in 1820, bequeathed to him the use of his library and collections for life. In 1827 these were transferred to the British museum and a new department, the Banksian department, was created, with Brown as keeper. In 1835 the Sloane collections were added and the department of botany was constituted. Brown was keeper of this department until his death in London on June 10, 1858.

Brown played a leading part in preparing the way for a natural system of classification, although he did not propose a classification of his own. He used considerable constraint, and almost casually announced epoch-making discoveries. He contributed much to the knowledge of the sexual process in higher plants. He was also the first to distinguish between the gymnosperms and angiosperms, and he initiated the microscopical examination of fossil plants. He also had considerable influence on the scientific study of geographical botany.

In 1825–34 his works up to that date were collected and published in five volumes by C. G. D. Nees von Esenbeck, in German, under the title of *Vermischte Botanische Schriften*. In 1866–68 the Ray society reprinted his complete writings, the *Prodromus* alone excepted.

See F. W. Oliver, *Makers of British Botany* (1913); *Proceedings of the Linnean Society of London*, session 1931–32, pp. 17–54. (J. RM.)

BROWN, THOMAS (1663–1704), English satirist whose extempore translation of an epigram by Martial with the lines beginning "I do not love thee, Dr. Fell" both prevented his expulsion from Oxford and won him lasting fame. Born at Shifnal Shropshire, in 1663, he entered Christ Church, Oxford, in 1678 The irregularity of his life there almost caused his expulsion b John Fell, the dean, and he left without taking a degree. H settled in London, where his life combined pugnacity in literar argument with licentiousness, and wrote many satires, epigram and lampoons. He also translated works from Latin and French His prose *Amusements Serious and Comical, Calculated for th Meridian of London* (1700; mod. ed., 1927) presents a vivid pic ture of the city and its inhabitants as seen by the Grub stree writers which is of historical rather than literary value. Brow died in London on June 16, 1704.

See *The Works of Mr. Thomas Brown,* 3 vol. (1707–08).

BROWN, THOMAS (1778–1820), Scottish metaphysicia whose work marks a turning point in the history of the so-calle "common-sense school," was born at Kirkmabreck, Kirkcudbright, on Jan. 9, 1778, the son of a Presbyterian minister. Afte going to school in England, he entered Edinburgh university i 1792, where he studied philosophy, then law (from 1796) an finally medicine (1798–1803) and there came into contact wit Dugald Stewart, professor of moral philosophy, and with th founders of the *Edinburgh Review*. After some practice as doctor, Brown was invited to lecture as deputy for Stewart i 1808–09; and in 1810 he was appointed joint professor wit Stewart. Taken ill in 1819, he went to London to recuperate bu died at Brompton on April 2, 1820.

Brown began writing early. His works include *Observatio on the Zoonomia of Erasmus Darwin* (1798); an article in th *Edinburgh Review*, no. 2 (1803), criticizing Kant's philosoph which he knew only through a French account of it; *Observatio on the Nature and Tendency of the Doctrine of Mr. Hume Co cerning the Relation of Cause and Effect* (1805; 3rd ed., *An I quiry into the Relation of Cause and Effect,* 1818), original intended to show how Hume's views were compatible with Chri tian teaching; eight books of undistinguished verse (collected e 4 vol., 1820), in the manner of Mark Akenside, whom he moreov used to quote in his lectures; and the posthumously publishe *Lectures on the Philosophy of the Human Mind,* 4 vol. (182 20th ed., with memoir by D. Welsh, 1861).

Brown, as Dugald Stewart's pupil, accepted the arguments f certain noninferential beliefs that Thomas Reid (*q.v.*) had ma characteristic of the "Scottish" or "common-sense" school philosophy (*see* COMMON SENSE, PHILOSOPHY OF), but he r sisted the tendency to dissolve the substance of the mind in separate "faculties" and differed markedly from his predecesso in his attitude toward Hume and in his approach to sensationis He accepted Hume's interpretation of causality (*q.v.*) in ter of-repeated sequence, though he argued that belief in the regularity of the repetition was independent of experience. His debt to French sensationism as represented by Condillac is evident (1) in his general contention that we look intuitively on a sensation in the mind and (2) in his particular account of touch and of "muscular sense." He thus stands at the point where the Scottish school divides into two lines: the one, headed by Brown, with its sensationist orientation, in which J. S. Mill and Alexander Bain followed him; the other represented by Sir William Hamilton, who sought to combine the views of Reid and Stewart with German philosophy and resented Brown's deviation, especially where it had led him to criticize Reid.

See D. Welsh, *Account of the Life and Writings of Thomas Brown* (1825); F. Rethoré, *Critique de la philosophie de Thomas Brown* (1863); L. Dobrzynska-Rybicka, *Die Ethik von Thomas Brown* (1909).

BROWN, THOMAS EDWARD (1830–1897), English poet, author of narrative poems and lyrics full of fervent local patriotism and simple natural piety. He was born May 5, 1830, at Douglas, Isle of Man, educated by a scholarly father and at King William's college, and entered Christ Church, Oxford, in 1849. Elected fellow of Oriel in 1854, and ordained in 1855, he returned to his old school as vice-principal in 1858. In 1863 he became second master at Clifton college where, by the time he retired (1892), "T.E.B.'s" genius and eccentricities had become a matter for pride. He died at Clifton, Oct. 30, 1897.

His first poem, "Betsey Lee," appeared in 1873, and was included in *Fo'c'sle Yarns* (1881), the first of several volumes. His most important narrative poems were written in Manx, sometimes with daring irregularity of rhythm, and are characterized by a rugged tenderness, but the emotion, almost equally explosive in mirth and in tears, is disciplined by a scholar's sense of language. In his lyrics he is happiest when yoking one of these emotions to serve a philosophy of life often audacious but always genial.

See *Collected Poems; Letters,* with a memoir (both 1900).
(A. T. Q.-C.; X.)

BROWN, SIR WILLIAM, Bart. (1784–1864), British merchant and founder of the banking house of Brown, Shipley and Co., was born May 30, 1784, at Ballymena, Ire. In 1800 his family moved to the U.S. to engage in the linen trade and organized the firm of Alexander Brown & Sons. In 1809 Brown established a Liverpool branch, which became a banking and mercantile operation, and later founded Brown, Shipley & Co., Liverpool and London merchants. By 1844 his company controlled one-sixth of the trade between Great Britain and the U.S. From 1846 to 1859 he was a member of parliament for South Lancashire and during the Crimean War helped ease friction between Great Britain and the United States. He gave the city of Liverpool its public library and museum, opened in 1860, and in 1863 he was created baronet. He died March 3, 1864, in Liverpool.

See H. R. Fox Bourne's *English Merchants* (1886). (J. R. Lt.)

BROWNE (Brown), **CHARLES FARRAR:** *see* Ward, Artemus.

BROWNE, EDWARD GRANVILLE (1862–1926), British philologist, who made basic contributions to the study of Persian literary history, was born on Feb. 7, 1862, at Uley, Gloucestershire. Educated at Trinity college, Glenalmond, and then at Eton and Pembroke college, Cambridge, he studied medicine and oriental languages. In 1887 he was elected a fellow of his college, in the same year qualifying M.B. at St. Bartholomew's hospital, London, but he never practised as a doctor. In 1887–88 he travelled in Persia, becoming afterward lecturer in Persian at Cambridge. In 1902 he was appointed Adams Professor of Arabic at Cambridge, a post he held until his death. Browne's published works include *A Traveller's Narrative* (1891), re-issued in 1926 under the title *A Year Amongst the Persians; Literary History of Persia Until the Time of Firdausi* (1902), continuations of which were published in 1906, 1920 and 1924; *The Persian Revolution, 1905–9* (1910); a translation of *Chahár Māqála,* with notes (1921); and *Arabian Medicine* (1921). He died at Cambridge on Jan. 5, 1926.

BROWNE, HABLOT KNIGHT ("Phiz") (1815–1882), English artist, pre-eminent as an interpreter and illustrator of Dickens' characters, was born at Lambeth on June 15, 1815, in humble circumstances and was early apprenticed to the engraver William Finden, in whose studio his only artistic education was obtained. At the age of 19 he abandoned engraving in favour of other artistic work, and a meeting with Dickens two years later determined the form which this should take. Robert Seymour, the original illustrator of *Pickwick,* had just committed suicide, and the serial publication of the book was in danger from the lack of a capable successor. Browne applied for the post, and the drawings which he submitted were preferred by Dickens to those of a rival applicant—W. M. Thackeray. His pseudonym of "Phiz" was adopted in order to harmonize with Dickens' "Boz," and it was by his work for Dickens (especially in *Pickwick, David Copperfield, Dombey and Son, Martin Chuzzlewit* and *Bleak House*) that his reputation was made. He also illustrated the best-known novels of Charles Lever and Harrison Ainsworth in their original editions, and his work was in constant demand by publishers until a stroke of paralysis, in 1867, permanently injured his powers. His early ambition to become famous as a painter was not realized, but he gained great popularity and was awarded an annuity by the Royal Academy in 1878. He died at West Brighton on July 8, 1882.

See Albert Johannsen, *Phiz Illustrations From the Novels of Charles Dickens* (1956).

BROWNE, ISAAC HAWKINS (1705–1760), English poet, author of *De Animi Immortalitate* and regarded by Samuel Johnson as "one of the first wits of this country," was born on Jan. 21, 1705, at Burton upon Trent, Staffordshire, and died in London on Feb. 14, 1760. Educated at Westminster school and Trinity college, Cambridge, he was called to the bar, but never practised. He was the author of "Design and Beauty," a poem addressed to his friend Joseph Highmore, the painter; and of "The Pipe of Tobacco" which parodied Colley Cibber, John Philips, James Thomson, Edward Young, Alexander Pope and Jonathan Swift, who were then all living. In 1754 he published his chief work, *De Animi Immortalitate,* a Latin poem on the immortality of the soul much admired by the scholars of his time.

See *Poems on Various Subjects, Latin and English,* published by his son Isaac Hawkins Browne (1768); the full account by Andrew Kippis in vol. 2 of *Biographia Britannica,* 6 vol. (1778–93).

BROWNE, MAXIMILIAN ULYSSES, Graf von (1705–1757), Austrian field marshal, one of Maria Theresa's most successful commanders. Born at Basel, Switz., on Oct. 23, 1705, he came of an Irish Jacobite family, his father having left Ireland and become resident in Austria. At the outbreak of the War of the Austrian Succession, Browne was in command of the troops in Silesia when Frederick the Great overran the country (1740–41), but he showed exceptional skill in delaying the Prussian advance and extricating his own troops—thereby giving the Austrians time to organize further defense and build up an army. He took part in the Italian campaign of 1746–49 where he again distinguished himself, and in 1751 became commander in chief in Bohemia. He was again on active service during the Seven Years' War. While advancing to the relief of Pirna, Browne was engaged and heavily defeated by Frederick at Lobositz on Oct. 1, 1756. Once again he conducted a skilful withdrawal. In the following year he was severely wounded at the battle of Prague and died of his wounds on June 26, 1757. It was said that his death was accelerated by the knowledge that he was being blamed for the lack of success of the campaign. (C. N. B.)

BROWNE, ROBERT (*c.* 1550–1633), was the leader of a group of Elizabethan separatists, called after him Brownists, and a pioneer in England of what are known as Free churches, that is, churches existing in independence of secular government. The son of a gentleman, claiming cousinship with Lord Burghley, he was born near Stamford, Lincolnshire, and educated at Corpus Christi college, Cambridge. In 1591 Burghley presented him to the living of Achurch, Northamptonshire, where he remained for the rest of his life. He died in Oct. 1633 at Northampton.

The significance of Browne's career lies in the 20 years between his leaving Cambridge and his becoming rector of Achurch. His temperament was of the kind that will not fit into any accepted framework, ecclesiastical or secular. When in 1579 he received the bishop's licence to preach, he threw it in the fire, crying that he preached "not as caring for, or leaning upon the bishop's authority, but only to satisfy his duty and conscience." Similarly, if the magistrate commands the preacher to give over his calling, Browne asserted, he ought not to obey him. In 1580, together with Robert Harrison, a Norwich schoolmaster, he gathered a separatist church in Norwich of the kind later known as Independent or Congregational. As a consequence of such teaching and behaviour, Browne was soon in trouble. He was imprisoned 32 times; and in 1582 he was in exile in the Netherlands. Eventually, however, he accepted convention and obscurity. He also quarreled with Henry Barrow (*q.v.*) and John Greenwood (*q.v.*).

While in exile Browne had been writing, and his books proclaim principles which, though later largely accepted by Protestants, were in his own day revolutionary. Browne's best-known tract, *A Treatise of Reformation Without Tarying for Anie* (1582), contains these pungent phrases: "It is the conscience and not the power of man that will drive us to seek the Lord's kingdom"; "The Lord's people is of the willing sort"; "In all things we must first look what is the Lord's will and charge, and then what is the will of man . . . And this freedom have all Christians"; "Let the Church rule in spiritual wise, and not in worldly manner"; "Though magistrates are to keep their civil power above all persons, yet they come under the censure of the Church, if they be Christians." In *A Booke Which Sheweth the Life and Manners of All True Christians* (1582) the contrasting state of true Christians and false is set forth. This is the first blueprint for an independent church polity in dependence on Christ alone. Browne's passion for freedom can be seen to spring from his faith in the character and capacity of the converted.

BIBLIOGRAPHY.—*The Writings of Robert Harrison and Robert Browne*, ed. by A. Peel and L. H. Carlson (1953). *See* also H. M. Dexter, *The Congregationalism of the Last Three Hundred Years* (1880); A. Peel (ed.), *The Brownists in Norwich and Norfolk About 1580* (1920); C. Burrage, *The True Story of Robert Browne* (1906).

(G. F. N.)

BROWNE, SIR THOMAS (1605–1682), English physician and author, who, chiefly famous for one small book of self-revelation, *Religio Medici,* is one of the outstanding 17th-century writers of English prose. He was born in London on Oct. 19, 1605. His father, a mercer in Cheapside, died when he was eight and his mother soon married Sir Thomas Sutton. Brought up by guardians, he was educated at Winchester and in 1623 entered Broadgates hall (later Pembroke college), Oxford, where his principal was Thomas Clayton, regius professor of physic, and his tutor Thomas Lushington, a broad-minded and witty clergyman who later moved to Norwich. These influences may have suggested his choice of medicine as a profession and his settling in Norwich as practitioner. He obtained his B.A. in 1626 and his M.A. three years later. The university did not offer courses in medicine and he probably began his medical studies as assistant to a doctor near Oxford. After visiting Ireland with his stepfather he went to study medicine abroad, first at the University of Montpellier, then at Padua and finally at Leiden, where he took his M.D. on Dec. 21, 1633. Details of Browne's experiences in these centres of learning can only be conjectured, but they were certainly of the first importance in the cultivation of his mind. On returning to England in 1634 he lived for a time at Shibden hall near Halifax, in Yorkshire, beginning to practice in the neighbourhood, and after two years was incorporated M.D. at Oxford. In 1636 he settled in Norwich.

The serious purpose of Browne's life had now reached fruition, but his parallel career as writer had also begun by chance at Shibden hall. There, when not yet 30, he had written his *Religio Medici,* which he described as "a private exercise directed to myself," and it did indeed circulate at first only in manuscript among his friends. In 1642, however, it was printed without his permission in London and so had to be acknowledged, an authorized version being published in 1643, together with letters to and from Sir Kenelm Digby, who had been so delighted with his first perusal of the surreptitious edition that he there and then composed his *Observations* upon it. The book was an immediate success in England and soon circulated widely in a Latin translation on the continent of Europe. It was also translated into Dutch and French. In English it has become a classic both for its language and for its cast of thought.

Browne shows himself as a latitudinarian in religion, expressing his ideas in a sane and unpretentious way. He is fond of paradox, but is not obscure or pedantic. His ideas are original and sometimes humorous, revealing an engaging character, interested in the scientific spirit of the time and caring deeply for the freedom of the individual. Religious toleration such as Browne's was then uncommon. His philosophy is not profound, but his views have a perennial interest and are expressed in a richly ornamented prose which has kept its freshness.

By 1643 Browne had been for seven years in Norwich, so that the establishment of his fame as an author saw him already well set on his career as a doctor. He had married in 1641 and his family was growing. In spite of the demands of a practice spreading over a wide area, he accumulated a large library and was deeply read in classical and medical literature. He began early to compile notebooks of miscellaneous jottings and, using these as a quarry, he compiled his second and larger work, *Pseudodoxia Epidemica, or, Enquiries Into Very Many Received Tenents, and Commonly Presumed Truths* (1646). This often known as *Browne's Vulgar Errors,* set out to correct many popular beliefs and superstitions. Written in a picturesque, but not over-elaborated, style, the book was a success and was reprinted five times during Browne's life.

In 1658 he published his third book, containing two treatises on antiquarian subjects, *Hydriotaphia, Urne-Buriall, or a Discourse of the Sepulchrall Urnes Lately Found in Norfolk,* and *The Garden of Cyrus, or the Quincunciall, Lozenge, or Network Plantations of the Ancients.* Around the theme of the urns he wove a tissue of solemn reflections on death and the transience of human fame in his most luxuriant style; in the latter work, in which he traces the history of horticulture from the garden of Eden to the Persian gardens in the reign of Cyrus, he is especially fascinated by the quincunx, which furnished him with a subject for majestic elaboration. The whole volume is the supreme example of his skill in the manipulation of language. He used latinized forms of words and inversions of structure in his sentences to obtain a highly stylized effect. Some critics have detected in his prose a rhythm which borders on poetry, but which may be more aptly compared with music. A smaller work of great beauty and subtlety, entitled *A Letter to a Friend, Upon Occasion of the Death of His Intimate Friend,* was published posthumously in 1690. This was probably written late in Browne's life, and is founded on the clinical history of an actual patient dying of phthisis.

Browne had always been a royalist, and his fame both as doctor and writer gained him a knighthood when Charles II visited Norwich in 1671. He seldom left the city except to visit patients in other parts of Norfolk, but corresponded with such men of learning as John Evelyn, Sir William Dugdale and John Aubrey. Most of his surviving letters, however, were written to his eldest son, Edward Browne, and these give an intimate picture of his medical practice and his relations with his family. His life pursued an even course until 1682, when he died at Norwich, on Oct. 19, his 77th birthday. Browne has been criticized for the part he played in 1664 as a witness at the trial and condemnation of two women as witches; a later age condemns this as an indulgence in superstition on the part of one who attacked superstition in others. This is to ignore the religious attitude of the time. Browne was only expressing the logic of his faith, which entailed a belief in a personal Satan and so in the possible existence of witches, who must be persecuted as Satan's representatives. He died a sincere Christian and was buried in Norwich in the Church of St. Peter Mancroft, where his monument still stands.

The first edition of Browne's collected works was published in 1686; other editions are by Simon Wilkin, 3 vol. (1835–36); by C. Sayle, 3 vol. (1904–7); and by Geoffrey Keynes (including letters), 6 vol. (1928–31). *Religio Medici* was edited by J. J. Denonain (1953 and 1955); *Hydriotaphia* and *The Garden of*

Cyrus were edited by John Carter (1958). *Notes and Letters on the Natural History of Norfolk* was edited by T. Southwell (1902).

Bibliography.—There is a full *Bibliography* by G. Keynes (1924). *See* also the lives by Samuel Johnson (1756); by S. Wilkin, in *Collected Works* (1836); by Edmund Gosse (1905); and by Jeremiah Finch (1950). (G. L. K.)

BROWNE, WILLIAM (1591?–1645?), English poet, author of *Britannia's Pastorals*, the *Inner Temple Masque* and other pastoral and miscellaneous verse, was born at Tavistock, Devon. He is said to have proceeded to Exeter college, Oxford, *c.* 1603, and he entered the Inner Temple in 1611. For some time between 1616 and 1621 he lived in France. In 1623 he became tutor to Robert Dormer, the future earl of Carnarvon, accompanying him to Eton and Exeter college, Oxford. Philip Herbert, earl of Montgomery, was Dormer's guardian, and the Herberts may have assisted Browne in other ways. His later life, after his marriage in 1628, appears to have been spent in the neighbourhood of Dorking, Surrey.

Browne's elegy on the death of Henry, prince of Wales, and the first book of *Britannia's Pastorals* appeared in 1613; *The Shepheards Pipe* in 1614; and the second book of the *Pastorals* in 1616, together with the first book, carefully revised. The *Inner Temple Masque*, which remained in manuscript until the collected edition of Browne's work of 1772, was written for performance in Jan. 1615. A fragmentary third book of the *Pastorals* exists in manuscript in Salisbury cathedral library. His miscellaneous poems are collected in Lansdowne Manuscript 777, at the British museum.

Britannia's Pastorals is a long, discursive pastoral narrative, interspersed with songs. Spenser was Browne's chief model here. Devoted to his country, and especially to Devonshire, he attempted to glorify them in pastoral verse of epic dignity. Although often imitative, Browne had originality. In the published pastorals, this appears mainly in his truthful, affectionate pictures of country life; in the unpublished verse, in many moving autobiographical passages. The *Inner Temple Masque*, on Circe and Ulysses, contains some exquisite songs. Mainly a backward-looking poet, Browne also came under contemporary metaphysical influence, while the erudition, social criticism and melancholy, even morbid, reflectiveness in parts of his work indicate a range wider than the label "pastoralist" suggests.

Bibliography.—The complete *Works of William Browne* were ed. by W. Thompson and T. Davies, 3 vol. (1773); there is a modern edition by G. Goodwin, 2 vol., in the "Muses Library Series" (1894). *See* also Joan Grundy, "William Browne and the Italian Pastoral," *Review of English Studies*, vol. iv, new series (1953). (J. Gy.)

BROWNE, WILLIAM GEORGE (1768–1813), English traveler in central Africa and the middle east, was born in London on July 25, 1768. In 1792 he set out for Egypt and at Asyut joined a caravan on its way to Darfur. There he was forcibly detained from 1793 to 1796 when he was allowed to return to Egypt. From Cairo he traveled leisurely through Damascus and Istanbul, reaching London in 1798. He published *Travels in Africa, Egypt and Syria* (1799; enlarged ed., 1806; French trans., 1800). Browne's remarkable book, not recognized during his life, contained the first scientific description of Darfur by a European visitor.

After desultory wanderings in the Levant in 1800–02, he started from England in 1812 in an attempt to reach Samarkand. Riding through Anatolia from Smyrna to Erzerum he reached Tabriz in June 1813 only to be murdered a few weeks later on the road to Teheran.

Browne published nothing on his later travels. Robert Walpole, in volume two of his *Travels in Various Countries of the East* (1820), printed hitherto unpublished papers by Browne including an account of journeys in Anatolia and a description of Istanbul, to which Walpole added a somewhat patronizing biography of the traveler. (R. L. Hl.)

BROWNELL, WILLIAM CRARY (1851–1928), U.S. critic, was an early proponent of modern realistic art and sought to do for U.S. criticism what Matthew Arnold did for British. Born in New York city, Aug. 30, 1851, he graduated from Amherst college in 1871 and joined the *New York World*, becoming city editor in a year. After serving on *The Nation* from 1879 to 1881, he became editor and literary adviser to Charles Scribner's Sons, New York publishers, in 1888, remaining there until his death.

His first two books, *French Traits* (1889) and *French Art* (1892), established a new and difficult standard for the U.S. critic, but a standard which Brownell maintained for himself in his succeeding books: *Victorian Prose Masters* (1901), *American Prose Masters* (1909), *Criticism* (1914), *Standards* (1917), *The Genius of Style* (1924) and *Democratic Distinction in America* (1927). He died at Williamstown, Mass., on July 22, 1928.

His wife, Gertrude Hall Brownell, edited an anthology of his works in 1933.

See Frank Fletcher, "A Bibliography of William Crary Brownell," *Bulletin of Bibliography and Dramatic Index*, 20:242–244 (Jan. 1953).

BROWNIAN MOVEMENT. The English botanist Robert Brown reported in 1827 that an aqueous suspension of the pollen of the herb *Clarkia pulchella* contained microscopic particles which carried out a continuous, haphazard zigzag movement. This random movement of microscopic particles was subsequently called Brownian movement. Brown noted that he was not the first to observe this phenomenon and referred to earlier observations by J. T. Needham and, particularly, by F. W. von Gleichen, whose work preceded his own by 60 years. He was, however, the first to carry out a detailed investigation. He was also the first to notice that the movement could not be attributed to life in the particles themselves: the pollen of plants that had been dead for at least a century exhibited the same phenomenon. This situation was noted by Brown as a "very unexpected fact of seeming vitality being retained by these 'molecules' so long after the death of the plant." Subsequently he found this irregular translational movement also in aqueous suspensions of minute particles of typically inanimate bodies such as minerals and smoke. This proved that the phenomenon was characteristic of suspensions of all microscopically small particles. Brown's observations were followed by a large number of detailed experimental investigations by other authors. Particularly noteworthy are the systematic investigations by C. Wiener (1863) and by G. L. Gouy (1889). Eliminating a number of explanations offered in the intervening period, they proved conclusively that the Brownian movement was due neither to thermal convections nor to capillary forces. Gouy also noticed that the liveliness of the Brownian movement was more pronounced, the smaller the size of the particles and the lower the viscosity of the liquid in which they were suspended.

Truly quantitative investigations awaited the 20th century, F. M. Exner (1900) being the first to determine photographically the speed of the random movement of the particles as a function of their size and of temperature. More precise measurements became possible with the introduction of the ultramicroscope (*see* Microscope: *Ultramicroscopy*) by H. Siedentopf and R. Zsigmondy (1903). This instrument made it possible to follow the behaviour of colloidal particles too small to be visible in the ordinary microscope. The greater liveliness of these extremely small particles, which was in agreement with Gouy's findings, made quantitative studies easier. Classical experiments on the Brownian movement, with this new technique, were carried out by Zsigmondy (1905) and by Theodor (The) Svedberg (1911).

Cause of the Translational Brownian Movement.—Wiener, by stating that the cause (of the movement) must be in internal movements characteristic of the state of the liquid, and Delsaulx (1877), by stating more explicitly, "In my way of thinking, the phenomenon is a result of thermal molecular motions in the liquid environment (of the particles)," provided the basis for the modern theory of the Brownian movement. According to the kinetic theory of gases, developed during the latter part of the 19th century (J. C. Maxwell, L. Boltzmann, R. J. E. Clausius), the molecules of a gas carry out a ceaseless translational movement at all temperatures above absolute zero (−273.16° C.). This movement, whose direction is not predictable, becomes more lively as the temperature rises and is, in fact, its measure. Because of elastic collisions between the molecules of the gas, the direction of their individual motions changes continuously. A similar description applies to the molecules composing a liquid, the principal difference being that the molecules of a liquid are more closely packed, making the path covered by a molecule between collisions far shorter.

If a microscopic or colloidal particle is suspended in a liquid, say water, it will be subjected to a continuous bombardment, from all directions, by the surrounding molecules. If the velocity of all the water molecules were the same, the particle would, of course, not move at all since all the momenta transferred during the collisions would neutralize each other. This is the argument used by K. W. von Naegeli (1879) against the early bombardment theories of the Brownian movement. This argument was fallacious, however, since molecules do not have a single velocity at a given temperature, but instead have a distribution of velocities of varying degrees of probability (*see* KINETIC THEORY OF MATTER). A suspended particle will, therefore, at a given instant, receive a finite momentum of unpredictable direction and magnitude and both the direction and velocity of the particle will change continuously. The observable result will therefore be a random zigzag motion; *i.e.*, Brownian movement. It is clear that the movement must continue as long as the system exists. This conclusion agrees with the result of an unusual, early experiment by Cantoni and Oehl (1865), who found that the Brownian movement remained unchanged for a whole year in a suspension sealed between two cover glasses.

For quantitative studies it must be borne in mind that it is not possible to record the exact position of a particle or observe its motion directly. A small colloidal particle manifests itself in the ultramicroscope only as a spot of light. Since the particle is being bombarded from all directions more than 10^{20} times per second, the spot may be seen trembling about a mean position. The mean position, however, is slowly changing and after a time interval of 30 sec. or 1 sec. or even 0.05 sec. it is obvious that the particle has moved. V. Henri's method of observation was to make photographs spaced 0.05 sec. apart with an automatic camera. The duration of the exposures was 0.003 sec. J. Perrin, in a similar series of observations, recorded the positions of a particle at 30-sec. intervals and plotted them on co-ordinate paper. The difference in the lengths of the intervals did not affect the qualitative character of the results.

From each pair of consecutive photographs Henri could determine the displacement of the particle projected on the plane perpendicular to the direction of observation. Since all directions in the plane are statistically equivalent it is sufficient to determine the displacement parallel to some one line selected as a reference within this plane. The direction of this line is often spoken of as the x direction. The projection of the displacement on the line will be denoted here by the symbol Δ_x. The theory to be discussed is concerned with $\overline{\Delta_x^2}$, which is always positive.

The quantitative theory of the translational Brownian movement was developed independently by A. Einstein (1905), M. von Smoluchowski (1906) and P. Langevin (1908). At about the time of Einstein's work Zsigmondy predicted, on the basis of his classical ultramicroscope investigations on gold sols (colloidal solutions), that the Brownian movement could be explained on the basis of the kinetic theory of the liquid state. One of Einstein's equations defines quantitatively the mean square displacement, $\overline{\Delta_x^2}$, of a particle within a given time of observation, τ:

$$\overline{\Delta_x^2} = RT\tau/(3\pi N\eta r) \tag{1}$$

Here, R is the gas constant, T is the absolute temperature, η is the viscosity of the surrounding liquid, N is Avogadro's constant and r is the radius of the particle which carries out the Brownian movement. The mean displacement is obtained by averaging the squares of the displacements, $\Delta_{x,1}$, $\Delta_{x,2}$, etc., as actually observed for a series of uniform time intervals of short duration, and by then taking the square root of the average. It should be noted that $\sqrt{\overline{\Delta_x^2}}$ is not the absolute displacement, but its projection upon a line, designated as the x axis, in the plane perpendicular to the direction of observation. Equation (1) is in accord with the experiments mentioned according to which the liveliness of the Brownian movement increases with temperature and decreases both with an increase in particle size and with an increase in viscosity of the liquid.

Particularly interesting is the variation of $\overline{\Delta_x^2}$ with τ. For example, a particle with a diameter of about $\frac{1}{50,000}$ in. (0.5 μ), suspended in water, shows a displacement, $\sqrt{\overline{\Delta_x^2}}$, of about $\frac{1}{22,000}$ in. if observed for one second and of about $\frac{1}{7,000}$ in. if observed for ten seconds. This and also the other quantitative implications of the equation were quantitatively varified for liquid suspensions by M. Seddig (1908), V. Henri (1908) and particularly by J. Perrin and M. Chaudesaigues (1908–11) and The Svedberg (1906–12). Although translational Brownian movement was first observed in suspensions in liquids, and early studies concerned this environment, the explanation of its nature and Einstein's theory obviously did not so limit its occurrence. In fact, L. J. Bodaszewski (1883), using a microscope, first observed it in the smoke of burning paper and cigars and in other aerosols (air or gas suspensions of fine particles). Equation (1) was verified for such suspensions by F. Ehrenhaft (1907), M. de Broglie (1909) and H. Fletcher (1911).

Rotational Brownian Movement.—Atoms and molecules carry out not only a translational movement, but also a rotational movement. A finite angular momentum will therefore be imparted, at any instant, to a particle since the molecules of the surrounding liquid, which collide with it, all possess angular momenta. These momenta differ more or less from a most probable value, the rotations taking place about axes oriented in random directions. The magnitude of the momentum acquired by the particle will therefore vary continually, although there will, again, be a very specific most probable value for it at any given temperature. Furthermore, the spatial directon of the axis of rotation will change in a random fashion. Einstein developed the theory of this phenomenon, which he called rotatory Brownian movement, within the framework of his general theory of Brownian movement. He obtained the relation:

$$\overline{\Delta_\alpha^2}/\tau = RT/4\pi N\eta r^3 \tag{2}$$

where $\overline{\Delta_\alpha^2}$ is the mean square angle of rotation for this phenomenon, which was experimentally still unknown at that time. This equation, again, applies not only to suspensions in a liquid (sols and emulsions), but also to aerosols. According to equation (2), a particle with a diameter of about $\frac{1}{50,000}$ in. (0.5 μ), suspended in water, should carry out, on the average, three-fourths of a turn in a second. The rotation is therefore rather rapid, but its rate decreases much more rapidly with increasing particle size than that of the translational movement, the ratio of the rates being equal to $1/r$, as a comparison of equations (2) and (1) shows. For a convenient study of the rotational Brownian movement, rather large microscopic particles are therefore required. Perrin, who verified experimentally the existence of the rotational Brownian movement (1909), used particles of mastic of about $\frac{1}{2,000}$ in. in diameter. Particles of this large size are considerably above the resolving power of an average microscope so that they are directly seen as objects and not merely as spots of light. In order to facilitate the observation of their rotation, he took occlusions of foreign matter, below their surfaces, as index marks. The average rotation observed was 14.5° per minute which compared well with the theoretical value of 14°.

The diameter of large microscopic particles can be determined with great accuracy. Similarly, η is easy to determine. It is therefore possible to obtain Avogadro's constant (*q.v.*), N, from measurements of $\overline{\Delta_\alpha^2}$ and also from those of $\overline{\Delta_x^2}$. Perrin thus determined the numerical value of N from quantitative determinations of these quantities in emulsions. The value obtained was within 15% of the accepted modern value. In view of the fact that very few reliable determinations of N had been carried out in those days, this experiment by Perrin was deservedly considered an outstanding accomplishment.

Macroscopic Effects of the Translational Brownian Movement.—If water is poured very carefully upon the top of a suspension of very small coloured particles whose density differs very little from that of water, an observer will see a distinct horizontal boundary between the suspension and the pure water. Slowly, this boundary will become diffuse and after a sufficiently long period of time will disappear. The spontaneous mixing process responsible for this phenomenon is called diffusion (*q.v.*). It is due exclusively to the random translational movement of the suspended particles. At the outset, more particles are on one side of the boundary than on the other and more pass it in one direction than in the reverse direction since the probability of passing the boundary is the same for each. A concentration gradient perpendicular to the plane of the original boundary is, therefore, necessary in order to produce a directionally preferential mass transport by random motion of the individual particles. Quantitatively, the situation may be expressed by the relation

$$dn/d \log \tau = -(q/2)\, \overline{\Delta_x^2}(dc/dx) \qquad (3)$$

which represents a combination of Fick's and of Einstein's laws of diffusion. Here n is the number of moles, q is the cross section through which they diffuse and dc/dx is the concentration gradient; *i.e.*, the rate at which the concentration, c (in moles per cubic centimetre), changes with the distance x in the direction perpendicular to the plane of the original boundary. In Einstein's equation

$$\overline{\Delta_x^2} = 2D\tau \qquad (4)$$

the diffusion constant, D, represents the number of moles diffusing per second across a cross section of one square centimetre if the concentration gradient is one mole per centimetre. This equation was verified experimentally by a large number of investigators beginning with The Svedberg (1909–11), who tested it on gold sols. The diffusion equations are valid not only for suspended microscopic or colloidal particles but also for molecules or ions in solution. This means, by implication, that these solutes would be found to carry out a typical translational Brownian movement if instruments were available allowing one to see the molecules or ions directly in their liquid environment. There is, therefore, no really valid objection to one's extending, as is done quite frequently, the term Brownian movement to any body, irrespective of size, which is executing irregular thermal motions, caused by collisions, within an environment which is physically or chemically different from the body.

If, in the experiment outlined at the beginning of this section, the particles differed markedly in density from that of water, the diffusion process would be complicated by the simultaneous process of settling of the particles. Inversely, the settling of particles in a suspension whose concentration is uniform at the outset would be complicated by diffusion. The simple reason for this is that settling leads to the establishment, and then to an increase, with time, of a vertical concentration gradient. There are increasingly more particles in the lower portions of the vessel than in the upper ones. A preferential diffusion of particles back into the upper portions will therefore be initiated and accentuated, with time, according to equation (3). The end result will be a steady state when just as many particles settle through a given cross section of the vessel as migrate through it, in the reverse direction, by back diffusion. This steady state, called sedimentation equilibrium, is characterized by an exponential increase in the number of particles, per unit volume, from n to n_0 as the height decreases from h to h_0:

$$\log (n/n_0) = K(h-h_0) \qquad (5)$$

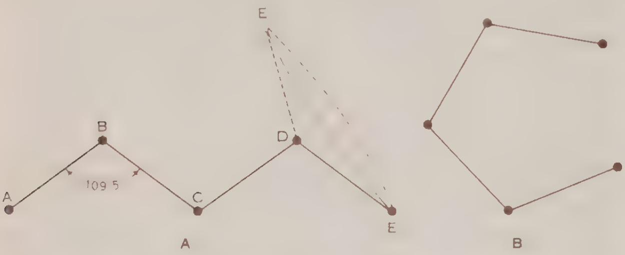
K is here a constant at a given temperature for a given settling system if it may be assumed that the variation of gravitational acceleration with height can be neglected (as it may be for vessels less than 50 ft. high). Perrin verified this law working with emulsions of microscopic particles. This law of the exponential vertical distribution of particles in a settling system applies, of course, not only to suspensions in a liquid (sols and emulsions), but also to aerosols. It allows one, therefore, to estimate, at least roughly, the vertical distribution of dust, smoke and other contaminants within the lowest strata of a quiescent atmosphere. In view of the general validity of equations (3) and (4), equation (5) applies also to molecules and ions in solution. The only difference is that the concentration gradient characterizing the steady state is too small to be measurable unless the column of the system considered is extremely high. If this is the case, then the variation of the acceleration with height and therefore the variation of K with height must be taken into account. The same applies to the situation where the concentration gradient in the steady state is made usefully large by substituting for the gravitational acceleration the far larger acceleration achieved with a centrifuge or ultracentrifuge (*see* CENTRIFUGE). This possibility is being used for determining the size or weight of large molecules or small organisms such as viruses, etc.

Perrin emphasized the fact, implicit in the theory, that there is really no basic difference between the laws governing the translational Brownian movement of particles colliding with molecules of a liquid or gaseous environment and the laws governing the random translational movement of the molecules colliding with like molecules. Hence equation (5) also expresses correctly the variation, with height, of the number of gas molecules per unit volume; *i.e.*, the decrease in gas pressure with increasing height. The decline of the atmospheric pressure with increasing elevation is a good example of this phenomenon.

If free diffusion of the solute of a solution into a supernatant layer of pure solvent is inhibited by the placing of a semipermeable membrane at the boundary, a pressure called osmotic pressure develops. Measurements of this pressure allow one to determine the weight of the dissolved molecules. The equation governing this phenomenon had been derived at an early date by J. H. van't Hoff (1886) by applying the laws of an ideal gas. It follows from the discussion of the diffusion process that there must be an intimate connection between osmotic pressure and translational Brownian movement of the solute. In fact, Einstein was able to develop an equivalent equation of broader validity, within the framework of his general theory of the Brownian movement; and he states: "According to this [his] theory a dissolved molecule is differentiated from a suspended body solely by its dimensions, and it is not apparent why a number of suspended particles should not produce the same osmotic pressure as the same number of molecules." Einstein was, therefore, the first to point out the broad scope of the phenomenon of osmotic pressure, which is of interest not only in chemistry and physics but also of paramount importance in processes involving transfers through membranes in the living human body.

Macroscopic Effects of the Rotational Brownian Movement.—Rotational Brownian movement prevents the perfect orientation of nonspherical particles in suspensions and of nonspherical molecules in solutions brought into an electric or magnetic field. One obtains, instead, a probability distribution for the particle axes, with a peak, *i.e.*, greatest probability, for that direction which would characterize perfect orientation in the field. The spread of this distribution at a given field strength and temperature makes it possible to determine the size or shape or internal anisotropy of colloidal particles or of molecules if two of these three quantities are already known from other measurements. Most generally used, however, is the effect of the rotational Brownian movement upon the more complicated process of orientation of particles or molecules in streaming, *i.e.*, moving, suspensions and solutions respectively. Here, the most probable direction, *i.e.*, the peak of the orientation-distribution curve, changes with the velocity gradient, but the internal anisotropy has no bearing upon the orientation. Therefore, molecular shapes can be determined, if the molecular weight is known, by ascertaining the most probable direction indicated by the distribution curve relative to the direction of flow, or by measurement of optical or other quantities dependent on the peak direction and on the spread of the direction-distribution curve. The dimensions of a series of important substances, such as of viruses, have thus been determined.

Intramolecular Brownian Movement and Its Macroscopic Effects.—Prior to 1930, one spoke only of translational and rotational Brownian movement. To these terms, an only partially accepted third has been added, that of the intramolecular or micro-Brownian movement (W. Kuhn, 1938). The phenomenon alluded to will be explained by means of fig. 1(A) and 1(B). Fig. 1(A) represents one possible configuration of the carbon skeleton of the pentane molecule, C_5H_{12}. Two atoms of hydrogen, not shown, are chemically combined with each of the carbon atoms B, C and D, three with A and three with E. Each of the atoms B, C and D forms with its two neighbours a valence angle of 109.5°. Any configuration of the molecule which is compatible with the maintenance of this angle is possible. Thus the centre of E may be located anywhere along the periphery of the base of a cone whose apex is the atom D. E, therefore, can and actually will rotate about D along the path indicated. The same applies to all other atoms.



CONFIGURATION OF THE CARBON SKELETON OF THE PENTANE MOLECULE, C_5H_{12} (*see* TEXT FOR FURTHER EXPLANATION)

A collision with, say, E, of an atom or an atom group of a molecule adjacent to E, will alter the angular momentum of this rotation and may even change the sense of rotation. In reality there will be a multitude of collisions of all 17 atoms of C_5H_{12} with atom groups or molecules of the environment so that the direction of the cones of rotation and the sense of the various rotations will change frequently, in a random fashion. The pentane molecule may, therefore, assume a multitude of three-dimensional shapes, of which only the two extremes are illustrated, in simplified planar projections, in fig. 1(A) and 1(B). The number of collisions sustained in a given instant by a molecule and the resulting variety of molecular configurations increase, of course, with the number of links in the molecule and become enormous for very large molecules, called polymer molecules, which contain 10,000 or even considerably more carbon atoms. While it is, therefore, impossible to assign to such a molecule a definite shape and a definite length, it is possible to characterize it by a set of most probable configurations and by a definite mean length or by a most probable length. Disregarding the existence of a valence angle, *i.e.*, assuming no restrictions at all, one obtains for the root mean square end-to-end distance, *R*,

$$\sqrt{\overline{R^2}} = ln^{1/2} \tag{6}$$

where *l* is the length of one link, *e.g.*, the distance between A and B in fig. 1(A), and *n* is the number of links. The most probable length, *r*, is

$$r = ln^{1/2}/\sqrt{3/2} \tag{7}$$

These lengths belong, of course, to configurations intermediate between the most unlikely extremes of a staggered rod (fig. 1[A]) and a tight coil (equivalent to fig. 1[B] if *n* is large). The intramolecular Brownian movement, the quantity $\overline{R^2}$ dependent on it and other related quantities, have proved to be of major importance in the theory underlying the behaviour of polymer solutions. They enter, for instance, into the interpretation of the viscosity of polymer solutions and into the derivation of molecular weights of such flexible macromolecules from optical properties of the solutions.

It is clear that a large flexible molecule will try to return, as quickly as possible, to its most probable end-to-end distance upon removal of an external force which has stretched it to a length in excess of *r*. This is of decisive importance in the explanation of rubber elasticity. The only difference between rubberlike materials and solutions of flexible macromolecules is (1) that the intermolecular collisions take place between atom groups (segments) of neighbouring macromolecules, and (2) that occasional chemical cross links between neighbouring macromolecules provide an increased lateral coherence for the entire system which prevents slippage under stress.

The quantitative modern theories are based upon this interpretation of rubber elasticity as an entropy effect (P. J. Flory [1944], E. Guth, H. James [1943] and F. T. Wall [1943]). From the point of view of definition, it is of course debatable whether or not one should apply the term Brownian movement here where the partners in a collision are identical or at least very similar, not only in size but also physically and chemically. Many authors prefer to speak of intramolecular thermal motion and of intermolecular collision.

Irregular Movements Within Solids, Resembling Translational Brownian Movement.—If a bar of copper and bar of silver are welded together, one will find, after a long period of time, that silver has diffused into copper and vice versa. Quantitative studies have left no doubt that the laws of diffusion valid in liquids apply also to solids. To account for this, a random translational motion, however slow, must be assumed to exist. As the atoms or ions composing a crystal lattice do not carry out translations in the usual sense, the explanation of this random translational motion must necessarily be somewhat different from that applicable to classical Brownian movement.

The atoms or ions oscillate in a crystal lattice about an equilibrium position, which corresponds to a minimum of potential energy. The position and the numerical value of this minimum potential energy are bound to change somewhat if the energy of oscillation of one, or of several, of the neighbouring atoms changes because of a transition to a higher energy state. These changes may be large enough to produce a translation of the atom or ion under consideration to a different site, conceivably across a "saddle" of slightly higher energy. This event is more likely to occur if an adjacent lattice site is vacant. Upon its translation, the atom or ion will then leave a vacant site behind, which in turn will be filled up in due time. Thus, the vacant site, which may have a positive, a negative or no charge associated with it, will also travel inside the crystal lattice in a random fashion. The randomness is due to the fact that it is impossible to predict which of the neighbouring atoms or ions will occupy a vacant site. The transition of any oscillator to a higher energy state is an unpredictable random process.

Thus, it is seen that the migration of an atom or ion or of a vacant site is dependent upon the action of surrounding atoms or ions. Therefore, its cause is very similar to that of the classical Brownian movement.

It is clear that what applies to an atom or ion of a given species inside a crystal also applies to any foreign atom or ion which can fit into the host lattice.

See also COLLOID.

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See also E. F. Burton, "The Brownian Movement" in *The Physical Properties of Colloidal Solutions,* with bibliography (1921); A. W. Porter and J. J. Hedges, "The Law of Distribution of Particles in Colloidal Suspensions," *Phil. Mag.* (1922); A. Einstein, *Investigations on the Theory of the Brownian Movement,* trans. by A. D. Cowper (1956); P. J. Flory, *Principles of Polymer Chemistry* (1953); J. Frenkel, *Kinetic Theory of Liquids* (1947). (WI. H.; H. L. B.)

BROWNIE, in folklore, a small domestic fairy or hobgoblin of industrious nature and shaggy appearance who was believed to inhabit houses in some parts of Great Britain, particularly Scotland and northern England. He was shy and rarely seen but could often be heard during the night, cleaning rooms and doing other housework. He would also ride for the midwife in time of need and in Cornwall he caused swarming bees to settle quickly.

Though usually helpful, he sometimes mischievously disarranged rooms already set in order. Cream or bread and milk could be left for him, but any other offered award offended him. The surest method to drive him away was to make him a suit of clothes. He would put it on and then vanish, never to return.

The name Brownie is also used for a member of the youngest age group of the Girl Guides and Girl Scouts (*qq.v.*).

(C. S. He.)

BROWNING, ELIZABETH BARRETT (1806–1861), English poet and wife of the poet Robert Browning, was born on March 6, 1806, at Coxhoe hall near Durham. She was the eldest child of Edward Barrett Moulton, who later took the surname of Barrett on the death of his maternal grandmother, who left him her large estates in Jamaica. In 1810 the Barretts moved to Hope End, a country house within sight of the Malvern hills. There, in this "paradise," as she felt it to be, Elizabeth was to spend some of the happiest years of her life. Her country poems such as "The Lost Bower" and "The Deserted Garden" refer to the woods and gardens of Hope End. She was a voracious reader and was much spoiled by her father: a father so proud of the literary talents of his offspring that in 1819 he sent *The Battle of Marathon* to be printed in 50 copies. Elizabeth described this as "her great epic of eleven or twelve years old, in four books" and adds that the love of Pope's Homer led her to study Greek, and Latin as a help to Greek. At 15 she fell seriously ill, probably as a result of a spinal injury, and her health was permanently affected.

To the ardent young bluestocking, who more than once had dreamed of running away from home in order to become page to Lord Byron, it was to prove a shattering blow when in 1832, after the death of Mrs. Barrett and as a result of financial reverses, it was found expedient to move to Sidmouth, Devon. There Miss Barrett translated the *Prometheus Bound* of Aeschylus, which was published with some original poems in 1833 but was somewhat critically received. Later the author became so dissatisfied with it that she suppressed the edition as far as she could and issued a retranslation in 1850 in the same volume as *Sonnets From the Portuguese*.

In 1836 the family moved again, this time to London, and in 1838 they took up residence at 50 Wimpole street. In the course of these two years Miss Barrett published poems in many periodicals including *New Monthly Magazine* edited by Lytton Bulwer. Her first collection, *The Seraphim and Other Poems*, which includes such famous poems as "Cowper's Grave," "The Sea Mew" and "My Doves," appeared in 1838. In the same year she became so ill that she was compelled to leave London. She spent the next three years in Torquay, during which time Edward, the eldest and most dearly loved of her eight brothers, was drowned in a yachting accident in Babbacombe bay. The disaster and shock affected her health and spirits to such an extent that when she returned to London she rarely went out and her natural timidity developed into an almost morbid terror of meeting anyone outside her family and a small circle of intimates; twice, Wordsworth himself asked if he might call, not realizing that shyness would make the visit painful to her. However, Elizabeth Barrett was now well known in literary circles and her closest friends included R. H. Horne, Harriet Martineau, Mary Russell Mitford, W. S. Landor and John Kenyon, a distant cousin who was later a considerable benefactor to the Brownings.

Elizabeth Barrett now led the life of an invalid, but her output of poetry and essays was unabated. In 1841 she had a share in *Chaucer Modernized*, a venture prefaced by R. H. Horne to which he, Leigh Hunt and Wordsworth all contributed. The following year she wrote two papers on the Greek Christian poets and the English poets for the *Athenaeum*. At this period, as throughout her life, she was a voluminous correspondent.

Elizabeth Barrett's second volume of poetry, *Poems, by Elizabeth Barrett*, was published in 1844 and was enthusiastically received in England and the United States. The following January she received a letter from Robert Browning which began: "I love your verses with all my heart, dear Miss Barrett." To this was added the following sentence: "I do, as I say, love these books with all my heart—and I love you too." Writing to her old friend Mrs. Martin, Elizabeth says "I had a letter from Browning, the poet . . . which threw me into ecstasies—Browning, the author of *Paracelsus*, the king of mystics." The correspondence, once begun, never flagged and in early summer they met. Browning was six years younger than the woman he so passionately admired and although at first he believed her to be a total invalid he never doubted that he would marry her. The publication of the letters between them enables one to follow their love story day by day. Their courtship was carried on in secret since Mr. Barrett had forbidden any of his children to marry, and Elizabeth's reluctance to burden any man with an ailing wife was greatly aggravated by her fear of her despotic father. Her hesitation is recorded under a slight disguise in *Sonnets From the Portuguese* which her husband persuaded her to publish in 1850. At last she consented to marry Browning on the condition that the wedding was secret. The ceremony took place on Sept. 12, 1846, at St. Marylebone Parish church, after which Elizabeth returned home for a further week before joining her husband. When her father died in 1857 Elizabeth was still unforgiven.

The Brownings left England for Italy and during their brief stay in Pisa Elizabeth wrote "The Runaway Slave at Pilgrim's Point," a protest against American slavery, which was published in Boston in *The Liberty Bell* in 1848 and separately in England the following year. The Brownings moved to Florence in 1847 where they made their permanent home in an apartment in Casa Guidi, near the Pitti palace. There their only child, Robert Wiedemann Barrett, was born two years later.

In 1851 the Brownings returned to England for some months when they stayed with Kenyon. A new edition of Mrs. Browning's poetry was called for in 1850 and again in 1853, and in the latter year Elizabeth began work on *Aurora Leigh*. She dedicated it to Kenyon and completed it during their second visit to England in 1855. It is her most ambitious work consisting of about 11,000 lines of blank verse which tell the love story of a young girl of literary tastes and a misguided philanthropist. Though the plot is exceedingly complex and melodramatic both character and action are subordinated throughout to the perorations of the heroine, who is easily recognizable as the author herself. *Aurora Leigh* was published in 1856 and became immediately popular. A second edition had to be printed within a fortnight, a third a few months later. Several corrections were made in the fifth edition (1859). Her husband called it "this divine book," W. S. Landor spoke of "the wild imagination of Shakespeare" and Ruskin, too, praised it no less extravagantly. Nevertheless the majority of critics were unfavourably impressed by its diffuseness and its improbable plot. In spite of some good lyrical passages and an occasional flash of terse perception it is not a work of great poetic merit. Its failure is all the more saddening because Mrs. Browning was making a resolute attempt to achieve some understanding of many social evils of her day—poverty, unemployment, disgraceful living conditions and prostitution.

During their visit to London of 1855 the Brownings attended a séance conducted by the American spiritualist, Daniel Home. Elizabeth became fascinated by spiritualism and continued to attend séances with her friends in Florence in spite of Browning's skepticism and opposition. The subject that absorbed the greatest part of her attention and energy in the last years of her life was, however, Italian politics. Her interest had begun soon after her arrival in Italy and shortly became an obsession. In 1847 and 1851 she had written the two parts of *Casa Guidi Windows* (published 1851), "a simple story of personal impressions," in a definite attempt to win sympathy for the Florentines. Later she proclaimed to all that would listen that the English were ignoble in their treatment of the patriotic aspirations of the Risorgimento of Italy. She believed passionately in the integrity of Napoleon III and declared that he was "the only great-hearted politician in Europe." Even the peace of Villafranca in 1859 failed to destroy her admiration for him, though this bitter disappointment caused her much suffering and had an adverse effect on her already failing health. "A Tale of Villafranca" was published in the *Athenaeum* in September of the same year and was afterward included in *Poems Before Congress* (1860). During a long visit to Rome she prepared this volume for the press. It was judged with some impatience, the poem "A Curse for a Nation" being mistaken for a denunciation of England whereas it was really aimed at American slavery.

The following summer Mrs. Browning caught a severe chill and on June 29, 1861, she died. In the last hours of her illness she was largely unaware of Robert sitting at her bedside. Seeing her condition, he raised her on his shoulder, whereupon she repeatedly kissed him. A few moments later she died—to quote Robert's own words—"smilingly, happily, and with a face like a girl's." She was buried in Florence, and plaques on the wall of the Casa Guidi and in Kelloe church, Durham, commemorate her.

In 1866 Robert Browning published a volume of selections from his wife's works.

Elizabeth Barrett Browning is by no means an easy woman to assess. She was at once very gentle and exceedingly obstinate and despite her affability and her genuine interest in human beings, her judgments were often remarkably rigid. The last years of her life are overshadowed by the fact that she became increasingly willful and unpredictable. The strength of her emotions and sympathies—the undue affection she lavished on her son, her belief in spiritualism and her overwhelming obsession with Italian politics and her faith in Napoleon III—at times alarmed even her own visitors at Casa Guidi. There is no doubt, too, that Browning was deeply troubled. Their marriage had been a most happy and affectionate one. Loving her less, he would have had no problem; loving her as he did, he was committed to obey—even when he could no longer respect. He cherished her in her last years with a heavy heart.

As a poet, Mrs. Browning's undoubted gifts are often spoiled by diffuseness. Her enthusiasm tended to blunt her perception and her political poetry is unpersuasive. She is at her best in her sonnets where her abundant spirit is curbed and refined by the strict form. *Sonnets From the Portuguese*, gentle yet passionately sincere, is generally considered her best work and assures her of her place as a minor, but no means negligible, English poet.

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(BE. M.)

BROWNING, JOHN MOSES (1855–1926), U.S. inventor known for his work on small arms and automatic weapons, was born of Mormon parentage, Jan. 21, 1855, at Ogden, Utah. Inventive as a child, he made his first gun when he was 13 from scrap metal in his father's gunshop. In 1879 he secured a patent for a breech-loading, single-shot rifle, which he sold to the Winchester company. He designed many types of sporting firearms such as the Remington autoloading shotguns and rifles; the Winchester repeating shotguns, single-shot and repeating rifles; the Stevens rifles; and the Colt automatic pistols. Many of his weapons, including machine guns (*q.v.*), automatic pistols and automatic rifles, were adopted and widely used by the U.S. army. He died suddenly in Belgium on Nov. 26, 1926, while on a business trip.

BROWNING, ROBERT (1812–1889), English poet, was born on May 7, 1812, at Camberwell in southeast London. His father, a clerk in the Bank of England, could afford to indulge his artistic and literary tastes, and had a large and varied collection of books, which he encouraged his son to explore. Thus in his youth Browning's reading was unsystematic but exceptionally wide, especially in the drama and in works of history and scholarship. It was in his father's library that he acquired the extraordinary range of interests which distinguishes his writings; an even more powerful immediate effect was exerted by a volume of Shelley's lyrics which he read in 1826. Following Shelley's example Browning temporarily declared himself a vegetarian and an atheist, but the book had a more profound literary influence, for it introduced Browning to Keats and the other romantic poets and determined the course of his life. Thereafter Browning recognized that poetry was his profession. It was his fortune that he was able to devote his life to his chosen career without depending for his livelihood on the money he made by writing.

Browning's formal education was slight, although his father gave him a grounding in Greek and Latin. His mother, Sarah Anna Wiedemann, who was born in Scotland of German parentage, was an earnest Congregationalist and ensured that her son's religious education was not neglected, but his nonconformity barred him from the older English universities. In 1828 he attended classes at London university, but left after half a session. Apart from a journey to St. Petersburg in 1834 with George de Benkhausen, the Russian consul general, and two short visits to Italy in 1838 and 1844 he lived with his parents in London until 1846, first at Camberwell and after 1840 at Hatcham. During this period he wrote his early long poems and most of his plays.

Browning's first published work, *Pauline: a Fragment of a Confession* (1833, anonymous) gave a thinly disguised account of the first 20 years of his life. The well-known Radical editor W. J. Fox, who had already seen an earlier volume of Browning's work *Incondita* (begun 1824, privately circulated), reviewed *Pauline* enthusiastically. Browning however was far more deeply affected by the unpublished criticisms of John Stuart Mill, who condemned the poet's exposure and exploitation of his own emotions and his "intense and morbid self-consciousness." It was probably Mill's critique which determined Browning never to confess his own emotions again in his poetry, but to write always objectively. Certainly in his later work he used the impersonality afforded by the dramatic form to safeguard himself against any revelation of his intimate affairs. Similarly, he objected to any attempt to treat his poetry as autobiography, insisting that his poems though often lyric in expression were always "dramatic in principle, and so many utterances of so many imaginary persons, not mine."

In 1835 he published *Paracelsus* and in 1840 *Sordello*, both poems dealing with men of great ability striving to reconcile the demands of their own personalities with those of the world. *Paracelsus* was well received, but *Sordello*, which made exacting demands on its reader's knowledge, was almost universally declared incomprehensible. Nevertheless Browning's powers were recognized by several of the leading poets of the day, and he moved on friendly and equal terms among many young writers and artists.

Encouraged by the actor Charles Macready, Browning devoted his main energies for some years to verse drama, a form which he had already adopted for *Strafford* (1837). Between 1841 and 1846 in a series of pamphlets under the general title of *Bells and Pomegranates* he published seven more plays in verse, including *Pippa Passes* (1841), *A Blot in the 'Scutcheon* (produced at Drury Lane in 1843) and *Luria* (1846). These, and all his earlier works except *Strafford*, were printed at his family's expense. Although Browning enjoyed writing for the stage because of its objectivity and the close contact with his audience he was not successful in the theatre, since his strength lay in depicting, as he had himself observed of *Strafford*, "Action in Character, rather than Character in Action." The third and seventh pamphlets in the series (1842 and 1845) were devoted to short poems, including "My Last Duchess," "Waring," "The Pied Piper of Hamelin," "Home Thoughts From Abroad" and many others which look forward to the work of his maturity.

By 1845 the first phase of Browning's life was near its end, for in that year he met Elizabeth Barrett. In her *Poems* (1844) Miss Barrett had included lines praising Browning, who wrote to thank her (Jan. 1845). In May they met, and soon discovered their love for each other. Miss Barrett had, however, been for many years an invalid, confined to her room and thought incurable. Her father was moreover of a dominant and selfish temper, jealously fond of his daughter, who in turn had come to depend on his love. When her doctors ordered her to Italy for her health and her father refused to allow her to go, the lovers, who had been corresponding and meeting regularly, were forced to act. They were married secretly in Sept. 1846; a week later they left for Pisa.

Throughout their married life, although they spent holidays in

France and England, their home was in Italy, mainly at Florence, where they had a flat in Casa Guidi. Their income was small, although after the birth of their son Robert ("Pen") in 1849 Mrs. Browning's cousin, John Kenyon, made them an allowance of £100 a year. On his death in 1856 he left them £11,000. Thereafter they were never harassed by lack of money, and their life was full but tranquil. Browning was not as passionately devoted as his wife to the cause of a united Italy, but he loved his adopted country and wrote many of his finest poems on Italian subjects.

On the whole however Browning produced comparatively little poetry during his married life. Apart from a collected edition in 1849 he published only *Christmas-Eve and Easter-Day* (1850), an examination of different attitudes to Christianity, perhaps having its immediate origin in the death of his mother in 1849; an *Introductory Essay* (1852) to some spurious letters of Shelley, Browning's only considerable work in prose and his only piece of critical writing; and *Men and Women* (1855). This was a collection of 51 poems—dramatic lyrics such as "Memorabilia," "Love Among the Ruins" and "A Toccata of Galuppi's"; the great monologues such as "Fra Lippo Lippi," "How It Strikes a Contemporary," and "Bishop Blougram's Apology"; and a very few poems in which implicitly ("By the Fireside") or explicitly ("One Word More") he breaks his rule and speaks of himself and of his love for his wife. Before the book appeared he wrote "I am writing—a first step towards popularity for me—lyrics with more music and painting than before, so as to get people to hear and see." However *Men and Women* had no great sale, and many of the reviews were unfavourable and unhelpful. Disappointed for the first time by the reception of his work, Browning wrote to Ruskin "A poet's affair is with God, to whom he is accountable, and of whom is his reward." In the following years he wrote little, sketching and modeling by day and enjoying the society of his friends at night. At last Mrs. Browning's health, which had been remarkably restored by her life in Italy, began to fail. On June 29, 1861, she died in her husband's arms. He at once decided to "go away, break up everything, go to England and live and work and write." In the autumn he returned slowly to London with his young son.

His first task on his return was to prepare his wife's *Last Poems* for the press. At first he avoided company, but gradually he accepted invitations more freely and began to move in society. Another collected edition of his poems was called for in 1863, but *Pauline* was not included. When his next book of poems *Dramatis Personae* (1864)—including "Abt Vogler," "Rabbi Ben Ezra," "Caliban Upon Setebos" and "Mr. Sludge, 'The Medium'"—reached two editions it was clear that Browning had at last won a measure of popular recognition. After the death in 1866 of his father, who had lived in Paris since 1852, the poet shared his house in Warwick crescent with his sister Sarianna.

In 1868–69 he published his greatest work *The Ring and the Book,* based on the proceedings in a trial for murder in Rome in 1698. Grand alike in plan and execution it was at once received with enthusiasm, and Browning was established as one of the most important literary figures of the day. For the rest of his life he was much in demand in society, dining out so frequently that many observers remarked the difficulty of reconciling his intensely imaginative poetic life with his life as a high-spirited man of the London world whose only serious concern was apparently the education of his son. He spent his summers with friends in France, Scotland or Switzerland, or, after 1878, in Italy. While he was in Scotland in 1869 he stayed with the rich and attractive Lady Ashburton and proposed to her, explaining candidly that their marriage would be of advantage to his son. When Lady Ashburton refused him Browning was distressed less by his rejection than by the subsequent gossip and recriminations.

The most important works of his last years, when he wrote with great fluency, were the long narrative or dramatic poems, often dealing with contemporary themes, such as *Prince Hohenstiel-Schwangau* (1871), *Fifine at the Fair* (1872), *Red Cotton Night-cap Country* (1873), *The Inn Album* (1875) and the two series of *Dramatic Idyls* (1879 and 1880). He wrote a number of poems on classical subjects including *Balaustion's Adventure* (1871) and *Aristophanes' Apology* (1875), and made a translation of the *Agamemnon* of Aeschylus (1877) which, it was said, could be understood quite easily with the help of the Greek. In addition to many collections of shorter poems—*Pacchiarotto* (1876), *Jocoseria* (1883), *Ferishtah's Fancies* (1884) and *Asolando* (1889)—Browning published toward the end of his life two books of unusually personal origin—*La Saisiaz* (1878), at once an elegy for his friend Anne Egerton Smith and a meditation on mortality, and *Parleyings With Certain People* (1887), in which he discussed books and ideas which had influenced him since his youth.

While staying in Venice in 1889 Browning caught cold and became seriously ill; he had time to learn of the favourable reception of *Asolando* before he died on Dec. 12. Public recognition of his eminence, which had been successively shown by honorary degrees from Oxford university (M.A. by diploma, 1867; D.C.L., 1882), an honorary fellowship of Balliol (1867) and presentation to the queen (1869), was completed by his burial in Westminster abbey.

Characteristics of Browning's Poetry.—Few poets have suffered more than Browning from hostile incomprehension or misplaced admiration, both arising very often from a failure to recognize the predominantly dramatic nature of his work. The bulk of his writing before 1846 was for the theatre; thereafter his major poems showed his increasing mastery of the dramatic monologue. This consists essentially of a narrative spoken by a single character, and amplified by his comments on his story and the circumstances in which he is speaking. From his own knowledge of the events described (as in "An Epistle of Karshish" and "Cleon") or by inference from the poem itself (as in "Andrea del Sarto") the reader provides a quasi-dramatic context for the poem, and is eventually enabled to assess the intelligence and honesty of the narrator and the value of the views he expresses. Thus the dramatic monologue, since it depends on the unconscious provision by the speaker of the evidence by which the reader is to judge him, is eminently suitable for the ironist. Equally, it offered the technical impersonality of the dramatist to a poet who, like Browning, distrusted the romantic exploitation of the writer's own personality. Browning's fondness for the form has, however, encouraged the two commonest misconceptions of the nature of his poetry—that it is deliberately obscure, and that its basic "message" is a facile optimism. Neither of these criticisms is groundless; both are incomplete.

Of course, Browning is not always difficult. In many poems, especially short lyrics, he achieves effects of obvious felicity, while even in his thorniest poems there are many passages which give an immediate poetic pleasure, and many in which the force of his imagination is perfectly conveyed by the rough vigour of his language. Nevertheless his superficial difficulties, which prevent an easy understanding of the sense of a passage, are evident enough—his attempts to convey the broken and irregular rhythms of speech, running the sense on from line to line, yet often stressing an unusual or arresting rhyme, so that it is almost impossible to read the verse quickly; his elliptical syntax, which disconcerts and sometimes confuses the reader, but which can be mastered with little effort; the demands he makes on his readers' knowledge, as in *Sordello* or "Old Pictures in Florence," poems which require for full appreciation a considerable acquaintance with their subjects; and his fondness for putting his monologues into the mouths of charlatans and sophists, such as Mr. Sludge or Napoleon III, and thus obliging the reader to follow a chain of subtle or paradoxical arguments. Further, Browning frequently indulges his taste for the grotesque and yields to the temptation to display his prodigality of technical invention. Yet while there is admittedly much hasty and slipshod writing, much overcleverness and much distortion of language for the sake of a poor rhyme, the surface difficulties of Browning are on the whole no greater than those of most of his successors.

But even when local significances have been established, the poem's interest is seldom exhausted. First, Browning often chooses an unexpected point of view, especially in his monologues, thus forcing the reader to accept an unfamiliar perspective. Secondly, he is capable of startling changes of focus within a poem. For example, he chooses subjects in themselves insignificant, as in "Fra

Lippo Lippi" and "Master Hugues of Saxe-Gotha," and treats through them the eternal themes of poetry. This change from particular observation to transcendental truth presents much the same difficulties to the reader as do the metaphysical poets of the 17th century, and much the same excitement. Thirdly, as Browning seldom presents a speaker unironically, there is a constant demand on the reader to appreciate exactly the direction of satiric force in the poem. Even in a melodious poem such as "A Toccata of Galuppi's" the valid position must be distinguished from the false at every turn of the argument, while in the major casuistical monologues, such as "Bishop Blougram's Apology," the shifts of sympathy are subtler still.

Browning's poetry then is seldom simple, but its complexity is a legitimate source of poetic pleasure, since it springs not from a desire to mystify and impress but from the seriousness of Browning's attitude to his art. He wrote in 1868 "I can have little doubt that my writing has been, in the main, too hard for many I should have been pleased to communicate with; but . . . I never pretended to offer such literature as should be a substitute for a cigar or a game at dominoes to an idle man."

It has also been objected that Browning uses his poetry as a vehicle for his philosophy, which is not of itself profound or interesting, being limited to an easy optimism. Against this, it may be argued, in the first place, that since Browning seeks to win imaginative rather than speculative conviction it is inadmissible to judge his poetry simply by its value as versified metaphysics. Secondly, Browning's dramatic monologues must, as he himself insisted, be recognized as the utterances of fictitious persons drawing their strength from their appropriateness to the speaker, and not as expressions of Browning's own sentiments. Thus his great gallery of imagined characters is to be regarded as an exhaustive catalogue of human motives, not as a series of self-portraits. Nevertheless certain fundamental assumptions are made so regularly that they may be taken to represent Browning's personal beliefs.

Browning normally considers the existence of a God and of a life after death as certain beyond the need of proof, and often accepts the central beliefs of the Christian faith. Readers who cannot follow him in this complain that this leads him to view the human situation with an equanimity not far removed from complacency. Yet in many poems he allows his speakers to debate at length the problem of reconciling the unhappiness of mankind with the providence of a benevolent God. The solutions which he accepts, in "Abt Vogler" or "Rabbi Ben Ezra" for example, may often seem too easy, but it is significant that he at least starts from a recognition that misery and evil are at large in the world; in his best work, notably *The Ring and the Book,* he makes such answers as a poet may to the manifold perplexities that beset men of faith.

In matters of human conduct his sympathies are with those who show loving hearts, honest natures and warmth of feeling; certainly these qualities are never satirized. He is in general on the side of those who commit themselves wholeheartedly to an ideal even if they fail.

By itself this might suggest rather a naïve system of values, yet he also, sometimes in the same poem, shows his understanding of those who have been forced to lower their standards and accept a compromise. Thus, although Browning is far from taking a cynical or pessimistic view of man's nature or destiny, his hopes for the world are not simple and unreasoning but qualified and considered.

Browning did not share the prevailing romantic interest in nature, declaring that men and women interested him far more. Consequently the diversity and external picturesqueness of the settings of his poems are unimportant compared with his abiding interest in the springs of human conduct. Thus he was able to find subjects fit for poetry in the life of his own times as well as in the events of the past. In the long poems of his prime, from 1855 to 1880, he demonstrated that sustained narrative in verse was still possible in an age which furnished the poet with none of the materials of the conventional heroic poem. In these works he wrote as none of the other great poets of the 19th century chose to write about contemporary life, and, as nearly as he could, used the language of his time. If this makes his poetry unmistakably Victorian, its Victorianism is its strength rather than its weakness. Even *The Ring and the Book* was felt by its first readers to be a modern poem, since it recognized that to urban readers in industrial civilizations the truly heroic action was not that which showed most strength and courage, but that which showed the greatest moral strength and intellectual power. In this poem Browning displays all his distinctive qualities. He allows a dramatic monologue to each character he portrays—to Guido, who is on trial for murder, to Pompilia, his young wife whom he has mortally wounded, to Caponsacchi, her protector, to various Roman citizens, to the opposing lawyers and to the pope, who ultimately decides Guido's fate. Each deals with substantially the same occurrences, but each, of course, describes and interprets them differently. By permitting the true facts to emerge gradually by inference from these conflicting accounts Browning reveals with increasing subtlety the true natures of his characters. As each great monologue illuminates the moral being of the speaker, the meanness and triviality of the subject are seen to be irrelevant, for it becomes clear that nothing less is in question than the whole ethical basis of human actions. For over 20,000 lines Browning explores his theme, employing an unfaltering blank verse, rising often to passages of moving poetry, realizing in extraordinary detail the life of 17th-century Rome and creating a series of characters as diverse and fully realized as those in any novel. Indeed Browning's achievement in this and in his other long poems, which show his genius to the full, is most fittingly compared with that of the great 19th-century novelists, particularly Balzac.

During his lifetime his reputation was slow to recover from the general rejection of *Sordello;* even his plays were financially unsuccessful. After 1864 critical recognition came rapidly, and, while his books never sold as well as his wife's or Tennyson's, he had a considerable and enthusiastic public for the rest of his life, and, what he valued more, a large circle of friends and distinguished admirers, including Carlyle, Rossetti, Benjamin Jowett, Alfred Domett and the French critic Joseph Milsand. Since his death he has not been widely read, perhaps because of increasing skepticism of the values he implies in his poetry. He has, however, influenced many modern poets, such as Robert Frost and Ezra Pound, partly through his development of the dramatic monologue, with its emphasis on the psychology of the individual and his stream of consciousness, but even more through his success in writing about the multitudinousness of modern life in language that owed nothing to convention.

Critical assessments of Browning have varied widely, but as long as technical accomplishment, richness of texture, sustained imaginative power and a warm interest in humanity are counted virtues, he will be numbered among the great English poets.

BIBLIOGRAPHY.—Of many editions of Browning's works the most complete is that of Augustine Birrell (1915). Editions of the letters have been published as follows: *Letters of Robert Browning and Elizabeth Barrett Browning, 1845–1846,* 2 vol. (1899, 1930); *Letters,* ed. by T. L. Hood (1933); *Robert Browning and Julia Wedgwood,* ed. by R. Curle (1937); *New Letters,* ed. by W. C. DeVane and K. L. Knickerbocker (1950); *Dearest Isa: Letters to Isabella Blagden,* ed. by E. C. McAleer (1951). *See* also L. N. Broughton, C. S. Northup and R. Pearsall, *Robert Browning: a Bibliography, 1830–1950* (1953); W. H. Griffin (completed by H. C. Minchin), *The Life of Robert Browning* (1910; enl. 1938); G. K. Chesterton, *Robert Browning* (1903); Henry James, *William Wetmore Story and His Friends* (1903); Mrs. Sutherland Orr, *A Handbook to the Works of Robert Browning,* 6th ed. (1892); W. C. DeVane, *A Browning Handbook,* 2nd ed. (1955); Henry Jones, *Browning as a Philosophical and Religious Teacher* (1891). (P. Dw.)

BROWN-SÉQUARD, CHARLES ÉDOUARD (1817–1894), British physiologist and neurologist, one of the founders of the science of endocrinology, was born at Port Louis, Mauritius, on April 8, 1817, of mixed U.S.-French parentage. After graduating in medicine at Paris in 1846 he held chairs at Harvard university and at Paris. Eventually he succeeded Claude Bernard in 1878 as professor of experimental medicine in the Collège de France. He died on April 2, 1894, at Sceaux.

Brown-Séquard was the first scientist to work out the physiology of the spinal cord, demonstrating that the decussation of the sensory fibres is in the cord itself. His contributions to the study of the endocrine glands were of major importance. Among other classical discoveries was his demonstration that removal of the adrenals causes death in animals. It was his misfortune, in extreme old age, to bring upon himself the ridicule of scientists by advocating the hypodermic injection of a fluid prepared from the testicles of sheep, and called derisively the Brown-Séquard elixir, as a means of prolonging human life. His researches were published in about 500 essays and papers, especially in the *Archives de Physiologie,* which he helped to found in 1868.

BROWNSON, ORESTES AUGUSTUS (1803–1876), U.S. transcendentalist writer, whose writings and intellectual wanderings represent expressively the intellectual restlessness and vitality of the pre-Civil War period, was born in Stockbridge, Vt., Sept. 16, 1803. He was brought up on a farm and had no formal education. No man of his time was more proficient in reasonable argument; yet he often left an impression of overpowering logic rather than warmth of personality. His peripatetics took him from Presbyterianism to Universalism; from Unitarianism to his own Society for Christian Union and Progress; from the modified intuitionalism of Comte and Victor Cousin to Roman Catholicism and Aristotelian Thomism. Brownson wrote on Calvinism, labour and social reform, transcendentalism (*q.v.*), Catholicism, state's rights, democracy, nativism and emancipation in the period 1830–70 when such subjects were unpopular. His versatility was expressed in mystical poetry, foreign philosophy, religious ecstasy, social uplift and literary enthusiasm. Typical of his many writings are *The Spirit-Rapper: an Autobiography* (1854); *The American Republic* (1865); and *The Convert* (1857). He published *Brownson's Quarterly* (1844–75) as a journal of personal opinion, except for the years 1865–72, when it was suspended. He died April 17, 1876, and slipped into oblivion until a Brownson revival during the second quarter of the 20th century brought his thought to the fore again.

After Brownson's death, his son, Henry F. Brownson, collected and published his *Works* (1882–1907) in 20 volumes. Alvan S. Ryan issued a one-volume *Brownson Reader* (1955).

Henry F. Brownson also published a biography of his father (1898–1900). Two interesting modern biographies are Theodore Maynard's *Orestes Brownson: Yankee, Radical, Catholic* (1943), and Arthur M. Schlesinger, Jr.'s *Orestes A. Brownson: a Pilgrim's Progress* (1939). A doctoral dissertation by Virgil G. Michel, O.S.B., *The Critical Principles of Orestes A. Brownson* (1918), contains a complete bibliography of his works. (C. J. By.)

BROWNSVILLE, a city in Texas, U.S., about 22 mi. from the mouth of the Rio Grande, and the seat of Cameron county, is directly across the river from Matamoros, Mex. On March 28, 1846, Gen. Zachary Taylor placed the flag of the United States on the site of what was to become a fort, later named Ft. Brown, for Maj. Jacob Brown, who died defending it from Mexican attack on May 9, 1846.

Brownsville was incorporated as a town in 1850. The old military reservation buildings now serve many purposes: as the Brownsville police headquarters, as a museum of the Brownsville Historical association and as the administration department of Texas Southmost college.

The city has a council-manager form of government, which went into effect in 1915.

The Brownsville area figured prominently in the early stages of the war with Mexico. The Thornton skirmish on April 25, 1846, led Pres. James K. Polk to declare a state of war. On May 8, 1846, occurred the battle of Palo Alto. The following day, Mexican troops attacked the Americans at Resaca de la Palma. A so-called "last battle" of the Civil War was fought at Palmito Ranch near Brownsville May 13, 1865.

The port of Brownsville, with a 17-mi. channel, handles shrimp and cotton. An improved ship channel was opened in 1936. The international airport is the air gateway to and from Mexico, with customs, immigration, public health and other federal administration services. Major industries in the area are devoted mainly to chemicals, food processing, and clothing.

Brownsville has mild winters and exotic tropical foliage. The annual pre-Lenten Charro Days fiesta, which lasts four days, combines the cultural elements of Mexico and Texas. The residents of Matamoros and Brownsville dress in the costumes of Latin America. The thousands of costumed children and gaily attired marching bands are special attractions.

Boca Chica beach, a hunting and fishing area, lies about 20 mi. east of Brownsville on the Gulf of Mexico. Cameron county maintains a causeway at Port Isabel connecting the mainland with Padre Island.

Brownsville is the largest city in the Rio Grande valley; pop. (1970) 52,522. Latin Americans were in the majority until an influx of Anglo-Americans from northern states during and after World War II changed the proportion somewhat. The population in the early 1960s was approximately 55% Latin American to 44% Anglo-American and 1% Asian and Negro. The Brownsville-Harlingen-San Benito standard metropolitan statistical area, consisting of Cameron county, had a population of 151,098 in 1960 and 140,368 in 1970. For comparative population figures of the city *see* table in TEXAS: *Population.* (O. Mo.)

BROWN UNIVERSITY, an institution of higher learning founded as Rhode Island college at Warren, R.I., in 1764 and moved to Providence in 1770. It was renamed Brown university in 1804. *See* PROVIDENCE.

BRUAY-EN-ARTOIS, a town in northeastern France, *département* of Pas-de-Calais, is on the Lawe river, near Béthune and 30 km. (19 mi.) N.N.W. of Arras. Pop. (1968) 28,628. It is a coal-mining centre in the western part of the northeastern coal field, where the coal is deeply buried beneath the chalk country of Artois, and is important for the manufacture of patent fuels. There are also breweries. The town name was changed from Bruay by decree in 1924. (AR. E. S.)

BRUCE, the name of a Scottish family to which two kings of Scotland belonged, and which was descended from Robert de Bruce (d. 1094?), a Norman knight who came to England with William I. The family's connection with Scotland dates from David I's grant (1124) of the lordship of Annandale to the second Robert de Bruce (1078?–1141). The sixth Robert (1210–1295), son of the 4th lord of Annandale and of Isabel, second daughter of David, earl of Huntingdon, brother of the kings Malcolm IV and William, was one of the 13 claimants to the Scottish throne in 1291. When the English king Edward I decided in favour of John Balliol, Robert de Bruce resigned Annandale to his son, the seventh Robert (1253–1304), already (by marriage) earl of Carrick. The eighth Robert (1274–1329) revived his grandfather's claim and became king of Scotland in 1306 (*see* ROBERT I, the Bruce). His brother Edward was killed in 1318 while fighting to make himself effective king of Ireland. The direct line of the Bruces ended in 1371 with the death of King Robert's son, David II (*q.v.*). (R. G. NI.)

BRUCE, JAMES (1730–1794) was the first British explorer of modern times to investigate the Nile sources, and in 1770 reached the source of the Blue Nile in Abyssinia. Bruce was born at Kinnaird house, Larbert, Stirlingshire, on Dec. 14, 1730, and was educated at Harrow, privately, and at Edinburgh university. In 1754 he married Adriana Allan and joined her brother in the family wine business. His wife's early death set him traveling, and he became interested in Arabic. In 1762 he was appointed British consul in Algiers with a commission to study the ancient ruins of the country, and at the end of his appointment he set off to study and record the antiquities of north Africa. Between 1765 and 1768 he traveled widely in Mediterranean countries, especially Syria. He arrived in Alexandria in June 1768, intent on seeking the source of the Nile, and after an arduous journey he reached Gondar, then capital of Abyssinia, on Feb. 15, 1770. He spent three years in Abyssinia, establishing himself at the young king's court by means of his medical skill and his sportsmanship. He managed to reach the source of the Blue Nile at Geesh, on Lake Tana, on Nov. 4, 1770, returning to Cairo by way of the Sudan early in 1773. On his arrival in London the following year his traveler's tales were received with some incredulity, and he retired to Kinnaird house where he died on April 27, 1794.

Bruce published in 1790 *Travels to Discover the Source of the Nile in the Years 1768–73,* in five volumes, a remarkably true and observant account of the countries that he had visited.

See A. Murray, *Account of the Life and Writings of James Bruce* (1808); Sir F. B. Head, *The Life of Bruce* (1830); Sir Robert Playfair, *Travels in the Footsteps of Bruce* (1877). (D. Mn.)

BRUCE, MICHAEL (1746–1767), Scottish poet whose works were allegedly "stolen" by John Logan, was born at Kinnesswood, Kinrosshire, on March 27, 1746, and died there on July 5, 1767. His finest poem, "Elegy Written in Spring," was composed just before his death. Logan obtained Bruce's manuscripts to publish Bruce's *Poems on Several Occasions* (1770), including "Ode to the Cuckoo." Bruce's friends claimed that many missing poems were later printed as Logan's (*Poems,* 1781), including an altered version of "Ode to the Cuckoo."

See W. Mackelvie (ed.), *Lochleven and Other Poems* (1837), with a list of poems not printed in Logan's selection and those that are lost; and the admirable paper in *The Mirror,* no. 36 (1779), said to be by W. Craig, one of the lords of session.

BRUCELLOSIS (Malta Fever or Undulant Fever). Brucellosis is one of the more than 80 diseases of vertebrate animals transmissible to man (called zoonoses). Sir David Bruce, as a member of the British army medical service in 1887, first isolated and identified the causative bacteria from the spleen of a soldier who died from the infection. Subsequently these microbes were designated as belonging to the genus *Brucella.* The illness is characterized by fever, chills, sweats, weakness, pains and aches, all of which usually terminate within three to six months. Occasionally chronic illness may endure for many more months.

Three main species of brucella are the common cause of human disease, and the organism of each of the species has its major reservoir in domestic animals. The causative organisms are *Brucella melitensis* (goats and sheep), *Brucella suis* (swine) and *Brucella abortus* (cattle). These bacteria are small, nonmotile, Gram-negative rods. The species are differentiated by growth requirements, by the inhibition of reproduction by certain dyes and by biochemical tests. Brucellosis not only has serious public health aspects, but the disease in animals also results in severe economic losses to livestock owners. Brucellosis in cattle, also known as Bang's disease, is a frequent cause of bovine abortion. This also applies to swine. The microbes of brucellosis commonly localize in the udders of lactating cattle, sheep and goats, resulting in a reduction of milk secretion and thereby also curtailing cheese production. Brucellae are highly invasive microbes, the disease spreading rapidly from animal to animal. The immediate environment of domestic animals, including their food, becomes heavily contaminated by the bacteria as a result of the dissemination of aborted material, vaginal discharges and infected urine. Infection of healthy animals takes place through the ingestion of contaminated food or by direct entrance of the brucellae through abrasions of the skin or through the mucous membrane of the eyes. Infected but healthy appearing cattle, sheep and goats can excrete considerable numbers of brucellae in their milk for months and in some instances for years.

Man contracts brucellosis either directly or indirectly from infected animals. The majority of human cases result from invasion of the bacteria through small abrasions of the skin following contact with infected animals, fresh carcasses or a contaminated environment. Brucellosis therefore is primarily an occupational disease of farmers, employees in meat-packing plants, livestock producers and veterinarians. Another major cause of human brucellosis is drinking unpasteurized milk and eating fresh cheese prepared from contaminated milk (there is no danger of contracting brucellosis from eating well-ripened cheese). For reasons not clearly understood, children are more resistant than adults to brucellosis. The disease is very rarely transmitted from one human being to another.

Nature of the Disease.—The manifestations of acute human brucellosis are characteristic but not specific. The illness often starts abruptly with fever, chills, sweats, weakness and bodily aches and pains. Brucellosis can resemble many other febrile diseases such as malaria, typhoid fever and influenza. The illness is commonly insidious in its onset, extending unrecognized for many weeks, the patient having low-grade fever, weakness, loss of appetite, generalized aches, nervousness and mental depression. Recovery of the uncomplicated and untreated case usually occurs within three to six months. Complications are more likely to appear in infections caused by *Br. suis* or *Br. melitensis. Br. suis* is often the cause of abscesses and suppurative bone lesions. *Br. abortus* and especially *Br. melitensis* cause inflammation of the spine, resulting in a very chronic and painful illness. Brucellosis rarely is the cause of abortion in human beings.

Chronic brucellosis, in which the illness persists for a year or more, is most commonly encountered in infections due to *Br. melitensis,* and sickness is frequently prolonged because of complications. Patients often complain of persistent weakness, excessive lethargy and fatigue, nervousness and mental depression, without any evidence of abnormal physical condition. It is thus difficult to distinguish neurotic symptoms from those of chronic brucellosis. An attack of brucellosis may "trigger" a display of underlying neurosis, and the symptoms of neurosis may persist long after the infection has ended.

Diagnosis.—Definitive recognition of both animal and human brucellosis is dependent on laboratory procedures. The agglutination test is a blood reaction valuable in diagnosing the disease in animals. By means of this test brucella antibodies, or agglutinins, can be detected in the milk or blood of infected animals. Except under special circumstances attempts are not made to culture brucellae from animals for diagnostic purposes.

The brucella agglutination test on blood serum also is used widely in diagnosing human brucellosis. The results of this test are of particular diagnostic value when brucella agglutinins are present in serum that has been diluted one hundred fold or more. This titre of agglutinins usually is associated with active disease. Many healthy persons living in an area where the disease is prevalent in animals reveal a low titre of brucella agglutinins in their blood, usually denoting past exposure to the disease. Brucella agglutinins can be detected in the blood of some healthy persons over a period of many years. An unqualified diagnosis of human brucellosis can be made when brucellae are isolated from the blood of patients, and this procedure should be attempted in all suspected cases. A skin test, similar to the tuberculin test used for detecting exposure to tuberculosis, is employed for human brucellosis, but the results are of doubtful value in the individual case. The reaction induced by injecting brucella antigen into the skin is specific for brucellosis, but a positive test often is an expression of past exposure to brucellosis and does not necessarily mean that active disease is present. The skin test is a useful epidemiologic tool for determining the degree of human exposure to animal brucellosis in a given locality.

Treatment and Control.—There is no dependable or practical form of drug therapy for animal brucellosis, but antibiotics are very effective in the human disease. A combination of a sulfonamide drug and streptomycin has proved to be successful in treatment, and therapy with tetracyclines, such as aureomycin and terramycin, has given more satisfactory results. Some physicians prefer to employ a combination of streptomycin and tetracycline. When antibiotic therapy is maintained for three to four weeks the duration of the illness is shortened, complications are prevented and deaths directly attributable to brucellosis are practically eliminated. Management of chronic cases is more difficult. Some patients improve with one or two courses of antibiotic therapy, but further treatment is usually without benefit. Treatment with brucella vaccines sometimes causes improvement.

Since human brucellosis cannot be eliminated until the reservoir of infected animals is eradicated, vigorous efforts have been made to control animal brucellosis. The results have been most successful in the attempts to eliminate bovine brucellosis. Extensive regional control programs include the testing of herds by means of the agglutination reaction, and then the elimination of the infected animals. This test and slaughter approach is supplemented with a program of vaccination using a living brucella culture known as strain 19 *Br. abortus.* The vaccine is most effective as a prophylactic agent when given to calves; indeed, calfhood vaccination has proved so successful that it has been applied almost universally in the prevention of brucellosis in cattle. As bovine brucellosis has been controlled, the incidence of human brucellosis has declined. This correlation is most apparent in countries such as the United States and Puerto Rico.

For reasons that are not apparent, strain 19 *Br. abortus* vaccine does not produce satisfactory protection of sheep and goats against *Br. melitensis* or of hogs against *Br. suis*. Intensive and successful experimental work has resulted in a successful vaccine for *melitensis* infections in sheep and goats. Brucellosis in swine can be controlled by carrying out blood agglutination tests on a herd of swine, and, if positive reactors are detected, disposing of the entire herd. Promising results are anticipated following vaccination of sheep and goats with a living culture of *Br. melitensis,* which possesses attenuated virulence.

Immunization of human beings with living brucella vaccine is not generally recommended. The incidence of human disease can be further reduced through the widespread pasteurization of milk for human consumption. Modern methods of preparing and refrigerating meat products permit the marketing of slaughtered infected animals for human food with little or no danger of infection occurring in the consumer.

See I. Forrest Huddleson, *Brucellosis in Man and Animals* (1943); Wesley W. Spink, *The Nature of Brucellosis* (1956). (Wy. W. S.)

BRUCE OF MELBOURNE, STANLEY MELBOURNE BRUCE, 1st Viscount (1883–1967), Australian statesman and diplomat, was prime minister from 1923 to 1929, but is chiefly remembered for his long and successful appointment as Australian high commissioner in London. Born in Melbourne on April 15, 1883, and educated at Melbourne grammar school and Trinity hall, Cambridge, he was called to the bar by the Middle Temple in 1906 and stayed on in England to practise. Being in England at the outbreak of World War I, he served with distinction in the British army from 1914 until invalided home to Australia in 1917.

Bruce was elected to the Australian federal parliament in 1918. His rise in politics was rapid and he became a prominent figure not only in Australia but also in international affairs. He was federal treasurer in 1921 and became prime minister, leading a coalition of the National and Country parties in 1923 after the resignation of W. M. Hughes. Simultaneously he was minister of external affairs. His government was defeated at a general election in 1929 and he lost his seat. Returning to parliament in 1931, he became minister without portfolio under J. A. Lyons, and represented Australia in London until 1945, first as resident minister and after 1933 as high commissioner.

As prime minister Bruce had represented Australia at the imperial conferences of 1923 and 1926, and at several sessions of the League of Nations assembly. He was Australian representative on the League of Nations council from 1933 to 1936, in which year he was president of the council. He was appointed Australian representative to the United Kingdom war cabinet in 1942, and was Australian minister to the Netherlands government in exile in London from 1942 to 1945, when his long term as Australian high commissioner ended. He was chairman of the United Nations Food and Agriculture organization's preparatory commission in 1946 and, as chairman of the World Food council from 1947 to 1951, made his mark by insistent emphasis on the need for international co-operation to raise the standards of nutrition and health throughout the world.

Bruce's service to the Commonwealth of Nations was recognized in 1947 by the first award of a viscountcy to an Australian. In the same year he was appointed chairman of the U.K. Finance Corporation for Industry—a post he held until 1957. He became first chancellor of the Australian National university, Canberra, in 1951, but continued to live mainly in London, taking an active part in the house of lords especially on questions of economics and finance, and retaining a close interest in commonwealth affairs. He died in London on Aug. 25, 1967. (C. Com.)

BRUCH, MAX (1838–1920), German composer, remembered chiefly for his violin concertos, was born Jan. 6, 1838, at Cologne. He was a precocious child. At 14 he wrote a symphony and in 1852 won a scholarship from the Mozart foundation at Frankfurt am Main that enabled him to study under Ferdinand Hiller and Carl Reinecke at Cologne. His first opera, *Scherz, List und Rache,* was performed there in 1858. He had a distinguished career as conductor of choral and orchestral societies at Coblenz (1865), Sondershausen (1867), Berlin (of the *Sternscher Gesangverein,* 1878), Liverpool (the Philharmonic orchestra, 1880–83) and Breslau (1883–90). From 1891 until his retirement in 1910, he was in charge of a master class at the Berlin Academy of Arts. He died at Friedenau, near Berlin, Oct. 2, 1920.

Bruch was an unusually productive and ambitious composer, and contributed to almost all the musical kinds. His greatest successes in his own lifetime were massive works for choir and orchestra. *Schön Ellen* (1867), *Odysseus* (1872), *Das Lied von der Glocke* (1878) and *Gustav Adolf* (1898) were favourites with German choral societies during the late 19th century. The reason for their failure to maintain their position was probably that Bruch's remarkable facility is not sufficiently controlled by critical judgment, and although his workmanship is sound, his orchestration colourful and his choral writing effective, he lacks the depth of conception and the originality needed to sustain large-scale works. The only works to outlive him were his three brilliant violin concertos, the first of which, in G minor, has a permanent place in the violinist's repertory, and his *Kol Nidrei* fantasy for cello and orchestra.

See F. Gysi, *Max Bruch* (1922); H. Pfitzner, *Meine Beziehungen zu Max Bruch* (1938). (H. Ga.)

BRUCINE, an alkaloid occurring in about equal parts with strychnine in the seeds of *Strychnos nux-vomica* and other species of *Strychnos*. It has been found in plants only in association with strychnine, to which it bears a close chemical relationship; brucine is dimethoxystrychnine. It has an intense and persistent bitter taste resembling that of strychnine and produces similar but much weaker effects when injected into animals. When administered by mouth, its action is slight because of its rapid elimination from the body. In the 19th century brucine was sometimes used for the same purposes as strychnine, but because of its relatively low potency it was of much less importance. It has little if any therapeutic use in modern medicine. *See* also Alkaloids; Strychnine. (V. E.)

BRUCITE, a mineral consisting of magnesium hydroxide, has a higher percentage of magnesium (*q.v.*) than any other ore. It was first described in 1814 as "native magnesia" from New Jersey by A. Bruce, a U.S. mineralogist, after whom the species was named. Brucite is usually found as platy masses, sometimes of considerable size, which have a perfect cleavage parallel to the surface of the plates. It is white, sometimes with a tinge of gray, blue or green, varies from transparent to translucent, and on the cleavage surfaces has a pronounced pearly lustre. In general appearance and softness (hardness 2.5) it is not unlike gypsum or talc, but it may be readily distinguished from these by its double refraction.

Brucite is generally associated with other magnesian minerals, such as magnesite and dolomite, and is commonly found in serpentine, or sometimes as small scales in phyllites and crystalline schists; it has also been observed in metamorphosed magnesian limestone, such as the rock known as predazzite from Predazzo in Tirol. The specific gravity of brucite is 2.38 to 2.40. The formula is $Mg(OH)_2$, and it crystallizes in the rhombohedral system. (L. J. S.)

BRÜCKE, ERNST WILHELM VON (1819–1892), German physiologist who helped introduce physical and chemical methods into medical research and gave a great impetus to animal experimentation, was born in Berlin, June 6, 1819, and died in Vienna, Jan. 7, 1892.

Brücke was a member of a school of physically oriented German physiologists who undertook to create a new biology rigorously based on physics and chemistry. He studied medicine in Berlin and was trained as a physiologist by Johannes Müller. In the biophysical movement he was associated with Emil du Bois-Reymond, Karl Ludwig and Hermann von Helmholtz. Their biophysical program was formulated about 1847. Although the group did not achieve their goal they did much to influence the study and practice of medicine.

Brücke was professor of physiology in Vienna from 1849 to

1891. He conducted research on the structure of skeletal muscle, on vision and on the mechanism of speech. He was, like Müller and Helmholtz, interested in art, and he wrote on the relationship of the physiology of vision to painting. Josef Breuer and Sigmund Freud were attracted to physiology through Brücke's lectures, and Freud worked in Brücke's institute. It was largely through Brücke that Freud acquired the mechanistic bias that is seen in his early "Project for a New Psychology." Brücke was a member of the Viennese Academy of Science.

For a bibliography on Brücke *see* the article DU BOIS-REYMOND, EMIL. (P. F. C.)

BRUCKNER, (JOSEF) ANTON (1824–1896), Austrian composer whose fame, firmly established in German-speaking countries, is less well recognized elsewhere. He was born at Ansfelden, Upper Austria, Sept. 4, 1824. After his father's death (1837) he was educated as a chorister at the monastery of St. Florian and became a village schoolmaster. In 1855 he was appointed organist at Linz cathedral, and this enabled him to travel regularly to Vienna, where he studied composition (in which he had been until that time largely self-taught) with Simon Sechter. He continued his studies until 1861, making up for lack of facility and for intellectual slowness by his determined perseverance. In 1868 he was appointed to teach counterpoint and the organ at the conservatory at Vienna, and also to play the organ at the court chapel. He had already written three masses, for performance at Linz cathedral, and the first version of his first symphony. He lived in Vienna as a rustic outsider and, hardly noticed by the public, wrote one symphony after another, some of which were performed but were merely regarded as oddities and ridiculed by the press. Appearances as an organist in Nancy and Paris (1869) and in London (1871) were chance events without any practical results. A spectacular success of his Seventh Symphony in Leipzig under A. Nikisch (1884) turned the tide. When he died in Vienna on Oct. 11, 1896, he was on the way to wider recognition, which slowly spread. But the universal acceptance of his monumental nine symphonies in the German repertory dates only from the years after World War I.

Bruckner's genius and originality, the grandeur of his symphonic vision and the nobility of his invention cannot conceal the deficiencies of formal continuity and consistency from which his works suffer. These may be explained by the peculiarities of his musical education and the laboriousness and lateness of his artistic development, as a result of which his rich inspiration was never quite integrated with his technique. At the same time, his deep spirituality, firmly based on a devout Catholic's conception of the world, also cut him off from the intellectual trends of his day. His style is a product of disparate elements, combined in a strange uncouth amalgamation: the overwhelming impression made on him by Beethoven's *Choral Symphony* was decisive in forming his monumental idea of the symphony; he became an addict of Wagner's music; his practical experience lay chiefly in the performance of a provincial type of church music and in improvisation at the organ. These elements, backed by an awkwardly stiff, sometimes scholastic contrapuntal texture, produce the strangest possible blending of classical tradition, Wagnerian harmony and baroque ecclesiastical splendour. There is something cyclopean in the vigour with which Bruckner has followed the same great symphonic obsession nine times, with a naïve disregard for variety of form and expression. In spite of such shortcomings, the sincerity and genuineness of his utterance and the rich background of the Austrian landscape, a reflection of which can be felt in his music as in Schubert's, make his works both venerable and unique.

Besides the works mentioned—his masses and his symphonies, the ninth of which remained unfinished—Bruckner's mature output comprises a string quintet (1879) and a number of choral works, among them a magnificent *Te Deum* (1884).

See H. F. Redlich, *Bruckner and Mahler* (1955). (H. GA.)

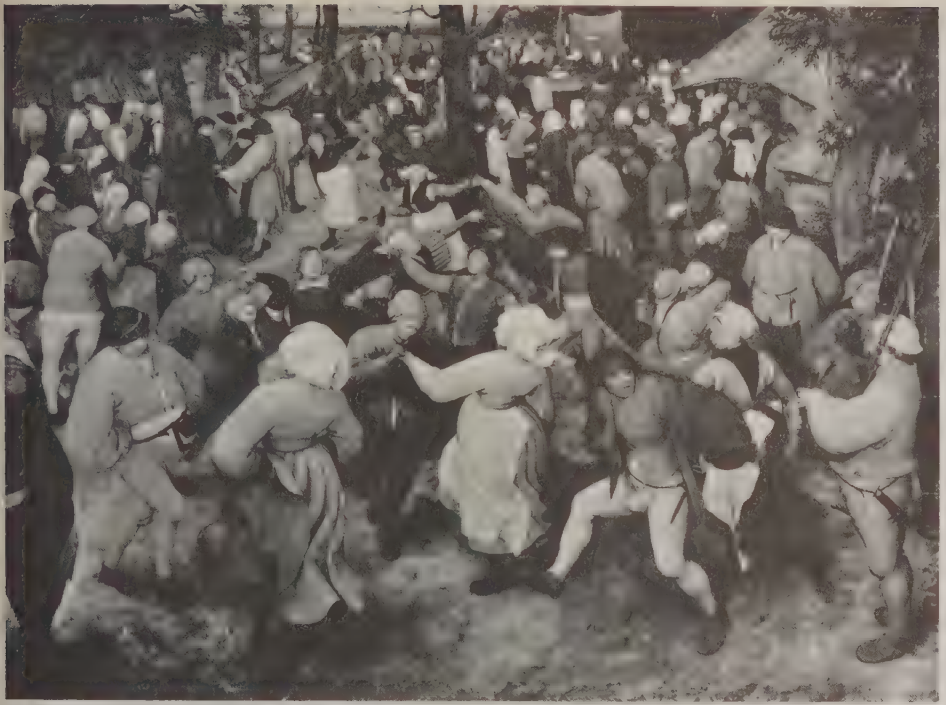
BRUDIEU, JEAN (JOAN) (*c.* 1520–1591) French composer, born about 1520, probably near Limoges, arrived at Seo de Urgel in Catalonia in 1538–39 with four other French singers, and seems to have remained there as choirmaster of the cathedral almost continuously until his death (1591). His only known works—a *Missa defunctorum* and a set of 16 madrigals (some in Castilian, some in Catalan), dedicated to the duke of Savoy (1585)—have been edited by F. Pedrell and H. Anglès (Barcelona, 1921). Stylistically they are rather old-fashioned, but the melodic and rhythmic influence of Catalan folk song gives the madrigals a particular interest. (J. J. N.)

BRUEGHEL (BRUEGEL, BREUGHEL), **PIETER** (*c.* 1525–1569), the most original and powerful spirit in Flemish 16th-century art. He was born probably at Brueghel, near Eindhoven, and entered the Antwerp painters' guild in 1551. His alleged training under Pieter Coecke van Aelst has left no apparent traces in his work, but his style does show affinities with certain other Antwerp artists, particularly Jan van Amstel and Pieter Aertszen and the landscape specialists Cornelis Massys and Matthys Cockx. These were painters relatively little affected by the Romanist figure style then prevalent in Flemish painting, and it is significant that Brueghel seems to have used his visit to Rome (*c.* 1552–53) not to acquire the usual stock of classical and Renaissance motifs but to widen his experience of landscape. His appreciation of the sublimity of alpine scenery was to be fundamental for his art. His work at this time is best seen in landscape drawings, but one picture, a view of Naples (Doria gallery, Rome), must presumably be connected with the Italian journey, and several others, notably the luminous "Fall of Icarus" (Brussels), are generally considered to be early.

Though Brueghel remains at all times the most vigorous and independent of artists, the pictures painted during the decade after his return to Antwerp give evidence of an intimate study of earlier Flemish art. He reanimated the monstrous inhabitants of the fantasy world of Hieronymus Bosch, at first in engravings, such as the set of "Seven Deadly Sins" (1556–57), designed for the printseller Hieronymus Cockx, and later in such paintings as "The Fall of the Rebel Angels" (1562; Brussels) and the "Dulle Griet" (Musée Mayer van den Bergh, Antwerp). The compositional formula of the wide stage, viewed from above and peopled with a multitude of lively figures, is likewise derived from Bosch and his contemporaries and appears constantly in Brueghel's pictures of this period. These include themes from Flemish peasant life and folk wisdom, such as the "Flemish Proverbs" (1559; Berlin) and the "Children's Games" (1559; Vienna), and also a number of biblical subjects, such as the "Tower of Babel" (1563), "The Way to Calvary" (1564) and the "Massacre of the Innocents," all in Vienna.

In about 1563 Brueghel moved from Antwerp to Brussels (where he died, Sept. 5, 1569); he now turned to more concentrated forms of composition and adopted a more monumental style. His greatest achievement in landscape painting, a series of the months of the year (1565; Vienna and New York), is characteristic in its combination of a medieval theme with an entirely new and deeply sensitive rendering of the moods of nature. But most of his pictures of this period represent a new departure, in that they are primarily figure compositions. The range of subjects remains as before—religious, as in the "Adoration of the Kings" (1564; National gallery, London); rustic, as in a "Peasant Wedding" and the "Peasant Dance" (Vienna); or proverbial, as in "The Birdnester" (1568; Vienna) and the "Blind Leading the Blind" (1568; Naples). The conception, however, is presented in far more vigorous and impressive form. It is noteworthy that the figures owe something of their monumentality to the use, for the first time in Brueghel's work, of motifs from Italian art and particularly from Michelangelo.

Brueghel was not, as he has sometimes been represented, a Flemish peasant upholding the virtues of his fellows against the Spanish oppressor. He was, on the contrary, a cultivated townsman, working for discriminating clients, among whom the Spanish authorities were prominent. A profoundly thoughtful painter, he succeeded in combining his own vivid perceptions with elements from the art of other periods and places, so as to present a vision of the world more complete and coherent than that of any of his contemporaries. It is a vision in which the littleness, the cruelty and the stupidity of man are starkly emphasized against the sublimity and indifference of nature. Yet its pessimism is counter-



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"WEDDING DANCE" BY BRUEGHEL

balanced by a sanity, a humour and a sensitivity to every kind of natural beauty, which makes Brueghel one of the most delightful as well as one of the most philosophical of artists.

Through his sons Pieter Brueghel (*c.* 1564–*c.* 1637), called "Hell Brueghel," an imitator of his father, and Jan Brueghel (1568–1625), called "Velvet Brueghel," a painter of somewhat artificial landscapes and religious pictures, the elder Pieter founded a dynasty of artists that flourished down to the 18th century.

See G. Glück, *The Large Bruegel Book* (1953); F. Grossman (ed.), *The Paintings of Peeter Brueghel* (1955). (D. Kg.)

BRUGES (Flemish, Brugge, "bridge"), capital of the province of West Flanders, Belgium, one of the most interesting cities in the Low Countries preserving a medieval aspect, lies 24 km. (15 mi.) E. of Ostend and 13 km. (8 mi.) S. of the sea at Zeebrugge. Pop. (1961) 52,220.

The centre of Bruges is the Markt dominated by the belfry or halletoren (13th–15th centuries) with its carillon of 46 bells (1742–43), which surmounts the Halles or market built around an interior court. To the east of the Markt are the provincial palace and the post office (1887) in neo-Gothic style. Steenstraat leads southwestward to the cathedral of St. Salvatorskerk (12th–16th centuries, vaults 1635 and 1739), which possesses important works of art. Zuidzandstraat leads on to the Zand, the former site of the railway station. From there southward is a wide boulevard bordered by plantations, leading to the new station. The rampart Begijnenvest opposite leads to the Minnewater, the 17th- and 18th-century harbour. To the east of the Markt are the Burg, former fortified home of the counts of Flanders, and the *stadhuis* (town hall) (1376–1420). To the north is the site of the cathedral of St. Donatian, destroyed in 1799. The Gerechtshof or law courts (1722–27) replaced the ancient Palais du Franc. The southeast side has a remarkable Renaissance façade. To the southwest of the Burg are two chapels, that of the Holy Blood (14th–15th centuries) built on top of that of St. Basil (1150). Bruges is transversed by several canals, which greatly add to its charm. Chief of these is the Rei (Reye or Roya), a canalized river. One of the most scenic spots in Bruges is near the Gruuthuse mansion (1420–70) where the Dyver canal makes several right-angled turns past ancient houses and underneath equally old bridges. Groeningestraat leads to the Parc Arents, close by which is the Groeninge museum of fine arts. It contains works by Jean van Eyck, Hugo van der Goes, Hans (Jan) Memling and Gerard David. In the park is the museum of the painter Sir Frank Brangwyn. In the south of the city adjoining the Gruuthuse is the church of Notre Dame (13th–15th centuries) which contains pictures by G. David and A. Isenbrant, mausoleums of gilded bronze and enamel of Mary of Burgundy and Charles the Bold, as well as a Madonna and Child in marble by Michelangelo. Nearby to the west the Hospital of St. John contains the Memling gallery with masterpieces of that painter.

Bruges is on the main line from Ostend to Brussels; other lines run to Eeklo, Torhout, Blankenberge and Zeebrugge. As a canal junction Bruges is linked with Zeebrugge harbour; other canals connect with Ostend and Ghent. There are airports near the sea at Knokke and Ostend. The tourist trade is the chief industry, but a new industrial area is growing up to the north, where shipbuilding, the manufacture of electronic equipment and dies and spinning are carried on. Yeast and industrial glass are also produced. Coal, chemical products, machines and munitions are imported while fuel oil, coke, fruits and vegetables are exported.

Originally Bruges was a landing place on the Zwyn estuary into which the Rei flowed. In the 7th century mentioned as the Municipium Brugense (named for a Roman bridge over the Rei) it was evangelized by St. Eloi, bishop of Noyon-Tournai. In a curve of the Rei the first counts of Flanders built a fortification, the *castrum* or *burcht*, against the Norman invaders. The town that grew up around it became an emporium for the Hanseatic league cities and attained great importance by the 13th century. The foundation of the various churches marked stages in the town's growth. In the 14th century the silting up of the Zwyn harmed its trade and Damme became the outer port of Bruges. Despite the commercial decline, the most brilliant period in the history of Bruges was the 15th century when the dukes of Burgundy held their court there attended by the artists who later became known collectively as the Primitive Flemish school. The political troubles of the 16th century brought the prosperity of Bruges to an end, and it remained a sleepy medieval town until the cutting of the canal to Zeebrugge in 1903 made it a port once more and new industries grew up rapidly, while the tourist trade brought a new prosperity. In World War I Bruges was occupied by the Germans in Oct. 1914. On April 23, 1918, the harbour of Zeebrugge was raided by the British and blockships sunk in the Bruges canal, to deny the use of the port of Bruges to German submarines. On Oct. 19, 1918, the Allies reoccupied the town. In World War II Bruges was occupied by the Germans from May 1940 until Sept. 1944.

See also references under "Bruges" in the Index.

(A. J. De B.)

BRUGMANN, (FRIEDRICH) KARL (1849–1919), German linguist, specialist in the comparative grammar of the Indo-European languages, was born in Wiesbaden on March 16, 1849. Educated in the *Gymnasium* there and at the universities of Freiburg and Leipzig, he was for 32 years professor of Sanskrit and comparative linguistics at the latter. He died in Leipzig, June 29, 1919.

Brugmann was an enormously productive scholar, a keenly perceptive original investigator, a vigorous defender of theoretical principles and the greatest synthesist among the grammarians of his time. Of his 400 publications the most original is his article (1876) on the sonant nasal in Indo-European; but the work on which his fame most securely rests is his *Grundriss der vergleichenden Grammatik der indogermanischen Sprachen,* of which the volumes on the sounds and forms, supplemented by three volumes on syntax by Berthold Delbrück (*q.v.*), appeared first between 1886 and 1893 and in a second greatly enlarged edition between 1897 and 1916. Brugmann's ability to control vast masses of exceedingly complex phenomena is evident in all his work, but nowhere with such perfect clarity as in the great *Grundriss.*

As a member of the group of "young grammarians" at Leipzig in the 1860s and 1870s, Brugmann ardently espoused the cause of unexceptionality in sound laws, and in an article "Zum heutigen Stand der Sprachforschung" (1885) he vigorously defended the new linguistics against the animadversions of his own teacher Georg Curtius. In the first volume (1878) of *Morphologische Untersuchungen,* edited by Brugmann and his friend Hermann Osthoff, may be found Brugmann's statement of the young grammarians' views.

A bibliography of Brugmann's work from 1871 to 1909 was published in *Indogermanische Forschungen,* vol. 26, 425–440 (1909); and a supplement was printed in *Indogermanisches Jahrbuch* for 1919, vol. 7, pp. 148–152. (My. F.)

BRUGSCH, HEINRICH KARL (1827–1894), German Egyptologist, a pioneer in the decipherment of demotic (*see* DEMOTIC LANGUAGE AND WRITING), was born in Berlin on Feb. 18, 1827. He was sent to Egypt by the Prussian government in 1853 and met Auguste Mariette there. He then worked in the Berlin museum. In 1860 he was sent to Persia; in 1864 he was consul at Cairo; and in 1868 he was professor at Göttingen, Ger. On the foundation by the khedive of the Cairo school of Egyptology (1870) he was appointed director, a post he held for nine years. He then returned to live in Germany, frequently visiting Egypt until his death. Brugsch's services to Egyptology are most important. His vast hieroglyphic-demotic dictionary appeared during 1867–82. He died in Charlottenburg, near Berlin, on Sept. 9, 1894. *See* also EGYPT: *Archaeology.*

See H. Brugsch, *Mein Leben und mein Wandern* (1893). (W. R. D.)

BRÜHL, HEINRICH, GRAF VON (1700–1763), the director of policy in electoral Saxony from 1738 to 1763, was born at Glanloffsömmern in Thuringia on Aug. 13, 1700. He became a page to the dowager duchess of Saxe-Weissenfels in 1713 and then, in 1720, to Frederick Augustus I, elector of Saxony and, as Augustus II, king of Poland. In 1731 he became successively head of the excise office, director of the department of internal affairs and privy councilor, but only after Frederick Augustus I's death (Feb. 1733) did he attain the rank and title of cabinet minister. In 1734 he was given control of the electoral finances by the new elector Frederick Augustus II (*see* AUGUSTUS III, king of Poland) as president of the chamber. In 1737 he was created a count of the empire by the emperor Charles VI. From 1738, when he received charge of military affairs, Brühl was in effect sole minister and director of Saxon policy; and in 1746 he received the title of *premier ministre.* He was also president of the mining monopoly from 1733 and director of the Meissen porcelain factory from 1739. Enjoying the full confidence of the elector until his death, Brühl amassed a large fortune from his stipends, but the charges of wholesale embezzlement once leveled against him are discounted by modern historians. His chief political aims were the acquisition of a land corridor between Poland and Saxony and the establishment of a hereditary kingdom in Poland. These brought him the political enmity of Prussia and the fierce personal hatred of Frederick the Great of Prussia, whose writings have blackened Brühl's posthumous reputation. It was thus against Brühl's will that Frederick Augustus allied himself with Prussia in the War of the Austrian Succession, and the cost in men and money brought no compensation to Saxony, as Saxon interests were ignored in the peace of Breslau (1742). Early in the Seven Years' War (*q.v.*) after the capitulation of the Saxon army at Pirna (Oct. 1756) Brühl and Frederick Augustus fled to Warsaw, where they remained throughout the war. During the war Saxony, especially Brühl's estates, was ruthlessly exploited by Prussia. Brühl died at Dresden on Oct. 28, 1763, having survived his master only a few weeks.

See R. L. Koehl, "A Saxon Politician of the 18th Century," *Journal of Central European Studies* (Jan. 1954); H. Rössler, article in *Neue Deutsche Biographie,* vol. ii (1955).

BRÜHL, a town of Germany which after partition of the nation following World War II was located in the newly formed *Land* of North Rhine-Westphalia of the Federal Republic of Germany, is 11 km. (7 mi.) S. of Cologne. Pop. (1959 est.) 34,349. From the end of the 13th century onward it was a stronghold of the electors of Cologne and the 18th-century baroque castle, the Augustusberg (with its extensive gardens and famous staircase built by Balthasar Neumann), was their summer residence. After 1945, the castle was frequently used for receptions by the president of the Federal Republic of Germany. The town is a resort for the people of Cologne. It is a centre of lignite (there are numerous brown-coal mines on the slopes of the Vorgebirge), briquette and subsidiary industries.

BRUM, BALTASAR (1883–1933), Uruguayan statesman, was born near Salto, June 18, 1883. He received a law degree in 1908 and practised briefly, but in 1913 was appointed minister of public instruction and later served as minister of foreign relations (twice), of finance and of the interior. While serving as minister of foreign relations and just before assuming the presidency, Brum made official visits to Washington, D.C., and certain Latin-American capitals. He was elected president in 1919, the first to serve after the constitution of 1917 established a bifurcated and bipartisan executive (president and independent national council of administration). His presidency continued until 1923. Brum was president of the council on March 31, 1933, when Pres. Gabriel Terra in his *coup d'état* suspended the constitution. Brum in protest against the action dramatically killed himself, defying police who came to arrest him.

His chief contribution, both as minister and president, was in the field of foreign relations. He consistently urged inter-American solidarity and in 1920 proposed an American League of Nations. (R. H. Fi.)

BRUMAIRE (from Fr. *brumes,* "mists"), the second month in the French Republican calendar (*q.v.*), began on Oct. 22 or 23 and ended on Nov. 20 or 21. The *coup d'état* of 18 Brumaire, year VIII (Nov. 9, 1799), and the law of 19 Brumaire overthrew the Directory and established the consular regime (*see* FRANCE: *History;* NAPOLEON I).

BRUMEL, ANTOINE (*c.* 1460–*c.* 1525), a leading church composer of his time, probably born in Flanders about 1460. He may have been in Chartres in 1483, certainly worked in Laon in 1497 and was choirmaster of Notre Dame, Paris, 1498–1500. He left Paris in 1505 and went to Lyons. He was in Rome in 1513 and in Ferrara in 1520. No further record is known. His music, highly regarded by contemporary writers, consists mainly of four-voiced masses and motets. His 12-part mass, one of 12 masses, published in Venice (1503–08), Rome (1516–22) and Nürnberg (1539), was an unusual experiment. He used canon and *cantus firmus* easily, and his gift for imitative writing was advanced for his time.

BIBLIOGRAPHY.—A useful selection of Brumel's music was reprinted in *Trésor musical* (for 1866 and 1874–75), ed. by R. van Maldeghem; complete ed. by A. Carapetyan (vol. i, *Missa L'Homme armé,* 1951). *See* also A. Pirro, "Dokumente über Antoine Brumel . . . ," in *Zeitschrift für Musikwissenschaft,* vol. xi (1928–29); G. Reese, *Music in the Renaissance* (1954). (B. L. Tr.)

BRUMMELL, GEORGE BRYAN (1778–1840), English man of fashion, known as "BEAU" BRUMMELL, famous for his friendship with the prince of Wales (afterward George IV) and as the undisputed leader of fashion at the beginning of the 19th century, was born in London on June 7, 1778. His father was private secretary to Lord North from 1770 to 1782, and subsequently high sheriff of Berkshire; his grandfather was a shopkeeper in the parish of St. James, who let lodgings to the aristocracy. From his early years George Brummell paid great attention to his dress. At

Eton, where he was sent to school in 1790, and was extremely popular, he was known as Buck Brummell, and at Oxford, where he spent a brief period as an undergraduate at Oriel college, he preserved this reputation, and added to it that of a wit. He returned to London, where the prince of Wales, to whom he had been presented at Eton, gave him a commission in his own regiment (1794). Brummell soon became intimate with his patron and, in 1798, having then reached the rank of captain, he left the service.

Next year he succeeded to a fortune of about £30,000. Setting up a bachelor establishment in Mayfair, he became, as a result of the prince of Wales's friendship and his own good taste in dress, the recognized *arbiter elegantiarum.* For a time his sway was unchallenged, but eventually gambling and extravagance exhausted his fortune, while his tongue proved too sharp for his royal patron. They quarreled in 1812, and although Brummell did not immediately lose his place in society, his debts increased so much that in 1816 he fled to Calais to avoid his creditors. There he struggled on for 14 years, always hopelessly in debt. From 1830 to 1832 he was British consul at Caen. In 1835 he was imprisoned for debt, but his friends once more came to the rescue, and provided him with a small income. He soon lost all his interest in dress; his personal appearance was slovenly and dirty, and he began to live in the past. In 1837, after two attacks of paralysis, shelter was found for him in the charitable asylum of Bon Sauveur, Caen, where he died on March 30, 1840.

See Lewis Melville, *Beau Brummel, His Life and Letters* (1925).
(A. Al.)

BRUNE, GUILLAUME MARIE ANNE (1763–1815), the only one of Napoleon's marshals to have been associated with the French Revolutionary terror, was born on May 13, 1763, at Brive-la-Gaillarde, the son of a lawyer. He met Danton as a journalist in Paris, turned to the extremists of the Revolution and was a *commissaire* for purges of the army of the north and later commander of a camp which terrorized Bordeaux. Under the Directory he served in Paris with Barras and Napoleon Bonaparte and, after three months' war in Italy (1797) under the latter, was general of division. Barras used him in a series of commands-in-chief to coerce the Helvetian, Cisalpine and Batavian republics. Brune beat the Anglo-Russian army in Holland at Bergen and at Castricum (Sept.–Oct. 1799) and then "carried terror and respect," as he said, to western France. Sent by Napoleon to end the Italian campaign, he fought a battle against the Austrians in Dec. 1800. He was ambassador at Constantinople when he was made a marshal in 1804. On return he guarded the French coast (1805–07) with small forces, aided by his reputation as defender of Holland. He had cleared the Swedes from Stralsund in 1807, when he was abruptly removed from employment, for reasons never divulged. The shadow of Jacobinism still rested on Brune in 1815 when Napoleon sent him to defend Provence (which was strongly royalist). Returning at the end of hostilities he went into Avignon for horses; a crowd gathered against the alleged "murderer of the princesse de Lamballe" and killed him on Aug. 2, 1815. (I. D. E.)

BRUNEAU, (LOUIS CHARLES BONAVENTURE) ALFRED (1857–1934), French opera composer whose works were inspired by the naturalism of Émile Zola, was born in Paris on March 3, 1857. He was a pupil of Massenet at the Paris Conservatoire. On leaving the Conservatoire he was employed as a copyist to the publisher Georges Hartmann. In his youth he wrote three choral symphonies, conducted by Jules Pasdeloup, and in 1887 produced his first opera, *Kérim.* In 1888 he met Zola with whom he formed a close friendship and whose works served him as librettos for eight operas produced between 1891 and 1916. The first of these, *Le Rêve* (1891), was criticized for its Wagnerian associations, but *Messidor* (1897) and *L'Ouragan* (1901), the librettos of which were written in prose, showed Bruneau's original dramatic gifts. "Music that should be both realistic and symbolical" was his aim, achieved in *L'Attaque du moulin* (1893), based on Zola's *Soirées de Médan,* and in the incidental music for Zola's *La Faute de l'abbé Mouret* (1907). Political rather than musical reasons accounted for the failure of *L'Enfant-roi* (1905) and *Naïs Micoulin* (1907), Bruneau having supported Zola in the conflicts that arose from the Dreyfus case. After Zola's death in 1902 Bruneau's works include the ballets *Les Bacchantes* (1912) and *L'Amoureuse Leçon* (1913). His last operas, *Angelo* (1928) and *Virginie* (1931), were not revived. Bruneau's works were widely played during his lifetime, Gustav Mahler conducting *Le Rêve* at Hamburg and Sir Charles Stanford the first performance of his *Requiem* (1896) in London. He wrote music criticism for *Gil Blas, Le Figaro* and *Le Matin,* and published books on contemporary French and Russian music. He died in Paris on June 15, 1934.

BRUNEI, a British-protected Muslim sultanate in Borneo. Area 2,226 sq.mi. (5,765 sq.km.); population (1969 est.) 130,849. Once a powerful sultanate, it gave its name to the whole island of Borneo. Brunei's modern development has been financed by the exploitation of the oil fields at Seria, on the coast of the South China Sea. The capital city is Bandar Seri Begawan (pop. [1969 est.] 20,463).

Physical Characteristics.—Lying in Borneo (*q.v.*) between 114° 4′ and 115° 22′ E Brunei's coastline on the China Sea stretches 100 mi. (160 km.) along a coral sand beach from Seria northeast into Brunei Bay. Brunei is divided by the Limbang River Valley (Sarawak) into two enclaves. The larger western enclave consists of the valleys of the Belait and Tutong rivers, and is mainly a series of hills and swamps. The hilly eastern sector, in which some rubber is grown, stretches up the valley of the Temburong River to the main Bornean mountain range. The jagged massif of Pagon Priok (6,070 ft. [1,850 m.]) is 40 mi. (64 km.) inland.

The climate is tropical. Average daily temperatures range from 76° to 86° F (24° to 30° C). The annual rainfall varies from 100 in. (2,540 mm.) on the coast to over 200 in. (5,080 mm.) in parts of the interior.

Population.—The population grew from 30,135 (1931 census) to 83,877 (1960 census) and to an estimated 130,849 in 1969. Nearly 70% are Malays (54% in 1960), mostly peasant farmers, the descendants of pagan converts to Islam. They also dominate the administration. The Chinese (about 33,000) own most of the

SHELL PHOTOGRAPH

FISHERMEN AWAIT CUSTOMERS AT THE WHARF OF BANDAR SERI BEGAWAN

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THE OMAR ALI SAIFUDDIN MOSQUE AND SURROUNDING KAMPONG AYER IN BANDAR SERI BEGAWAN

shops and small businesses, and provide much of the labour. The pagan indigenous races (about 22,000) include Ibans from Sarawak who form the main labour force in the oil fields. Malay is the official language.

History.—Sultan Hassanal Bolkiah, whose father abdicated in 1967, is the 29th ruler in descent from Sultan Mohammed (1405–15), who embraced Islam. Brunei's earlier history is obscure, but it was trading with and paying tribute to China in the 6th century, and then came under Hindu influence for a time through allegiance to the Majapahit kingdom in Java. When Magellan's ships anchored off Brunei in 1521 the fifth sultan, the great Bolkiah, controlled practically the whole of Borneo, the Sulu Archipelago, and neighbouring islands. Toward the end of the 16th century Brunei was torn by internal strife. A gradual decline in power continued through the 19th century, notably with the cession of Sarawak to Sir James Brooke in 1841, the expansion of Sarawak by additional grants, the cession to Britain of the island of Labuan, and the final loss of what is now Sabah (East Malaysia). Brunei's fortunes had begun to revive, however, with the discovery of oil in 1929.

Administration.—Brunei came under British protection in 1888, following treaties for the suppression of piracy, and in 1906 administration was vested in a British resident, whose advice the sultan was bound to accept. After the Japanese occupation (1941–45) the resident was responsible to the governor of Sarawak and not the governor of the Straits Settlements, an arrangement changed in 1959, with administrative separation from Sarawak and the appointment of a British high commissioner. Brunei then had its first written constitution, and in 1962 a partly elected Legislative Council with limited authority was installed, but political progress was interrupted by a revolt, suppressed when the sultan called in British forces. There were new elections in 1965. Britain remained responsible for defense and external affairs. The council, with a majority of ex-officio members, has executive responsibility. The sultan's judicial powers devolved upon the High Court and the Court of Appeal. The instrument of abdication in 1967 provided for the former sultan's continued participation in affairs of state in an advisory capacity.

The Royal Brunei Regiment, formed in 1961, has helicopters, hovercraft, and a small number of fast patrol boats for internal security purposes.

Brunei has non-contributory pensions for the old and disabled and free elementary education. There were 37,000 pupils in 1968.

The Economy.—Bandar Seri Begawan (Brunei Town until October 1970), largely destroyed in World War II, has been rebuilt since 1945. The principal buildings include a new royal palace; the golden-domed mosque, the largest in the Far East; administrative and religious offices; a sports stadium; and an Olympic swimming pool. The historic water village, Kampong Ayer, whose houses are built on stilts in the Brunei River, is overcrowded and unsanitary. Its 20,000 Malay inhabitants are being persuaded to live ashore.

Oil from Seria, piped to, and some of it refined in, Sarawak, together with natural gas, accounts for almost the whole of Brunei's exports (97% in 1967) worth Br$244,000,000. Principal imports are machinery, vehicles, manufactured goods, materials for development, and food, at a total cost (1967) of Br$150,000,000. Oil also provides two-thirds of Brunei's revenue, which rose from $4,380,000 (Straits) in 1947 to Br$142,000,000 in 1967. Brunei has issued its own currency since 1967, freely exchangeable at par with the Malaysian and Singapore dollar (worth *2s. 8d* or 32.6 U.S. cents). Revenue has always substantially exceeded expenditure. Brunei has large overseas reserves ($674,000,000 in 1968). Oil production, which was 117,000 bbl. a day in 1957, fell to 69,000 bbl. in 1963, but offshore wells eight miles out at sea increased the output to 123,000 bbl. early in 1968. Operated by the Brunei Shell Petroleum Company, the oil field stretches for 20 mi. along the coast, and is the third largest producer in the Commonwealth. A 66-kv. electric grid run on natural gas was opened in 1967. There is a government broadcasting service, and a daily and weekly newspaper. (A. KE.)

BRUNEL, the name of two noted British engineers of French stock, father and son.

SIR MARC ISAMBARD BRUNEL (1769–1849), engineer and inventor, builder of the world's first underwater tunnel, was born at Hacqueville, Normandy, France, on April 25, 1769. After six years' naval apprenticeship, his royalist sympathies compelled him to leave France when the Revolution broke out. In 1793 he fled to the United States, where he held the post of chief engineer of New York. Having evolved a method of making ships' blocks by mechanical means, he sailed to England in 1799 to lay his plans before the British government. He was engaged to superintend the erection of his machines at Portsmouth dockyard. When completed, this installation was one of the earliest examples in the world of completely mechanized production.

Brunel was a prolific inventor, designing machines for sawing and bending timber, bootmaking, stocking knitting and printing, among many others. Having encouraged him to equip a factory for making army boots, the government refused to accept his output when peace was restored in 1815. This, combined with the destruction by fire of his sawmills at Battersea, London, led to his imprisonment for debt in 1821, but his friends obtained from the government a grant of £5,000 for his release.

Brunel also practised as a civil engineer, designing, among other works, the Île de Bourbon suspension bridge and the first floating landing stage at Liverpool. He is chiefly remembered as the designer of the first tunneling shield and as the builder of the Thames tunnel between Rotherhithe and Wapping where this shield was first used. This scheme, which had no precedent, was begun in 1825 and completed after great physical and financia difficulties in 1843. It was for this work that he received a knighthood in 1841.

Sir Marc Brunel died in London on Dec. 12, 1849.

ISAMBARD KINGDOM BRUNEL (1806–1859), a civil and mechanical engineer of outstanding originality, the designer of the first transatlantic steamer, was born at Portsmouth on April 9, 1806 the only son of Sir Marc I. Brunel. Educated at the college of Caen and at the Lycée Henri Quatre in Paris, he was apprenticed for a short period to A. L. Bréguet, the great horologist, before returning to England to assist his father in 1822. When work on the Thames tunnel began under his father's direction in 1825, he was appointed resident engineer, a post he held until 1828 when a sudden inundation seriously injured him and brought the tunnel works to a standstill for seven years. Sent to Clifton to recuperate, he prepared designs for a suspension bridge over the Avon gorge, one of which was ultimately adopted in preference to design by Thomas Telford. Because of lack of funds, the bridg was not completed until after his death.

Brunel next carried out improvements in the Bristol docks This work introduced him to the promoters of the Great Wester railway and in 1833, when he was 27, he was appointed chief engineer to that company. It was on the main line from Paddingto to Bristol that he introduced the broad (seven-foot) gauge and s provoked the famous "battle of the gauges." A failure commercially, the high speeds obtained on the broad gauge were a great stimulus to railway progress. In south Devon he introduced the "atmospheric" system of traction, but the experiment was a failure.

Brunel was responsible for building over 1,000 mi. of railway in the west country, the midlands, south Wales and Ireland. His first notable railway works were the Box tunnel and the Maidenhead bridge, and his last the Chepstow and Saltash bridges. The Maidenhead bridge had the flattest brick arch in the world, while in sinking the pier foundations for the last-named bridges he was the first engineer to use a compressed-air caisson.

Brunel also made an outstanding contribution to marine engineering with his three ships, "Great Western" (1837), "Great Britain" (1843) and "Great Eastern" (1858), each the largest in the world at date of launching. The first, a wooden paddle steamer, was the first successful transatlantic steamship; the second was the first large iron-hulled screw steamer; the third was propelled by both paddles and screw and had a double iron hull which was the prototype of the modern ocean liner. Of a size which was not exceeded for 40 years, the "Great Eastern" was not a success as a passenger ship, but achieved fame by laying the first successful transatlantic cable.

Unable to delegate, Brunel wore himself out with worry and overwork. He died at his home in Westminster on Sept. 15, 1859. He was remarkable for his versatility, and his works unconnected with railways or steamships included the design of a complete prefabricated hospital building which was shipped in parts to the Crimea in 1855.

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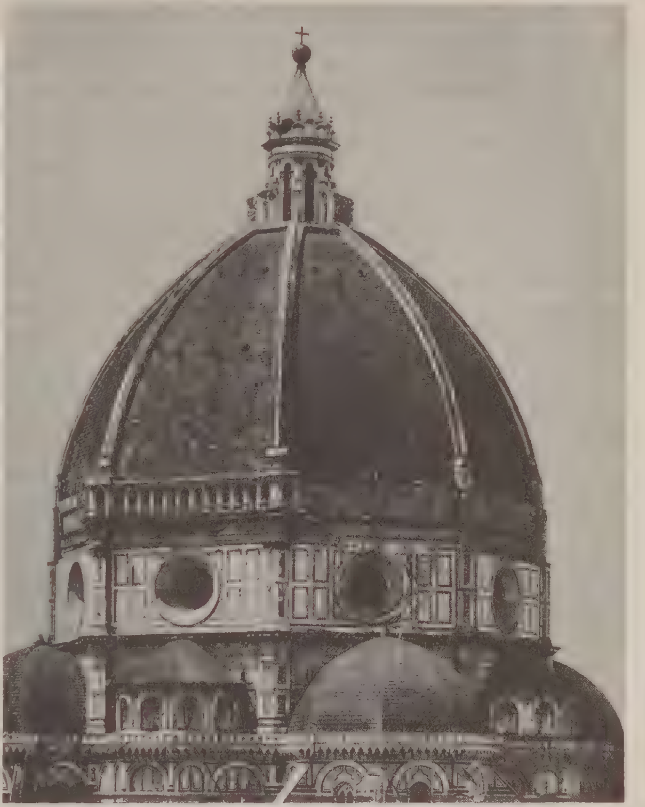
BRUNELLESCHI, FILIPPO (Filippo di Ser Brunellesco) (1377–1446), Italian architect and inventor, was one of the great personalities of the Early Renaissance. He was born in Florence and executed his major works there. His training as goldsmith prepared him for his career as a designer and builder. Many-faceted, he wrote poetry, competed (unsuccessfully) with Lorenzo Ghiberti for the commission to execute the second pair of bronze doors of the Baptistery of S. Giovanni in 1401, and painted panels experimenting with constructed perspective. Brunelleschi's optical and mathematical discoveries in this field are reflected in Leon Battista Alberti's *Della pittura,* the 1436 (Italian) edition being dedicated to him.

Brunelleschi combined the broad interests of a humanist with the solid traditions of the medieval builders, supervising every detail of construction and sculptural decoration, sometimes acting also as building contractor. As engineer-architect his dominant achievement is the final design and execution (in collaboration with Ghiberti) of the great cupola of Sta. Maria del Fiore, the Florentine cathedral, probably the largest groin vault ever built.

Brunelleschi adopted the Florentine late medieval tradition of simple, clearly articulated and evenly lit spaces and transformed it with his personal language of *all'antica* details, executed in gray-green sandstone, giving geometrically proportioned form to light-coloured stucco wall and vault surfaces. He reintroduced antique features such as large monolithic columns as well as pendentive vaults and melon domes of late antique-Byzantine derivation. He may have discovered both these forms and the ancient Mediterranean technique of vaulting without centring (*senza armadura*) with interior masonry chains and herringbone brick masonry (for greater cohesion) in the Byzantine-influenced Veneto and Ravenna rather than in Rome, where great vaults had been built in concrete (*e.g.,* the Pantheon).

His major works are few but significant, each one varying and developing his basic classical vision of a flawless ideal building: the Ospedale degli Innocenti (Foundling Hospital; begun 1419), followed by the Barbadori Chapel in Sta. Felicita (*c.* 1420); the churches of S. Lorenzo (begun 1421) and Santo Spirito (begun *c.* 1436), and the Pazzi Chapel in the cloister of Sta. Croce (1430–42). The upper story of the main wing of the Palazzo di Parte Guelfa, containing a great hall (probably begun *c.* 1440), remained unfinished as did the octagonal cloister Church of Sta. Maria degli Angeli (begun *c.* 1434). The Pitti Palace (built after 1458) and the Badia in Fiesole (built after 1456, probably according to a concept of Alberti), often attributed to him (following Giorgio Vasari), are not by Brunelleschi. Brunelleschi died in Florence on April 16, 1446, and was buried in the cathedral. *See* Renaissance Art and Architecture.



ALINARI

CUPOLA OF STA. MARIA DEL FIORE, THE CATHEDRAL OF FLORENCE, DESIGNED BY BRUNELLESCHI

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BRUNET, JACQUES CHARLES (1780–1867), author of the standard French bibliographical work of his time. He was born in Paris on Nov. 2, 1780, the son of a bookseller. In 1802 he printed a supplement to the *Dictionnaire bibliographique de livres rares* (1790) of R. Duclos. In 1810 there appeared the first edition of his *Manuel du libraire et de l'amateur de livres,* a great bibliographical dictionary, which rapidly became the standard work. Among his other works are *Nouvelles recherches bibliographiques* (1834), *Recherches . . . sur les éditions originales de Rabelais* (1852), and an edition of the 16th-century French poems of G. G. Alione (1836). He died in Paris on Nov. 14, 1867.

BRUNETIÈRE, FERDINAND (1849–1906), French critic, literary historian and controversialist, was born in Toulon, July 19, 1849, and educated in Lorient, in Marseilles and at the *lycée* Louis-le-Grand in Paris. He volunteered for military service in 1870 and was profoundly affected by his experiences during the siege of Paris. Afterward he started contributing articles on Darwin, Huxley and Spencer to the *Revue Bleue* and on classical and contemporary French (and occasionally foreign) literature to the *Revue des deux mondes.* Here he was undoubtedly unjust to Zola and Baudelaire (although no more so than most contemporary reviewers) but he showed considerable discernment in his studies of Pascal, Bossuet and George Eliot. His critical approach was more flexible than is commonly supposed and he examined various possible answers (including those of evolutionary science and comparative religion) to the moral issues of the day. In 1886 he was appointed (with no academic qualification other than the *baccalauréat*) to a chair at the École Normale. In 1889 he outlined his celebrated theory of the evolution of literary genres. His many adversaries made much of this theory in their attempts to invalidate his criticism but he himself explicitly abandoned it several years later and excessive attention to it has obscured the value of his other innovations (*e.g.*, the impetus he gave to the development of comparative literature). In 1894, after he had been elected to the Academy and had become an influential editor of the *Revue des deux mondes*, an audience with Pope Leo XIII decisively affected his outlook. Thereafter, although he never became an orthodox apologist or even, except *in extremis*, a true convert, he made many public pronouncements in favour of Catholicism. He died in Paris, Dec. 9, 1906.

BIBLIOGRAPHY.—Brunetière's published works include *Le Roman naturaliste* (1883); *Les Époques du théâtre français* (1892); *L'Évolution de la poésie lyrique en France*, 2 vol. (1894); nine series of *Études critiques* (1880–1925); *Manuel de l'histoire de la littérature française* (1898); a monograph on *Balzac* (1906); and the *Discours de Combat*, 3 vol. (1900–07). A voluminous correspondence is deposited in the Bibliothèque Nationale. Among modern studies *see* V. Giraud, *Brunetière* (1932); J. van der Lugt, *L'Action Religieuse de Ferdinand Brunetière* (1936); J. G. Clark, *La Pensée de Ferdinand Brunetière* (1954). (J. G. CK.)

BRUNHILD, a female figure from the heroic literature of the ancient Teutons, known from Old Norse sources (the *Edda* poems and the *Volsungasaga*) and from the *Nibelungenlied* (*q.v.*) in German. In the former she plays the leading role in those poems in which she appears, whereas in the *Nibelungenlied*, because of a shift of emphasis, her prominence is greatly reduced. Common to both, and no doubt original, is the conception of her as the central figure of a story in which she vows to marry only a man of the most outstanding qualities. One man, Siegfried (*q.v.*), is able to fulfill her conditions, but he woos and wins her, not for himself but for another. When Brunhild discovers this treachery she exacts vengeance and this involves the death of Siegfried. In some of the Norse sources she has supernatural qualities and is described as a valkyrie; it is still a matter of dispute whether these attributes are an accretion or whether their absence from the German version is due to an omission. Many critics who doubt their originality seek the source of the poetic figure in the history of the Merovingian kings of the Franks, in which Queen Brunichildis plays an important part; the name is also found as an element in place and field names in the region of the Rhine and in northeastern France and Belgium, but this could have resulted from the popularity of the literary figure. *See* also GERMANIC MYTHOLOGY AND HEROIC LEGENDS. (K. C. K.)

BRUNHILDA (BRUNECHILDIS; Fr. BRUNEHAUT) (d. 613), queen of the Frankish kingdom of Austrasia, was the daughter of the Visigothic king Athanagild. In 567 she married Sigebert (*q.v.*), king of Austrasia, changing her religion from Arianism to Catholicism. In the same year her sister Galswintha married Sigebert's half brother Chilperic I, king of the western part of the Frankish territory, but in 567 or 568, at the instigation of his concubine Fredegund, Chilperic had Galswintha murdered. Prompted by Brunhilda, Sigebert then exacted Galswintha's marriage settlement (Bordeaux, Limoges, Quercy, Béarn and Bigorre) as retribution from Chilperic. When Chilperic tried to recover this territory war broke out between him and Sigebert (573). At first it ran in Sigebert's favour, but in 575 he was assassinated and Brunhilda was imprisoned at Rouen. There, however, Merovech, one of Chilperic's sons, went through a form of marriage with her (576). Chilperic soon had this union dissolved, but Brunhilda was allowed to go to Metz in Austrasia, where her young son Childebert II had been proclaimed king. There she was to assert herself against the Austrasian magnates for the next 30 years. In 584 she gave some encouragement to the pretender Gundobald against Guntram king of Burgundy. Guntram to conciliate her made Childebert his heir.

After Childebert's death (595 or 596), Brunhilda failed to set herself up as guardian over Childebert's elder son Theudibert (Thibert) of Austrasia and so stirred up against him his brother Theuderic (Thierry), who had succeeded to Burgundy. Theudibert was finally overthrown in 612, but Theuderic died soon afterward (613), whereupon Brunhilda tried to make the latter's eldest son, the 12-year-old Sigebert, king of Austrasia. The Austrasian magnates, reluctant to endure her tyrannous regency, appealed to Clotaire II of Neustria against her. Brunhilda tried in vain to enlist the help of the tribes east of the Rhine, then fled to Burgundy. Garnier, the mayor of the palace, was however in communication with Clotaire, and the queen's army refused to fight when it met Clotaire's on the Aisne river. Handed over to Clotaire at Renève (northeast of Dijon), she was tortured for three days, bound on to a camel and exposed to the mockery of the army and finally dragged to death at a horse's tail (autumn 613).

Brunhilda's ashes were interred in a mausoleum erected near the abbey of St. Martin at Autun, which she had founded; and there her memory was highly venerated. Gregory of Tours applauds her for her personal morality and for her political wisdom, but Fredegarius presents her as a new Jezebel. Modern historians likewise have conflicting opinions about her. The Franks over whom she sought to rule resented her Gothic origin, and the tragic course of her life has made her a figure of legend.

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BRUNI, LEONARDO (1370–1444), also called Leonardo Aretino, Italian scholar and historian whose major work, *Historiarum Florentini Populi libri XII*, in Latin, is the first history of Florence based on an accurate critical examination of the sources. Born at Arezzo in 1370, he was secretary to the papal chancery from 1405, and from 1427 to his death (March 9, 1444) was chancellor to the republic of Florence.

His Latin translations from the Greek classics (Demosthenes, Xenophon, Plato, Aristotle among others) greatly advanced the knowledge of Greek literature, and his lives of Dante and Petrarch are important documents. His Latin has elegance, and his republican outlook was well suited to the style of Livy and Cicero, which he tried to imitate. (F. DI.)

BRÜNING, HEINRICH (1885–1970), German statesman, chancellor from March 1930 to May 1932, was born at Münster in Westphalia on Nov. 26, 1885. As a student of philosophy, history and politics, he visited France and England. Volunteering for military service in 1915, he rose, in the course of World War I, to the command of a machine gun company. After the war, he decided to make politics his career. He felt himself in sympathy with the younger generation and also believed that solidarity between ex-servicemen would form the basis for solving many political questions. A quiet, hypercritical man with ascetic features, an open-minded son of the Roman Catholic Church one who saw the faults of society yet remained basically conservative, Brüning received his political training as the protégé of Adam Stegerwald and as the business manager of the German Economic federation (Deutscher Gewerkschaftsbund). From 1924 as a member of the Centre party, he represented Breslau in the *Reichstag*, winning recognition as an expert on finance and taxation. In the spring of 1929 he became the leader of the Centre party in the parliament, an important post which brought him leadership of the party as a whole.

In March 1930, although he had done his utmost to save the Hermann Müller coalition, Brüning was called to form a government himself, to face the spreading world economic crisis. His immediate aim was to put the German finances in order as a measure toward the fulfillment of the Young plan. In July 1930, when an essential feature of his fiscal program was rejected by the *Reichstag*, he found himself obliged to resort to legislation by presidential decree, according to the emergency clause in the constitution. After the elections of Sept. 1930, the Nazis (who had enormously increased their share of the vote and completely upse the older balance of parties in the *Reichstag*) exerted increasing pressure against the government, and Brüning adopted a "national" foreign policy in an attempt to win their co-operation. The sincere pursuit of this aim brought him closer and closer to President von Hindenburg and the army leadership.

In view of the worsening economic situation it soon became clear that without foreign understanding and support Brüning would not be able to withstand his opponents. His discussions with the British and French prime ministers Ramsay Macdonald and Pierre Laval, together with the Hoover moratorium, did in fact help to overcome the worst effects of the July crisis of 1931. In April 1932, however, Brüning's attempt to gain Allied recognition of Germany's right to equal armaments failed despite his reputation as a diplomat. Finally, when he wanted to widen his cabinet to include rightist elements with a view to settling the reparations question, intrigue and provocation forced him to resign (May 30, 1932). (*See* GERMANY: *History*.)

Brüning played no further part in German politics. Forced to emigrate in 1934, he went to the U.S. and received a professorship at Harvard. Returning to Germany after World War II, he was for a time professor of political science at Cologne. He died at Norwich, Vt., on March 30, 1970.

See K. D. Bracher, *Die Auflösung der Weimarer Republik*, 3rd ed. (1960). (T. V.)

BRÜNN: *see* BRNO.

BRUNNER, (HEINRICH) EMIL (1889–1966), Swiss theologian in the Reformed tradition who helped to change the course of Protestant theology in the 20th century. He was one of the leaders of the movement, at the close of World War I, toward a reaffirmation of the central themes of the Protestant Reformation against the liberal theologies. Brunner was associated with Karl Barth (*q.v.*) in the early days of this movement, sometimes called dialectical theology, or crisis theology, or Neo-orthodoxy (*q.v.*), but Brunner developed his system in divergence from Barth. His theology presented itself, as did Barth's, as an alternative to literalistic orthodoxy and idealistic liberalism. While preserving the uniqueness of the Christian faith it sought a continuing dialogue between theology and humanistic culture. Brunner's theology was influential in Europe and in the United States. His works are widely read in Asian theological schools.

Brunner was born in Winterthur, Dec. 23, 1889. He was educated in Switzerland and Germany and went to Union Theological seminary, New York city, as the first exchange student after World War I. He received the doctor of divinity degree from the University of Zürich in 1913, was ordained to the ministry of the Swiss Reformed Church and from 1916 to 1924 was a pastor in Switzerland. In 1924 he became professor of systematic and practical theology in the University of Zürich, where he continued to teach except for lecture tours in the United States and Asia.

The close link between Brunner's theology and that of Barth was broken early in their theological careers when in 1934 Brunner wrote a monograph entitled *Natur und Gnade: Zum Gespräch mit Karl Barth* ("Nature and Grace; a Conversation With Karl Barth"). Brunner held that while God's saving revelation is known only in Jesus Christ, there is a revelation in the creation; this revelation is reflected in the "image of God," which man bears and which is never wholly lost. This provoked a vigorous reply from Barth, who attacked Brunner's view that the image of God remains formally but not materially in man after sin has entered. Brunner replied, insisting upon the sense of responsibility as the "point of contact" between sinful human nature and the divine.

Among Brunner's earlier works are *The Mediator* (1927), a study of Christology, and *The Divine Imperative* (1932) on Christian ethics. His thought took a decisive new turn with the publication of *The Divine-Human Encounter* in 1937 and *Man in Revolt* in 1938. In these works he adopted a position that had been given significant expression by Martin Buber in his *I and Thou*—that there is a fundamental difference between knowledge of impersonal objects and knowledge of other persons (*see* BUBER, MARTIN). Brunner took this doctrine as a key to the biblical conception of revelation and developed his position in a series of books, among which are *Revelation and Reason* (1941), a three-volume *Dogmatics* (1946–60), *Justice and the Social Order* (1945) and the Gifford lectures, *Christianity and Civilization* (1948–49).

Brunner's writing is characterized by extensive learning, concern for the personal dimension of religious faith and the search for a distinct and autonomous theological standpoint that will remain relevant to cultural and philosophical issues.

All of Brunner's major works except his study of F. D. E. Schleiermacher (*Die Mystik und das Wort*, 1924) have been translated into English, and most are mentioned above. The discussion with Karl Barth was published under the title *Natural Theology*, introduction by John Baillie (1946). A critical review of this discussion is given by Baillie in *Our Knowledge of God* (1939). Brunner died at Zürich on April 6, 1966.

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BRUNNER, HEINRICH (1840–1915), German legal historian whose work laid the foundations of the systematic study of early Germanic law and institutions, was born in Wels, Upper Austria, June 21, 1840. He studied at Vienna and became, successively, professor at Lemberg (Lviv), Prague, Strasbourg and Berlin, where he remained from 1874 until his death. His study of the laws and institutions of the Franks and early Germanic peoples, begun in 1872, was of great value in illuminating and classifying the groundwork of German law and formed the basis for his position as an authority on the administrative law of his time. His *Deutsche Rechtsgeschichte* (1887–92) and *Grundzüge der deutschen Rechtsgeschichte* (1901) became classics for their blend of the enthusiasm of the 19th-century historian with a lawyer's precision. He died at Bad Kissingen, Aug. 11, 1915.

BRÜNNOW, FRANZ FRIEDRICH ERNST (1821–1891), German astronomer, is best known for his *Lehrbuch der sphärischen Astronomie* (1851), which was translated into several languages and, in several editions, extensively used well into the 20th century. He was born in Berlin on Nov. 18, 1821, and after graduating as Ph.D. at Berlin in 1843 he spent four years with J. F. Encke at the Berlin observatory, working in the field of gravitational astronomy. He was appointed director of the Bilk observatory, near Düsseldorf, in 1847, first assistant at the Berlin observatory in 1851 and the director of the new observatory of the University of Michigan, Ann Arbor, in 1854. His journal, *Astronomical Notes*, was started at Ann Arbor. In 1860 he went, as associate director, to the Dudley observatory, Albany, N.Y., but returned to Michigan in 1861 and to Berlin in 1863. In 1865 he was appointed astronomer royal for Ireland and Andrews professor of astronomy in the University of Dublin. For his memoir on De Vico's comet (1849) he was awarded the gold medal of the Amsterdam academy. Brünnow retired to Basel, Switz., in 1874 and died at Heidelberg on Aug. 20, 1891. (O. J. E.)

BRUNO, SAINT (925–965), archbishop of Cologne, youngest son of King Henry I the Fowler, of Germany, and St. Matilda, and brother of the emperor Otto I the Great, was educated at the cathedral school of Utrecht and the court school of Otto I, then a fresh centre of studious activity. Proficient in Latin and Greek and an influential teacher, he remained always a sincere patron of learning. As chancellor from 940, he prepared his brother's official papers, and after ordination to the priesthood accompanied Otto to Italy in 951. Already abbot of Lorsch and Corvei, where he restored monastic observance, he was elected to the see of Cologne in 953 and soon after named duke of Lorraine. As bishop, Bruno was a zealous and exemplary pastor and founder of many institutions, the monastery of St. Pantaleon among them, and his episcopate marked a new epoch in the city's growth. In the troubled duchy of Lorraine, by his prudent and statesmanlike policies, he restored peace and devised a new administrative division, maintaining at the same time cordial relations with France. During Otto's absence in Italy for his imperial coronation (962), Bruno shared the responsibilities of government and care of the emperor's son, Otto II. On a mission to France he died at Reims (Oct. 11, 965) and in accord with his wish was buried at St. Pantaleon. His feast day is Oct. 11.

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BRUNO, SAINT, of Cologne (*c.* 1030–1101), founder of the Carthusians, was born in Cologne, where he was ordained. In 1057 he was called to Reims to become head of the cathedral school and overseer of the schools of the diocese. Among his pupils was Eudes de Châtillon, later Pope Urban II. Having protested against the misdoings of a new archbishop, he was deprived of all his offices and had to flee for safety (1076). On the deposition of the archbishop in 1080, Bruno was presented by the ecclesiastical authorities to the pope for the see, but he refused as he was already determined to forsake the world. With six companions he retired to the mountains near Grenoble, and there founded the Carthusian order (*see* Chartreuse, La Grande) in 1084. After six years Urban II called him to Rome and offered him the archbishopric of Reggio, which he refused, withdrawing to a desert in Calabria, where he established two other monasteries. He died in 1101. He did not himself write a rule for the order, but the customs he established as modifying the Benedictine Rule became the basis for the new foundations. Bruno was never formally canonized, but October 6 has been observed as his feast day since 1623. *See* also Carthusians.

For critical bibliography *see* H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints,* vol. iv, p. 40 ff. (1956). (Fs. P. C.)

BRUNO, SAINT, of Querfurt (*c.* 974–1009), German missionary bishop and martyr, belonged to the family of the counts of Querfurt in Saxony. At the age of 20 he was attached to the clerical household of the emperor Otto III. In 997 he accompanied the emperor to Rome, and when the news reached there of the martyrdom of Adalbert, Bishop of Prague (997), Bruno entered the monastery of St. Alexius, taking the name of Bonifacius. In 1004, after the pope appointed him archbishop of the eastern heathen, Bruno went to Germany to seek aid of the emperor Henry II, who opposed his enterprise. Bruno was so successful in converting the pagan Pechenegs, who inhabited the country between the Don and the Danube, that they made peace with the grand prince Vladimir of Kiev and for a while were nominally Christians. In 1008, after a vain effort to have the war between Germans and Poles ended, he determined to proceed with his mission. On the borders of the Russian (Lithuanian) country, he and his 18 companions were all massacred by the heathens on March 14, 1009. His feast day is celebrated on June 19.

See H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints,* vol. ii, p. 585 (1956). (Fs. P. C.; X.)

BRUNO, GIORDANO (baptized Filippo) (1548–1600), Italian representative of late Renaissance thought, whose teaching and writings, encompassing philosophy, cosmology, theology, mathematics, and creative literature, constantly brought him into collision with orthodox opinion and led him to a heretic's death, was born at Nola, near Naples. In 1562 he went to Naples where he attended the courses of G. V. de Colle ("il Sarnese"), known for his Averroist tendencies, and studied logic under an Augustinian friar. To continue his studies, he entered the Neapolitan convent of San Domenico Maggiore in 1565. On becoming a Dominican friar, he assumed the name Giordano. In the convent he began to develop theological doubts and to profess the necessity of Christian liberty, which led to trouble with the monastic authorities. After taking holy orders he was suspected of heresy and in 1576 fled to Rome. There he was involved in a murder case and had to flee again: first to Liguria (April 1576), then to Venice. After further wanderings in northern Italy, in 1578 he went to Geneva. There he abandoned the Dominican habit and earned his living by proofreading. In 1579 he adhered to Calvinism, but after publishing a broadsheet against the Calvinist professor Antoine de la Faye he was imprisoned. On his retracting, he was allowed to leave Geneva and went to Lyons and thence to Toulouse, where he was granted the degree of master of arts and obtained a lectureship in philosophy. In the summer of 1581 he moved to Paris where he enjoyed the protection of Henry III, who appointed him one of his *lecteurs.* In 1582 he published in Paris the comedy *Il Candelaio* and a group of mnemotechnic works (*De umbris idearum, Cantus circaeus, De compendiosa architectura et complemento artis Lullii*), which show the influence of Ramon Llull and Nicolaus Cusanus.

In April 1583 he went to London, and in June disputed at Oxford against John Underhill and delivered lectures on the immortality of the soul and on the quintuple sphere which had a hostile reception. Thereupon he went back to London, where he stayed with the French ambassador, Michel de Castelnau, and became associated with Robert Dudley's circle. In London he published the *Ars reminiscendi* (1583) and, between 1584 and 1585, the following Italian works in dialogue form: *La cena de le ceneri,* in which, after a qualified acceptance of Copernicus' solar system, he postulates the infinity of the universe as composed of an infinity of worlds (maintaining that the celestial bodies are substantially similar to the Earth), and criticizes Oxonian pedantry and English society; *De la causa, principio et uno,* in which he tries to demonstrate the basic unity of all substances as well as of form and matter and the coincidence of contraries; *De l'infinito, universo et mondi,* in which he uses pre-Socratic teachings in an attack against Aristotle's physics and introduces for the first time the notion of minimum; *Spaccio de la bestia trionfante* (dedicated to Sir Philip Sidney) and *Cabala del cavallo Pegaseo,* which express his ideal for an ethical and social reform in accordance with his anti-ascetic and anti-Christian tendencies; and *De gli eroici furori* (also dedicated to Sidney), in which he seeks for a harmony between the human soul and nature.

Back in Paris in October 1585, he published the *Figuratio Aristotelici physici auditus* (1586) and critical accounts in Latin of Fabricio Mordente's geometrical studies. Because of an attack on Aristotle at the Collège de Cambrai, he had to leave France in June 1586. He went to Germany, first to Marburg, then to Wittenberg, where he was allowed to teach and where he published a number of Latin works inspired by Llull. When the Calvinist party prevailed in Wittenberg, he had to flee once more (March 1588) and went to Prague, and to Helmstedt, where he stayed until he was "excommunicated" by the local Lutheran church. Among the works composed in this period are three Latin poems: *De minimo,* in which Bruno holds that it is impossible to confine the infinite fluidity of nature within the limits of quantitative systems; *De immenso,* based on a theory of cosmic monism in which he attacks mathematical astronomy; and *De monade,* which shows the same anti-metaphysical approach. To publish these poems he went to Frankfurt (June 1590), where he stayed until August 1591. In the autumn he delivered at Padua his *Praelectiones geometricae.* In May 1592 Mocenigo denounced him to the Inquisition. Arrested, he was transferred to Rome in 1593 and remained in prison for seven years. After a long trial for heresy, he was burned at the stake, in the Campo de' Fiori, on Feb. 17, 1600.

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BRUNSWICK, HEINRICH JULIUS, Duke of (1564–1613), a founder of modern German drama and a representative of early baroque culture. Born at Schloss Hessen, Wolfenbüttel, Oct. 15, 1564, he became rector of Helmstedt university (1576) and, though a Protestant, bishop of the Catholic see of Halberstadt (1578). Dorothea of Saxony, whom he married in 1585, died in 1587, and he then married Elizabeth of Denmark (1590). Heinrich Julius succeeded his father in 1589. By 1607 his earlier interest in his duchy had waned and he moved to Prague, becoming an adviser to the emperor Rudolf II. He died there, July 20, 1613.

Autocratic by conviction and a persecutor of Jews and witches, Heinrich Julius was a gifted scholar, theologian and jurist, a keen student of science and a generous patron of the arts. Of his own plays 11 have survived (10 were printed in 1593–94). Nearly all were written for English actors (notably Thomas Sackville) who visited Wolfenbüttel from 1592 onward. Typical pieces (*Von einem Buler und einer Bulerin, Von einer Ehebrecherin, Von einem Wirthe*) treat middle-class topics realistically and often humorously; some features, *e.g.*, the fool, are much influenced by English tradition. *Von einem ungeratenen Sohn*, a crude, pretentious horror-play on a desperate villain's fate, foreshadows certain features of baroque tragedy, while *Vincentius Ladislaus*, portraying a braggart's downfall, is a successful early baroque comedy.

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BRUNSWICK (Braunschweig), a German duchy from medieval times to 1918, then one of the German *Länder* until 1946, when its territory was merged with other states to form the *Land* of Lower Saxony in the Federal Republic of Germany.

Originating in the dominions of the house of Welf, the duchy and *Land* comprised three larger and six smaller parts. The principal or northern part, containing the towns of Brunswick, Wolfenbüttel and Helmstedt (*qq.v.*), with an extension northward from Helmstedt to Parsau, is mostly arable land and has little forest. South of this the two other major parts, separated from one another by the Harz mountains, were: (1) the western, namely Holzminden (until 1941), Gandersheim and (from 1941) Goslar; and (2) the eastern, namely Blankenburg (the greater part of Blankenburg, however, went to the Soviet zone of Germany after World War II). Of the six smaller parts, Calvörde, enclaved with the former Prussian Saxony, also went to the Soviet zone in 1945. Brunswick also included Harzburg in the Harz mountains east of Goslar; Bodenburg, enclaved in Hanover north of Gandersheim; Oelsburg and Ostharingen, both enclaved in Hanover to the west of Brunswick; and Thedinghausen, far to the northwest, near Bremen.

HISTORY

Brunswick-Lüneburg to 1635.—When in 1180 Henry the Lion (*q.v.*), duke of Saxony and Bavaria and ancestor of all the later branches of the house of Welf, was defeated in his conflict with the emperor Frederick I Barbarossa, his two duchies were confiscated. Nevertheless, in 1181 he received back his allodial lands, which were chiefly in eastern Lower Saxony, between the Elbe and the Weser rivers, as well as in the Harz district. From these territories the emperor Frederick II constituted the duchy of Brunswick-Lüneburg (Aug. 1235) for Otto the Child, Henry's grandson. The descendants of Otto have since borne the title of duke of Brunswick and Lüneburg. For a long time the two cities which gave the duchy its name remained in the common possession of the house of Welf (Lüneburg until 1512, Brunswick until 1671), but from 1267 the other territories underwent a series of partitions among the branches of the family, which at times were as many as six in number. As a result of the partition of 1267 the large and compact territory of Lüneburg was established in the north, and this underwent no further divisions until the 16th century. The southern Welf lands, however, were ruled by the Brunswick line, which in the 13th century split up into the branches of Wolfenbüttel, Grubenhagen and Göttingen.

Constitutionally, however, the unity of the house was not affected by these divisions. There was only one duchy of Brunswick-Lüneburg as the general fief of the house of Welf. The territories resulting from the partitions should more properly be designated as principalities (*Fürstentümer*) than as duchies, and all the rulers used the same ducal title and the same armorial bearings.

The possessions of the Welfs, considerably increased by inheritance during the 14th and 15th centuries, were, at the beginning of the 16th, divided between four lines: (1) Lüneburg, whose territory had approximately the same extent as the modern administrative district; (2) Grubenhagen, holding two districts situated around Einbeck and Osterode; (3) Calenberg-Göttingen; and (4) Wolfenbüttel. All the Welf dukes eventually accepted Lutheranism, the last line to do so being that of Wolfenbüttel, which Duke Henry II (*q.v.*) had maintained as the last outpost of Catholicism in Lower Saxony until his death in 1568. By the end of the 16th century the Welf dynasty had acquired the countships of Hoya, Diepholz, Blankenburg and Hohnstein and had also secured the appointment of members of the family as administrators of the neighbouring Lutheran bishoprics of Halberstadt, Minden, Verden and Osnabrück. The Calenberg line having died out in 1584 and the Grubenhagen in 1596, both these principalities were successively united with Wolfenbüttel, which was enjoying a period of great prosperity under its princes Julius (1568–89) and Henry Julius (1589–1613). On the death of Duke Frederick Ulrich of Wolfenbüttel in 1634 the entire inheritance fell to the surviving Lüneburg line, but in 1635 the dukes of Lüneburg again divided the territory into three parts: Lüneburg, with its princes residing at Celle (Zell); Calenberg-Göttingen, with its princes from 1636 at Hanover; and Wolfenbüttel, which went to the collateral line of Dannenberg. The new Calenberg-Göttingen line, soon known as the house of Hanover, became an electorate of the Holy Roman empire in 1692 and inherited the principality of Lüneburg in 1705 and the kingdom of Great Britain in 1714. (*See* Hanover).

The Duchy of Brunswick (1635–1918).—The Wolfenbüttel line, whose principality from the 18th century onward was generally designated as the duchy of Brunswick, did not rise to such power as the Hanoverian. Its possessions, moreover, were small and extremely scattered. The land, however, was prosperous being not only fertile but also sharing in the Harz silver mines, partly through a form of common ownership with Hanover, and it enjoyed good government under conscientious rulers. Augustus, duke from 1635 to 1666, founded the famous library at Wolfenbüttel (the Bibliotheca Augusta). His son Anton Ulrich, coregent with his elder brother Rudolf Augustus from 1685 and sole ruler from 1704 to 1714, likewise had a reputation as a patron of the arts, and as a writer, but exhausted himself in a fruitless struggle with the Hanoverian electorate and in short-lived alliances with France.

The elder Dannenberg male line died out in 1735 with Anton Ulrich's younger son Louis Rudolf, whose lands were then inherited by the house of Brunswick-Bevern. This house was bound to Prussia both by treaty and by family ties and provided the Prussian army with many senior officers. Among these were Duke Ferdinand (*q.v.*), famed as a commander during the Seven Years' War, and his nephew Charles William Ferdinand (*q.v.*). The latter, duke of Brunswick from 1780, commanded the Prussians at Valmy (1792) and was mortally wounded at Auerstädt (1806).

From 1807 to 1813 Brunswick belonged to Jerome Bonaparte's kingdom of Westphalia. Duke Frederick William's attempt to recover the duchy in 1809 was unsuccessful but his bold retreat from Bohemia to the North sea enabled him to bring his forces safely to England. Killed at the battle of Quatrebras (June 1815), Frederick William left the liberated and restored duchy to his son, Charles II (d. 1873), who after an unfortunate reign was driven from his land by a popular rising in 1830. Under his younger brother William, duke from 1831, Brunswick's industries rapidly developed. With William's death, in 1884, the Brunswick line of the Welfs became extinct.

As Prussia had annexed Hanover in 1866 (the Harz mining area was partitioned between Brunswick and Prussia in 1874), the duchy of Brunswick was "the last sod of Welf earth" (H. von Treitschke). It should accordingly have passed to the Welfs of the royal Hanover line, but Bismarck was able to prevent the duke of Cumberland, Ernest Augustus (*q.v.*, 1845–1923), from taking possession of it, for, like his father, the last king of Hanover, he was unwilling to renounce his rights to the kingdom. From 1885, therefore, Brunswick was ruled, in accordance with a regency law of 1879, by Prince Albert of Prussia (d. 1906) and by Duke John Albert of Mecklenburg from 1907 to 1913. In 1913, however, the duke of Cumberland's son Ernest Augustus (1887–1953) married Victoria Louise, daughter of the German emperor William II. Ernest Augustus was then permitted to reign over Brunswick without having to renounce Hanover. With the outbreak of revolution in Germany at the end of World War I he had to abdicate (Nov. 8, 1918).

The Land of Brunswick, 1918–1946.—Under the Weimar constitution of 1919 Brunswick was recognized as a *Land* or free state of the German *Reich*. Heavily industrialized and a stronghold of socialism, it experienced extreme political vacillations: it had a radical leftist government from 1919 to 1922, then an extreme conservative one from 1930, with Nazi participation in the government thereafter. After Hitler's seizure of power Brunswick, like the other German *Länder*, was divested of its independence as a state by the law of Jan. 30, 1934. Under the jurisdiction of the *Reichsstatthalter* for the *Gau* (district) of South Hanover-Brunswick, it nevertheless kept an administration of its own. In 1941 its territory was considerably reduced when the western *Kreis* or subdistrict of Holzminden, on the Weser, was accorded to Hanover, though it received in exchange the *Kreis* of Goslar and the new *Stadtkreis* (municipal district) of Salzgitter with the important works of Lebenstedt.

In 1945, the major part of Brunswick, then under British military government, was reconstituted as a state. In Nov. 1946, with the approval of the German authorities for the zone, the military government incorporated Brunswick into the *Land* of Lower Saxony (*q.v.*).

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BRUNSWICK (Ger. BRAUNSCHWEIG), a city of Germany which before partition of the nation following World War II was capital of Braunschweig *Land* (state) and until 1918 of the former duchy of that name. After the merger of Brunswick, Oldenburg and Schaumburg-Lippe *Länder* with Hanover in 1945, Brunswick city was incorporated into the new *Land* of Lower Saxony in the Federal Republic of Germany. The city is situated in fertile country on the Oker 53 mi. (85 km.) N.W. of Magdeburg. Pop. (1961) 246,200.

After very heavy damage during World War II, the city was rebuilt. The main streets, Bohlweg, Steinweg, Neue Strasse and Damm, were made broader; the old commercial streets were reconstructed; and modern blocks of flats were built in the city centre and the suburbs; but there remained two "isles of tradition," the Castle square and the Old town market with its ancient houses and churches.

The cathedral of St. Blasius (1173–94) in the Castle square (Burgplatz) is in Romanesque style. The chancel is decorated with 12th-century frescoes by Johannes Gallicus and contains the tombs of the founder, Henry the Lion, and his consort, and also that of the emperor Otto IV. In the vaulting beneath rest the remains of the Guelphs of the Brunswick line from 1681. An ancient building on the Castle square is the guildhall (the restored Huneborstelsche Haus) with its beautiful 16th-century oak carvings. The Burg Dankwarderode with the famous Treasure of the Guelphs is a fine modern structure, erected after 1865. On the Castle square is the Lion monument (Löwendenkmal), emblem of Brunswick, erected by Henry the Lion in 1166.

The Old town hall in the market is a gem of Gothic architecture (14th and 15th centuries) with arcades, damaged by bombs during World War II and carefully restored. St. Martin's church (1180–90) was originally a Romanesque basilica, enlarged in the 13th century in Gothic and also remarkable for the splendid late Gothic Annenkapelle (1434) and three magnificent portals. Near this church is the 13th-century cloth merchant's hall (Gewandhaus) with a richly ornamented Renaissance façade. Parts of this ancient house are occupied by the chamber of commerce.

Other churches in Brunswick are St. Katharine's church, with a fine tower. It was begun by Henry the Lion in 1172 and finished in 1500. Of the 13th, 14th and 15th centuries are St. Andreas' church and St. Aegidien's church. St. Magni's church (13th and 15th centuries) was completely destroyed in World War II. On the same site a new church has been built. New buildings of note include three skyscrapers, one in Hamburger street, the second in Oker street and the third near the technical institute. To the left of the Wolfenbütteler street is Richmond palace, built in 1768–69 by Prince Charles William Ferdinand, eldest son of Charles I of Brunswick and Philippine Charlotte, sister of Frederick the Great of Prussia. This prince married Princess Augusta in London in 1764. She was sister of George III of England and daughter of Prince Frederick of Wales.

The town is surrounded by parks and boulevards. The largest are the Citizen's park (Bürgerpark) near the old railway station in the south of the town, Prince Albrecht's park, Buchhorst forest and Querums forest with an airport in the north.

Brunswick has many schools and technical colleges and is internationally famous for its scientific research. The Technical university founded as the Collegium Carolinum in 1745 had, in the early 1960s, more than 4,000 students. There is also a teacher-training college and institutes for physics and technology, agriculture and forestry, and aeronautical research. Works by Rembrandt, Rubens and other Dutch, French and Italian painters are to be found in the gallery of the Herzog-Anton-Ulrich museum and the municipal museum.

Brunswick is on the main line from Berlin to Hanover and the west. Other lines run to Vorsfelde, Oebisfelde, Bad Harzburg, Hildesheim and Elze. It has direct connection with the Mittelland canal, and with the Autobahn from Berlin to the Ruhr. The chief industry of Brunswick is metal. Machinery and factory equipment, trucks, buses, boats, bicycles, photographic apparatus, calculating machines, office machinery, tin plate and pianos are made. Publishing and food preserving are also carried on.

Legend says that Brunswick was founded about 861 by Bruno, son of Duke Ludolf of Saxony. Probably the town was founded much later. Fortified and improved by Henry the Lion, it became one of the most important cities of northern Germany. In the 13th century it ranked among the chief cities of the Hanseatic League. It later declined in prosperity in consequence of the division of territory, the jealousy of the neighbouring states, the Thirty Years' War and the French occupation at the beginning of the 19th century, under which it was assigned to the kingdom of Westphalia. During the Reformation the sympathies of the people were with the new doctrines, and the city was a member of the League of Schmalkalden. In 1830 it was the scene of a violent revolution, which led to the removal of the reigning Duke Charles II. In World War II Brunswick was captured by Allied forces in April 1945. (H. O. S.)

BRUNSWICK, a seaport city in Georgia, U.S., and the seat of Glynn county, is on the Atlantic coast 77 mi. S.E. of Savannah. It is a railroad terminus and one of the important sea food centres in the southeast. Ft. Frederica, on nearby St. Simons Island, was the southernmost British outpost in North America during the colonial era and the area was early caught up in the Spanish-British colonial rivalry.

The town was laid out in 1771 by the council of the royal province of Georgia and named after the seat of the reigning house of Hanover. It was settled the following year but was not incorporated until 1856. Brunswick's live oak and palm-lined streets and parks, arranged in a symmetric pattern and bearing 18th-century English names, give the community a graceful appearance. Glynn academy, chartered in 1778, is one of the oldest public schools in the state. A public junior college was opened in 1964.

Near Brunswick are three of the most important all-year resort islands on the Atlantic coast: St. Simons, Sea Island and Jekyll, the latter being state-owned. In the early 1970s the area could accommodate more than 3,000 visitors in its hotels, motor courts and numerous guest homes.

Other than livestock growing, little agriculture existed but lands were profitably devoted to forestry products, the processing of which was the leading industry. The freezing and packaging of sea foods ranked second.

Pop. (1970) 19,585. For comparative population figures *see* table in GEORGIA: *Population.* (Js. C. B.)

BRUNSWICK, a town (township) of Cumberland County, Me., U.S., 27 mi. NE of Portland, on the Androscoggin River. Its location in an attractive recreational area brings many visitors and summer residents. Among the inhabitants are many French Canadian immigrants and their descendants. The population of the township in 1970 was 16,195.

First known as Pejepscot, the town was settled in 1628, but Indian hostility retarded its early development. Significant growth commenced with Brunswick's incorporation as a township in 1717. Control of town affairs by town meetings open to all registered voters continued until 1969, when a council-town manager government was adopted. The falls of the Androscoggin River furnished power for the manufacture of paper, textiles, and other products, but the closing of the Verney mill in 1955 ended the textile era. Industries include the manufacture of shoes, children's clothes, artists' supplies, and paper. The Brunswick Naval Air Station, established during World War II, was reactivated in 1951. Brunswick is the home of Bowdoin College, a widely known liberal arts college for men, with an enrollment of over 900 students. Founded in 1794 by act of the Massachusetts General Court, the college was named for Gov. James Bowdoin (*q.v.*). Among its graduates have been many men of prominence in American letters and public life, including Henry Wadsworth Longfellow, Nathaniel Hawthorne, Franklin Pierce, Melville W. Fuller, Oliver Otis Howard, Thomas Brackett Reed, and Robert Edwin Peary. (WM. B. W.; X.)

BRUNSWICK BLACK, a form of quick-drying black varnish used for metal, particularly iron, surfaces of indoor equipment, stoves, fenders and the like. Because of its bitumen content the preservative properties are high and, in the better qualities, the finish is attractive and reasonably durable.

The process of manufacture is simple, consisting essentially of dissolving premelted bitumen or natural asphaltum in a solvent of suitable boiling point—white spirit or turpentine—the bitumen being thinned down until the desired consistency for application is achieved. If common rosin (colophony) is included the lustre of the black finish is improved, but the amount used must be carefully controlled or the quality of the residual film will suffer, either cracking on aging or softening with heat.

More satisfactory and tougher films result if boiled linseed oil is added with the bitumen. The proportions of the individual ingredients vary considerably, but the following formulas may be taken as representative: (1) dark rosin 50 lb., asphalt 112 lb., white spirit 22 gal.; (2) gilsonite 112 lb., boiled linseed oil 2 gal., white spirit 25 gal. More elaborate formulation may be needed for finishes intended for exterior protection, but the basic ingredient is retained and blends of blown and unblown bitumen have been successfully employed. (E. G. Es.)

BRUNTON, SIR THOMAS LAUDER, 1ST BART. (1844–1916), Scottish physician, a specialist in problems of circulation, was born at Hiltonshill, Roxburghshire, on March 14, 1844. He was educated at Edinburgh university, and after three years of medical work in continental cities was appointed in 1870 as lecturer in materia medica and pharmacology at Middlesex hospital, London.

In 1871 Brunton went in the same capacity to St. Bartholomew's hospital where, three years later, he became assistant physician and in 1895 physician, a post which he resigned in 1904. He was knighted in 1900 and in 1908 was created a baronet. He died Sept. 16, 1916.

Brunton's papers on his early work on the use of digitalis, nitrates, enzymes, etc., were included in *Collected Papers on Circulation and Respiration* (1906).

BRUSH, GEORGE DE FOREST (1855–1941), U.S. painter, whose penetrating representations of family groups were suggestive of the work of the Dutch, German and Flemish masters, was born at Shelbyville, Tenn., on Sept. 28, 1855. He was a pupil of J. L. Gérôme at Paris, and became a member of the National Academy of Design, New York, and of the American Academy of Arts and Letters. From 1883 onward he attracted much attention by his paintings of North American Indians, his "Moose Hunt," "Aztec King" and "Mourning Her Brave," achieving great popularity and showing the strong influence of Gérôme. These were followed by picture portraits, particularly of mother and child, carefully arranged as to line and mass, and worked out in great detail with consummate technical skill. Several of his paintings had for subject his own children and his wife; one of these is in the Boston Museum of Fine Arts. His "In a Garden" is in the Metropolitan Museum of Art, New York city; "Mothers and Children," in the Pennsylvania academy, Philadelphia; and "Mother and Child," in the Corcoran Gallery of Art, Washington, D.C. He received gold medals from the Pennsylvania Academy of Fine Arts, 1897, and Paris exposition, 1900. He died in Hanover, N.H., on April 24, 1941.

BRUSH, a tool composed of animal, vegetable or man-made fibres twisted, bound, cemented or punched into a back or handle, the material used and the design of the implement being dictated by its intended use, whether it be for cleaning, polishing or painting.

The history of the brush, at least in its function of applying pigment, is of a hoary antiquity, as evidenced by the magnificent cave paintings of Altamira in Spain and the Périgord in France. These monumental art works demonstrate that the Paleolithic European knew how to manage his brush and palette with consummate skill. Within historical times, through the successive periods of his history, from the tomb paintings of ancient Egypt and the inception of the characteristic writing of the Chinese to the present, man has applied animal hairs and vegetable fibres in contriving tools for the expression of his pictorial and literary art.

Bristle.—Of the many types of animal hair used for centuries in brush manufacture none is more important than the bristle of the wild or semiwild boar or hog. One species of the animal is found in Germany, Poland, the U.S.S.R. and China, while three other distinct species are native to India, Tibet and Japan respectively. All are important sources of supply, with China and the U.S.S.R. leading in both the quantity and quality of the bristle obtained.

The individual bristle has a broad, sturdy base and a tapered tip split into several fine filaments, commonly termed a "flagged" tip. Flexible and resilient, with an excellent paint holding capacity, bristle is particularly well suited to use as paintbrush stock.

The hair on the neck of the animal is considered to be of finer quality than that on its sides. Several methods of removing bristle from the hide have been developed. Soaking the skin in a calcium sulfide or sodium sulfide bath serves to loosen the bristle so that it is easily detached. Bristle held in a coating of resin applied immediately after the death of the animal can be torn out after the resin has hardened. The bristle is then freed by melting down the resin. Also used are mechanical methods that employ the principle of toothed rollers revolving in opposite directions at different speeds. The skin is introduced between the rollers from a moving belt and the upper and faster roller tears loose the bristle that remains on top of the skin, from which it is readily removed. The finer neck hairs are generally removed by hand. The dressing of bristle involves washing and disinfecting, followed by a sorting of the hairs according to length and colour. They are then straightened out, tied to a short wooden rod and further cleansed and sterilized by boiling or steaming. (*See* BRISTLE.)

Other Animal Hairs.—Many other types of animal hair are employed in brush manufacture. Horsehair is widely used. The mane hairs, softer than those of the tail, make excellent polishing brushes. Other animal hairs utilized in brushmaking are ox ear, obtained from the tufts of silken hair found in the ears of cattle, goat, weasel, kolinsky (Asiatic weasel), squirrel (camel's-hair), civet (spotted American skunk), fitch (European weasel, or polecat) and badger. Badger hair has had a wide application as material for shaving brushes.

Man-Made Fibres.—Periods of scarcity and costliness of natural bristle prompted intensive research in the field of synthetics. A previously acquired knowledge of nature's method of building protein-type animal fibre (keratin) and vegetable fibre (cellulose) by linking up simple molecules, such as amino acids, in a molecular chain construction pointed the way to the chemical combining of molecules in similar chains. In this way, after much experimentation, nylon filaments were successfully produced.

Manufacturing methods were devised for making both tapered and untapered nylon brush fibres. The former compare favourably with hog bristle in the manufacture of paintbrushes and the latter are profitably utilized in making household and toilet brushes, particularly toothbrushes.

The chemical compound is extruded in a broad band and then reduced to flake form and melted in a spinning container. The molten substance is forced through the fine holes of a spinning jet and hardens into filaments upon contact with the atmosphere. These filaments pass under rollers in a cold water bath and emerge to be taken up through gripper-type rollers and wound on a reel. To align the molecular chains in proper formation, the filaments are drawn or stretched by running them through two sets of four rollers each, the second set revolving at a speed about four times that of the first. The drawn filaments are taken up on a collecting reel and relieved of strain by being relaxed in warm water. The completely processed filaments are then cut into lengths suitable for brush use. Tapered fibres are made by varying the speed of the gripper rollers during the manufacturing process, producing alternate thick and thin portions in the filament, a formation undisturbed by the drawing process, except that the degree of taper is controlled by the rate of speed of the stretching rollers. Cutting the filaments at the proper points results in fibres with broad bases and tapered tips similar in form to natural bristle. Splitting or "flagging" the tips of the fibres brings about an even closer approximation.

In addition to nylon, brush fibres are made of vinyl, polyethylene and polystyrene. Useful vinyl fibres are produced by cutting thin sheets of the material into fine strips. Rather short, stumplike polyethylene formations are satisfactorily employed in making massage brushes. Polystyrene fibres, which are readily chargeable with static electricity, possess the interesting and useful property of attracting dust. Two substances of animal origin, casein, derived from skim milk, and the protein constituent of animal skins, are utilized in the production of other man-made brush fibres.

Plant Fibres.—Plant cellulose can be converted into brush material by a process of dissolution and re-creation. An example is the dissolving of cotton fibres by treatment with acetic acid followed by diffusion of the acetylated product in acetone. Allowed to stand until sufficiently viscous, the solution can be spun and projected through the tiny orifices of a spinnerette. Emerging in a cylinder through which warm air circulates, the filaments solidify by evaporation of the acetone.

Many natural vegetable fibres have long been used in the manufacture of various types of brushes. Among these is Bahia bass, or piassava, a tough brown fibre obtained from a Brazilian pinnate-leaved palm. The young leaves are steeped in water, beaten into separate fibres, sun-dried and hackled. Palmyra bassine is obtained from the large leaves of the palmyra palm found in Africa, Ceylon and on the eastern coast of India. The central rib of the leaf stalk, when split lengthwise, furnishes material for very large revolving brushes, while shorter and softer fibres are obtained from the remainder of the leaf stalk. Kittul is a pliant, resilient fibre derived from the leaves of a palm tree native to India, Ceylon, Burma, Malaya and Thailand. In thickness, kittul ranges from almost hairlike fineness to a diameter of about ⅛ inch. Other vegetable materials used are Para or monkey bass; Sulima, Calabar, Cape Mount, Cape Palmas and Monrovia bass, all products of the African continent; gumati fibre from the sugar palm of southeast Asia, and fibres from the agave and yucca plants of Mexico.

Methods of Manufacture.—Brush fibres are united to handles or backs of wood, plastic or metal in several different ways. The amount of bristle used for any single paintbrush or varnish brush is determined by weight. The material is divided into two equal portions and rolled until the flagged tips point upward. The two portions are then placed one over the other so that the flags are turned inward. The bristle assumes the desired brush form in a metal cup whose interior is a pattern of the finished brush. The butt ends that protrude above the cup are leveled off by trimming, and the bristle is held in formation by a thread binding at the top. The material is transferred to a metal ferrule into which a pitch or cement "setting" is poured. When the setting has dried to hardness, the brush handle is securely fastened to the ferrule. A gum rubber solution may be used also to set paintbrushes.

Art brushes also, for the most part, are cupped and set. Some very fine brushes are shaped entirely by hand. Artists' brushes set in quills are still made in some parts of Europe, particularly in France, where quills are plentiful.

Many types of household and toilet brushes are made by inserting tufts of fibre into holes drilled in brush backs. Formerly such brushes were hand-set or hand-drawn. Set brushes were made by dipping knotted tufts in boiling pitch, binding them with thread, dipping them again in pitch and then punching or pegging them into the drilled holes. Hand-drawn brushes were made by drawing the tufts into the holes from the back of the brush by wire. The brush was finished by bonding a veneer to its back. By another method, called trepanning, the tufts were taken up into the holes, which were drilled only to a certain depth, by loops in a thread running through a perforation extending the length at the back and into which the small holes opened. Except for brushes with backs and handles of such luxury materials as tortoise shell and ivory, the earlier handmaking of brushes has yielded to mechanical methods of production. Economical quantity production of brushes has been made possible by automatic drilling and tufting machines. Knots of fibre can be punched in and securely stapled in a single operation.

Twisted-in-wire brushes are made by inserting the fibrous material between two wires that are twisted together spirally by machine. Some brushes of this type have a looped wire handle, but others are finished by inserting the twisted wire ends in wood or plastic handles. For some purposes, the wires are bent in a loop, making a brush of substantial face.

Useful in many areas, particularly in industry, are brushes made by clamping wire-secured brush filler in a fold-over metal channel. Such brushes are made in continuous strips by automatic machinery that forms the channel from metal strips, feeds the brush filler uniformly under a wire, clamps the channel over wire and filler in a secure grip, trims the fibre and cuts the clamped brush strips into desired lengths. The brush strips may be wound spirally for use as rotary brushes. Steel-gripped brushes can be produced in any required length or diameter.

Brooms.—Closely associated with brushes is the familiar broom, a stiff-fibre cleaning tool, generally applied in the large, vigorous motions of sweeping, or in rather coarse brushing operations. The broom had its origin in the primitive besom composed of twigs bound to a wooden stick.

Both vegetable and man-made fibres, such as polystyrene, are employed in broom manufacture. Of the plant fibres, broomcorn and bassine are the most widely used. Bassine is the processed fibre of the palmyra palm. Broomcorn is a sorghum having a jointed stem terminating in a stiff spike, the stems of which support oblong florets. The plant has been cultivated for centuries in Europe and is said to have been introduced in America by Benjamin Franklin. Two varieties of broomcorn are grown, the standard ranging from 10 to 15 ft. in height with a brush or spike 18 to 24 in. in length, and the dwarf or whisk, 3 to 6 ft. in height with a spike 10 to 18 in. long. The fibres from which brooms are made are obtained from the terminal spikes of the plant. Before being used they are scraped or seeded and aged in well-ventilated sheds.

Broommaking was once largely a home industry. The stalks were soaked in water to render them pliable, drained and arranged in a regular order with the best on the outside. They were bound together at the top with cord, after which a twine wrapping was applied covering a two-inch space. The broom was then clamped between two boards to hold it in a flattened formation. Twine was wound once or twice around the broom three or four inches below the two-inch wrapping and tied, a length of twine being left free for sewing. A wooden or iron needle from six to eight inches long was used to sew back and forth through the stalks, the sewing process being repeated two or three times. The pointed end of a handle was driven into the neck of the broom and secured with nails.

With the introduction of broommaking machines, at first of a simple order, factory production of brooms began. The fibres were fed under a wire supplied from a reel and attached to the broom handle, which was held in a revolving barrel by a set screw. After the material was securely wire-bound to the handle the broom was flattened in clamps and sewed. Improvements in mechanical methods culminated in automatic machinery. A sizing machine sorts the stalks according to size and cuts them to precise lengths. An exact quantity of the material is taken up and rapidly bound to the handle on a winding machine, from which the broom passes to an automatic stitcher. Such machines can produce upward of a thousand brooms a day.

See also references under "Brush" in the Index volume.

(E. L. Y.)

BRUSILOV, ALEKSEI ALEKSEEVICH (1853–1926), Russian general who played a distinguished part in World War I, was born on Aug. 19, 1853. Educated in the imperial corps of pages, he began his military career as a cavalry officer in the Caucasus. In the Russo-Turkish War of 1877–78 he distinguished himself by his bold and original tactics. On the outbreak of World War I he received command of the Russian 8th army and played a brilliant part in the campaign in Galicia. Then, in the spring of 1916, he succeeded the elderly and irresolute general N. Y. Ivanov as commander in chief of the 7th, 8th, 9th and 11th Russian armies, standing then between the Pripet and Prut rivers, south of the Pripet marshes. In the following summer he launched a massive offensive against the Austro-Hungarian forces. Though they suffered heavy losses mainly through shortage of artillery supplies, Brusilov's armies had by Aug. 1916 captured the whole original army lines and overrun much of eastern Galicia and all Bukovina, taking 375,000 prisoners. This effort, known as "the Brusilov break-through," served also to relieve pressure on Russia's allies on the Italian and western fronts.

During the Feb.–March Revolution of 1917, Brusilov and other generals urged the tsar Nicholas II to abdicate in favour of his son. After the Bolshevik Revolution, he remained in the service of the new regime and on May 2, 1920, during the war with Poland, was appointed chairman of the special commission commanding all Russian armed forces. Later he became inspector of cavalry in the Red army, retiring in 1924. He wrote *A Soldier's Note-Book 1914–1918* (Eng. trans. 1930). Brusilov died in Moscow on March 17, 1926. (I. Gy.)

BRUSSELS (French Bruxelles, Flemish Brussel), the capital and largest city of Belgium and chief town of the province of Brabant, lies in the valley of the Senne (Flemish Zenne), a small tributary of the Scheldt. Pop. (1955 est.) city or commune 175,301; greater Brussels (including the 18 suburban communes) 981,636.

The earliest inhabited site in the area is thought to have been what is now the southwestern suburb of Anderlecht, a natural clearing in the primitive forest, where foundations of a Roman villa and Frankish cemeteries have been discovered. Only some traces of the Neolithic period have been found in the city.

The 14th-century walls surrounding the city proper were removed between 1812 and 1840 and replaced by broad outer boulevards (du Midi, de l'Abattoir, Barthélemy, de Nieuport, d'Anvers, du Jardin-Botanique, Bisschoffsheim, du Régent, du 9^{me} de Ligne and de Waterloó). In 1868–71 the Senne river was covered over and now carries the central boulevard, called successively, from southwest to northeast, Maurice-Lemonnier, Anspach and Adolphe-Max. This boulevard links the two railway stations, the Gare du Midi and the Gare du Nord. The Place de Brouckère, at the junction of the boulevards Anspach and Adolphe-Max, is the central point of modern Brussels.

The lower town is the commercial quarter. It extends from the western outer boulevards to a little east of the central boulevard and includes (southeast of the Place de la Bourse in the Boulevard Anspach) the historic Grand-Place, the heart of the old town. There the Gothic town hall (1402–54) occupies the greater part of the south side of the square and contains pictures, tapestries, etc., of various periods. Its fine tower, 330 ft. high, is crowned by a 16-ft. gilded copper statue of St. Michael. Opposite the town hall is the smaller but extremely ornate Maison du Roi, which was almost entirely rebuilt during 1873–95 and contains the Historical museum. Nearby is a long arcade, called the Galeries St. Hubert, with shops, two theatres and cafés. One of the curiosities of the lower town is the Manneken-Pis fountain, noted for a bronze statue of a boy urinating whom the people of Brussels call their oldest "citizen." The statue, based on a model by the Brussels sculptor François Duquesnoy, was erected in 1619.

The upper town is the remaining eastern area of the city proper. It is also crossed from southwest to northeast by a thoroughfare formed by the Rue de la Régence which, at the Place Royale, becomes the Rue Royale. The upper town contains the church of St. Michael and Ste. Gudule, built on an earlier foundation on the side of a hill. Begun about 1220, it is considered to be one of the finest specimens of pointed Gothic and the stained glass of the 13th–15th centuries is very rich. The principal 18th- and 19th-century buildings in the Rue Royale are the Palais du Roi and the Palais de la Nation, erected by the Austrian governors. The last-named palace (1779–83) is shared by the senate and the chamber of representatives. It stands at the intersection

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TOWN HALL IN THE GRAND-PLACE, BRUSSELS; 1402–54 of the Rue Royale and the Rue de la Loi, the Whitehall of Brussels. Along the Rue Royale, between the two palaces, lies the large public park. On the opposite side of the Place Royale from the Palais du Roi is the Royal library containing the famous collection of illuminated manuscripts known as the Bibliothèque des ducs de Bourgogne, originally owned by Philip the Good. The Museum of Modern Painting and the Royal Museums of Ancient Painting and of Sculpture are close by. The latter contains many Flemish and other masterpieces, among them works by Rogier van der Weyden, Quentin Massys, Hugo van der Goes, P. Christus, Gerard David, Hans Memling, D. and A. Bouts, Pieter Brueghel, Hieronymus Bosch and Peter Paul Rubens. The Rue de la Loi is one of the most important thoroughfares running eastward toward the monumental Palais du Cinquantenaire (1905) with its park, and continued by the Avenue de Tervueren. The Palais du Cinquantenaire houses the Musées Royaux d'Art et d'Histoire with its splendid collection ranging from prehistoric objects to fine tapestries, lace and examples of other crafts. In the southern part of the upper town stands the huge Palais de Justice (1866–83) in the heavy style of Karnak and Nineveh, but surmounted by a dome. It suffered some war damage in 1944 but was restored.

The improvements effected in Brussels during the 19th century transformed the city, among them the Théâtre Royal de la Monnaie (1817), the Bourse (stock exchange) and the central post office. The column of the congress (*i.e.*, of the Belgian representatives who founded the kingdom of Belgium), surmounted by a statue of King Leopold I, was erected in the Rue Royale in 1859. After World War I the body of a Belgian Unknown Soldier was placed in a crypt in the base of the column.

In the early years of the 20th century new and spacious avenues were driven into the suburban communes in many directions. One of the most fashionable is the Avenue Louise, starting from Porte Louise (near the Palais de Justice) and running southeast toward the Bois de la Cambre. After World War II great public works were undertaken in order to link the two main railway stations, the Gare du Nord and the Gare du Midi. This junction railway, partly underground, was opened on Oct. 4, 1952. In addition, the southern outer boulevards were widened, and in the 1950s four tunnels and an overhead road were built to ease the traffic.

In 1788 the faculties of law, medicine and philosophy were removed from Louvain to Brussels, and in 1834 the Free University of Brussels was constituted with the addition of a faculty of natural science.

Brussels is linked by rail with many of the important cities of northwestern Europe. From the airport at Melsbroek, 7.5 mi. N.E. of the city centre, there are regular international air services. In addition, there are regular helicopter services to several large cities including Paris. Brussels also has a port, lying to the north of the outer boulevards, comprising two docks (21 ft. and 11 ft. in depth), a works quay and an outer harbour (21 ft.). After 1922 these were linked to the north by a canal with the Rupel and the Scheldt, taking seagoing vessels up to 49-ft. beam and 19-ft. draft. Southward, Brussels is linked by another canal to the industrial town of Charleroi (*q.v.*). Although mainly the seat of the government and a residential centre, Brussels has numerous light industries among which the chief are the manufacture of laces, carpets, furniture, beer, cigars and cigarettes.

Greater Brussels.—The area of the city proper was increased in 1921 to 12.7 sq.mi. by including the communes of Laeken, containing a residence of the royal family, Haeren and Neder-Over-Heembeek, with parts of Molenbeek and Schaerbeek. Toward the end of the 18th century the city proper, or commune of Brussels, had about 74,000 inhabitants; in 1920 it had 154,801; in 1938, in a larger area, it had grown to 191,678. However, with its 18 other communes, usually considered as part of the agglomeration of Brussels, the total population in 1938 was 912,774.

Beginning in the north of the city and east of the Senne and working around in a clockwise direction, the first of the 18 communes is Evere (pop. [1955] 18,421), with its restored romanesque church of St. Vincent and with mining industries. Schaerbeek (120,150), a village until 1795, manufactures foodstuffs, clothing, chemicals and machinery. St. Josse-ten-Noode (25,310), a town since the 13th century, adjoins the centre of Brussels and produces much the same products as Schaerbeek. On the east, Woluwe-St.-Lambert (32,129) and Woluwe-St.-Pierre (25,696) produce garden vegetables, machinery and building materials. Etterbeek (51,473), nearer to the city centre, was first mentioned in the early 12th century. It makes chemicals, clothing, metalwork and machinery as well as foodstuffs. At Auderghem (23,003), to the southeast, Aleyde, duchess of Brabant, founded a convent at the end of the 13th century. Ixelles (92,338), sprawling to the south and southeast, makes much the same products as the other suburbs. Watermael-Boitsfort (22,270), mentioned as early as A.D. 914, lies beyond Ixelles and stretches to the forest of Soignes. Uccle (64,594), to the south, was formerly a separate town dating back to the 12th century. It is now mainly residential. Forest (48,974), once part of the forest of Soignes, now makes chemicals, paper, photographic materials, clocks, clothing, leather goods and foodstuffs. St.-Gilles (57,289), formerly Obbrussel, makes products similar to those of Forest, as does Anderlecht (91,143), on the Senne to the southwest, the original kernel of the city. Molenbeek-St.-Jean (62,592), Koekelberg (15,099), Berchem-Ste.-Agathe (13,213), Ganshoren (11,849) and Jette-St.-Pierre (30,792) are all in the west and northwest of Brussels. Apart from the products common to most parts of Brussels they make rubber goods, electrical equipment, clocks, liqueurs and tobacco products.

History.—The Franks settled in the area in the 7th century, at the time of the evangelization of Brabant. They established themselves on the hill above the frequently flooded Senne valley, near the present collegiate church of St. Michael and Ste. Gudule. On an island in the valley Duke Charles of Lower Lorraine built a fortress containing a chapel dedicated to St. Géry (now marked by the Place St. Géry) and Charles transported there the relics of Ste. Gudule (transferred to St. Michael's in 1047). The first town grew up around the fortress and was called Bruocsella or Broecsele ("the settlement in the marshes"). It was at this point that the ancient road running north-south, between Antwerp and Nivelles, crossed the Senne which there ceases to be navigable. The great east-west road between Cologne and Bruges did not become an important highway until the end of the 12th century, and the commercial development of Brussels, which had already begun, was greatly increased as a result of its position at these crossings.

The merchants of the 12th-century industrial town, free from the authority of an overlord, created a market (the origin of the Grand-Place) and built a meetinghouse (the forerunner of the town hall). While the commercial town flourished and gradually formed the nucleus of the lower town, a ducal residence (on the site of the Place Royale) and the abbey of St. Jacques, both on the Coudenberg, on the edge of the plateau bordering the Senne valley, were built. This was the beginning of the ducal agglomeration and of the upper town.

Around 1100 new ramparts, including seven gates and 24 towers, were constructed to protect the industrial city. In 1312, Duke John II of Brabant granted the citizens their charter, distinguished from others as that of Cortenberg. This charter, with the Golden Bull of the emperor Charles IV (1356), was confirmed by the famous "joyous entry" of Duke Wenceslas into Louvain (1356). This established the early constitution of the South Netherlands, which remained almost intact until the Brabant revolution in the reign of Joseph II. The 11th-century wall was soon outgrown, and in 1357 Duke Wenceslas ordered a new wall to be built, enclosing a much greater area. It included 74 towers and eight gates, and survived until 1830. In the 14th century the dukes of Brabant transferred their capital from Louvain to Brussels, although residing for some time in their castle at Vilvorde, halfway between the two turbulent cities. At this time Brussels is said to have had 40,000 inhabitants, one-fifth the number of Ghent. In 1421 a further charter was granted recognizing the guilds of Brussels as the Nine Nations. The duchy was merged in the possessions of the duke of Burgundy in 1430. The castle of the dukes of Brabant on the Coudenberg was the scene of the abdication of Charles V in 1555.

In the 16th and 17th centuries, under the Spanish Habsburgs, Brussels was the capital of the Spanish Netherlands and one of the finest and most important cities of Europe. In 1695, the duc de Villeroi, a French commander, bombarded the city. Sixteen churches and about 4,000 houses were burned down, and the historic buildings on the Grand-Place were seriously damaged or destroyed. Much of the damage was repaired in the 18th century. From 1714 Brussels was the capital of the Austrian southern Netherlands.

During the French Revolution the city was reduced to the rank of chief town of the French *département* of the Dyle (1795–1814), becoming later, concurrently with The Hague, the residence of the king of the Netherlands. The Belgian revolution started in Brussels on the night of Aug. 22–23, 1830, and during Sept. 23–26 the Belgians defeated a Dutch army there. King Leopold I entered the city on July 21, 1831, and this date was proclaimed the national holiday. As capital of the kingdom of Belgium, Brussels recovered its former status of a great European metropolis.

In World War I the German occupation lasted from Aug. 20, 1914, to Nov. 18, 1918. Numerous social relief movements were instituted; among them the Comité National de Secours et d'Alimentation had its headquarters in Brussels and with U.S. aid organized the feeding of the Belgian population. The executions of Edith Cavell (Oct. 12, 1915) and Gabrielle Petit (April 1, 1916) took place there. Adolphe Max, the burgomaster, acquired great fame for his resistance to the abuses of the Germans. The Belgian army recovered Brussels on Nov. 18, 1918, and King Albert I and Queen Elizabeth re-entered the city in state four days later. In World War II Brussels fell to the Germans on May 18, 1940. It did not suffer extensive physical damage but was subjected to harsh terms of occupation. Gen. Eggert Reeder, chief of the German military administration for Belgium, dissolved all municipal councils on April 11, 1941, dismissed the burgomaster, François Joseph van de Meulebroeck, and on Sept. 27, 1942, created "greater Brussels" by amalgamating the city with other communes for easier control. Brussels was liberated on Sept. 3, 1944, by the British, and the legitimate Belgian government returned to its capital from London five days later. The German-created "greater Brussels" then ceased to exist.

(M. Ms.)

World's Fair of 1958.—Officially known as the Brussels Universal and International exhibition, the Brussels world's fair was held from April 17 to Oct. 19, 1958, at fairgrounds that covered 500 ac. of ancient woodlands in Heysel park, four miles from the centre of Brussels. Forty-five nations, six international and supranational agencies and four organizations of an international character took part in the 1958 exhibition, and more than 41,450,000 persons visited the fair during the six-month period (*see* EXHIBITIONS AND FAIRS).

See also references under "Brussels" in the Index volume.

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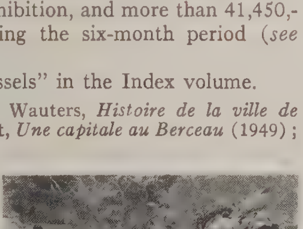
BRUSSELS SPROUTS, a botanical variety of cabbage (*Brassica oleracea* var. *gemmifera*). In its seedling stage and early development it closely re-embles common cabbage. Later he main stem rises two to three eet tall and the axillary buds along the stem develop into small heads (sprouts) similar to heads f cabbage but only one and one-half inches or less in diameter.



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BRUSSELS SPROUTS (BRASSICA OLERACEA FORM GEMMIFERA)

The plant is of obscure European origin and was possibly grown in Belgium as early as 200, but was first described in 1587. It was little known, even to botanists, for another century. Brussels sprouts is a popular and widely grown vegetable in England and in Europe.

It is little grown in the United States except in coastal areas or other districts having the mild, cool seasons that it requires. It is harmed by hot weather. In the U.S. most of the crop is produced in California and New York. The advent of quick-freezing preservation stimulated some expansion of production and use of Brussels sprouts. About 25,000 to 35,000 tons are produced annually on about 5,500 to 6,500 ac. in the United States. Over 40,000 ac. are devoted to the production of Brussels sprouts in Great Britain. *See* also CABBAGE. (V. R. B.)

BRUSTOLON, ANDREA (1662–1732), Italian sculptor and wood carver who created the supreme achievements of Venetian baroque furniture, was born on July 20, 1662, at Belluno. He went to Venice in 1677 and trained under Filippo Parodi, visiting Rome, 1678–80. On his return he undertook a certain amount of decorative carving in Venetian churches and created his most celebrated works, the furniture for the Venier di S. Vio and Correr di S. Simeone families (now in the Cà Rezzonico, Venice), exceedingly elaborately carved in walnut and ebony with Negro figures, cupids, etc. In 1685 he returned to Belluno and from that time devoted himself almost entirely to work in wood and occasionally ivory for religious uses. He died at Belluno on Oct. 25, 1732.

See G. Biasuz and E. Lacchin, *Andrea Brustalon* (1928).

(F. J. B. W.)

BRUT (BRUTE OR BRUTUS THE TROJAN), a legendary British character, who, according to Geoffrey of Monmouth and others, was the eponymous hero of Britain. He was reputed to be grandson of Aeneas, and the legend was that he was banished from Italy and made his way to Britain, where he founded New Troy (London). The name is an obvious confusion between Bryt (a Briton) and the classical name Brutus. For the romance literature of the subject *see* WACE; BARBOUR, JOHN.

BRUTTII, an ancient Italian tribe which occupied the southwestern peninsula of Italy in historical times, the *ager Bruttius*, corresponding almost exactly to the modern *regione* of Calabria. The Bruttii, perhaps speaking an Indo-European language (*see* INDO-EUROPEAN), may have occupied southern Italy before the conquest of Lucania, Calabria and Campania by Samnite tribes after the 5th century B.C. Ancient tradition suggested to the Romans that they were driven southward about 400 B.C. by the Lucanians, a Samnite tribe who spoke Oscan. The Bruttii adopted Oscan as their language, together with Greek.

The district of the Bruttii was separated from Lucania on the north by a line drawn from the mouth of the Laus (Lao) river on the west to a point a little south of the Crathis (Crati) river on the east. To part or the whole of this peninsula the name Italia was first applied. In alliance with the Lucanians the Bruttii made war on the Greek colonies of the coast, seized Hipponium (Vibo Valentia) in 356 B.C., and held it until it became a Latin colony at the end of the same century. The Bruttii were at the height of their power during the 3rd century B.C. Their chief towns were Consentia (Cosenza), Petelia (near Strongoli), and Clampetia (Amantea). Their coins belong to this period and they appear to have retained the right of coinage even after their final subjugation by the Romans.

The Bruttii first came into collision with the Romans (280–275 B.C.) during the war with Pyrrhus, king of Epirus, to whom they sent auxiliaries. After his defeat they were deprived of half their territory in the thickly forested Sila plateau, which was declared state property. In the war with Hannibal they were among the first to declare in his favour after the battle of Cannae (216), and it was in their country that Hannibal held his ground during the last stage of the war at Castrum Hannibalis on the Gulf of Scylacium (Squillace). After his defeat (202) the Bruttii lost their separate existence. In 194 B.C. colonies of Roman citizens were founded at Tempsa and Crotona (Crotone), and a colony with Latin rights at Hipponium, called Vibo Valentia (about 192). In 132 B.C. the consul Publius Popilius Laenas built the great road from Capua through Vibo and Consentia to Rhegium (mod. Reggio di Calabria). Spartacus held out a long time in the Sila

(71 B.C.). Vibo was the naval base of Octavian in the conflict with Sextus Pompeius (42–36 B.C.).

The most important products of the district were the wood from the forests of the Sila and the pitch produced from it. The coast plains were in parts very fertile, especially the lower valley of the Crathis. Under the empire the Sila was state domain, and most of the rest in the hands of large proprietors. When Augustus divided Italy into *regiones* he joined it with Lucania to form the 3rd region. Diocletian placed Lucania and the district of the Bruttii under a *corrector* ("governor"), whose residence was at Rhegium. From the 6th century A.D., after the fall of the Ostrogothic power and the establishment of that of Byzantium, the name Calabria was applied to the whole of southern Italy, and the name of the Bruttii entirely disappeared. After the eastern peninsula (ancient Calabria) had been taken by the Lombards, about A.D. 668, the western retained the name and still keeps it.

See R. S. Conway, *The Italic Dialects* (1897); J. Whatmough, *The Foundations of Roman Italy* (1937).

BRUTUS, in ancient Rome a cognomen or surname borne by members of the gens Junia, of which the first-mentioned, Lucius Junius Brutus, was the only patrician member to bear the name.

LUCIUS JUNIUS BRUTUS (consul 509 B.C.), probably a historical figure, traditionally led the Romans to expel from Rome their despotic king Lucius Tarquinius Superbus and founded the republic, being elected in 509 B.C. one of the first consuls (*see* CONSUL; TARQUIN). When the two sons of Brutus joined in a conspiracy to restore the Tarquins, he himself sentenced them to death. He fell in single combat with the son of Tarquinius Superbus during a battle with the Etruscans who were trying to restore the dynasty of the Tarquins. Tradition associated the name *Brutus* ("dull") with Brutus' feigned stupidity before he rose to power.

See Livy, *History of Rome,* i and ii.

DECIMUS JUNIUS BRUTUS (consul 138 B.C.), surnamed GALLAECUS from his victory over the Gallaeci (136) in northwestern Spain. He was a patron of literature and a friend of the poet Accius.

MARCUS JUNIUS BRUTUS (praetor *c.* 140 B.C.), a jurist considered by Cicero to be one of the founders of Roman civil law. His son of the same name, also a jurist, was known as "the Accuser."

See Cicero, *De Officiis,* ii, *De Oratore,* ii, and *Brutus.*

DECIMUS JUNIUS BRUTUS (d. 43 B.C.), surnamed ALBINUS after his adoptive father A. Postumius Albinus, first served under Caesar in Gaul and afterward commanded his fleet. Caesar made him master of the horse and governor of Transalpine Gaul for 48 and 46 B.C., and, in case of Octavian's death, nominated him as one of his heirs; early in 44 B.C. Caesar gave him charge of Cisalpine Gaul. Nevertheless Brutus was one of his assassins in March 44. He then went to Cisalpine Gaul which he held for the republicans against Antony, standing siege at Mutina; he then advanced to Gallia Narbonensis against Antony, but deserted by his soldiers and betrayed by a native chief, he was put to death by Antony's orders (43) while attempting to escape to the other assassins Cassius (*q.v.*) and Marcus Junius Brutus in Macedonia. He figures in Cicero's correspondence.

MARCUS JUNIUS BRUTUS (85–42 B.C.), also named QUINTUS CAEPIO BRUTUS after his adoptive father Q. Servilius Caepio, supported the cause of Pompey against Caesar (*q.v.*) but was pardoned by the latter after the victory of Pharsalus and subsequently appointed governor of Cisalpine Gaul (46). In 44 he was city praetor and Caesar promised him the governorship of Macedonia. But at the prompting of Cassius he became leader of the conspiracy against the dictator, and was himself one of the assassins. But the republicans had no program and in Aug. 44 he fled to the east with Cassius, seized Macedonia and raised forces against Antony. At Philippi (42) they were defeated by Antony and Octavian, and Brutus committed suicide.

Brutus divorced his first wife Claudia, daughter of Appius Claudius Pulcher (consul 54) in 46 and married Porcia, the daughter of his uncle M. Porcius Cato Uticensis. He was generally friendly with Cicero(*q.v.*) who dedicated the works *Brutus* and *Orator* to him, but Cicero frequently speaks of his lack of enthusiasm. The Romans admired him for his respectability and old-fashioned *gravitas* ("seriousness"). He was slow in decision, amazingly obstinate and, in his financial dealings with the provincials, both extortionate and cruel. Shakespeare's portrait of him is flattering. A Stoic, he wrote philosophical treatises and poetry, of which nothing has survived. Of the original nine books of his correspondence with Cicero two are extant.

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BRY, THÉODORE (THEODORUS DIRK) **DE** (1528–1598), German engraver and publisher, whose illustrations for travel works are of special interest, was born in Liège, Belgium, in 1528. He established an engraving and publishing business at Frankfurt, and also visited London in or before 1587. There he became acquainted with the geographer, Richard Hakluyt, with whose assistance he collected materials for a finely illustrated collection of voyages and travels, *Collectiones peregrinationum in Indiam orientalem et Indiam occidentalem* (25 parts, 1590–1634). Among other works he engraved a set of 12 plates illustrating the "Procession of the Knights of the Garter" in 1576, and a set of 34 plates illustrating the "Procession at the Obsequies of Sir Philip Sidney"; plates for Thomas Hariot's *Briefe and True Report of the New Found Land of Virginia* (Frankfurt, 1595); the plates for the first four volumes of Jean Jacques Boissard's *Romanae urbis topographia et antiquitates* (1597–98), and a series of portraits entitled *Icones virorum illustrium* (1597–99). He died at Frankfurt am Main on March 27, 1598. De Bry had been assisted by his eldest son, Jean Théodore de Bry (1561–1623), who carried on the *Collectiones* and the illustration of Boissard's work, and also added to the *Icones.*

BRYAN, KIRK (1888–1950), U.S. geologist internationally recognized as an authority on geomorphology, Pleistocene and Recent chronology, and cryopedology (a term he coined for the study of perennially frozen ground), and noted for his emphasis upon their relationship to climatic fluctuations and to the dating of early man in North America. Bryan was born in Albuquerque, N.M., July 22, 1888, and was educated at New Mexico and Yale universities. His first important scientific contributions, as geologist for the U.S. Geological survey, dealt with ground-water problems and the geomorphology of arid regions. His intense interest in the American southwest, especially the Rio Grande valley, is shown in his own publications and in those of his students at Harvard university, where he taught from 1926 until his death Aug. 22, 1950, at Cody, Wyo.

For bibliography and detailed biography *see* E. S. Larsen, Jr., "Kirk Bryan," *Proc. Geol. Soc. Amer.*, pp. 91–96 (1951). (L. L. R.)

BRYAN, WILLIAM JENNINGS (1860–1925), U.S. political leader and orator, was born in Salem, Ill., on March 19, 1860. He graduated from Illinois college in 1881 and from the Union College of Law, Chicago, in 1883. He practised his profession at Jacksonville, Ill., from 1883 to 1887 and then moved to Lincoln, Neb. There he soon became conspicuous both as a lawyer and as a politician, attracting particular attention by his speeches during the presidential campaign of 1888 on behalf of the candidates of the Democratic party. It was a time of depression and discontent in farming areas. From 1891 to 1895 he represented the 1st congressional district of Nebraska, normally Republican, in the national house of representatives. He soon attracted attention as a conscientious worker and became widely known for his ability in debate. His first great speech (March 16, 1892) was against the policy of tariff protection, and on Aug. 16, 1893, he made a remarkable speech against the repeal of the silver purchase clause of the Sherman act. Although the immediate loser in this contest, he attained a national reputation as the leader of the free-silver movement in opposition to the more conservative gold standard policy. In 1894 he was a candidate for the U.S. senate but was defeated in a campaign largely restricted to the silver question. From 1894 to 1896 he edited the *Omaha World-Herald,* in which he championed the cause of bimetallism, and lectured on the silver question.

Although defeated in all elections in which he subsequently appeared as candidate, he was the recognized leader of his party for the next 30 years. His panacea for the depressed conditions of agriculture and industry that followed the panic of 1893 was an "easy money" policy based on the free and unlimited coinage of silver at a ratio to gold of 16 to 1. In 1896 he was sent as delegate to the Democratic national convention at Chicago, and there easily captured control of the convention, wrote the party platform, which contained a plank providing for bimetallism, and in defense of his proposition delivered a celebrated speech containing the passage, "You shall not press down upon the brow of labour this crown of thorns; you shall not crucify mankind upon a cross of gold." As leader of the "silver" majority he became the Democratic nominee for president, champion of the agrarian west and south against the "hard money" policy favoured by most eastern bankers and industrialists. He also received the nominations of the Populist and the National Silver parties. In the ensuing presidential campaign he traveled over 18,000 mi. and made altogether 600 speeches in 27 different states—an unprecedented number. In the election, however, he was defeated by William McKinley, the Republican candidate, receiving 176 electoral votes to 271. During the Spanish-American War he was colonel in the 3rd Nebraska volunteers, but saw no active service. Even though he lent his support to the ratification of the peace treaty, he opposed the permanent acquisition of the Philippines and in 1900 was again nominated for the presidency on a platform that declared against "imperialism" and for "free-silver." He was defeated a second time by McKinley, receiving 155 electoral votes to 292. After the 1900 election Bryan established and edited at Lincoln a weekly political journal, *The Commoner,* which attained a wide circulation.

Although not an active candidate for the Democratic nomination in 1904, he was in attendance and assisted materially in framing the platform. The conservative element of the party had once more resumed control and nominated Judge Alton B. Parker of New York. In 1905–06 Bryan made a trip around the world, and in London was cordially received as a great American orator. He was nominated again for the presidency by the Democratic party at its national convention at Denver in 1908. The free-silver theory was now dead, and while the chief issue was over the formulation of a policy toward business trusts, the campaign was confused by personal issues, Roosevelt himself intervening in favour of Taft, the Republican nominee. Bryan was defeated again, receiving 162 electoral votes to 321 for Taft. In 1912 Bryan announced that he was not a candidate for the Democratic presidential nomination, but he attended the convention, dictated the platform, and inspired the general tone of proceedings at Baltimore. It was largely his influence that brought about the nomination of Woodrow Wilson (*q.v.*) instead of Champ Clark. In recognition of this service Wilson appointed him secretary of state in 1913.

As secretary of state Bryan devoted much attention to the negotiation of treaties with foreign nations to prevent war. Profiting from the sad experience of his predecessors in getting arbitration treaties approved by the senate, Bryan proposed new treaties that would provide a "cooling-off period" of one year during which the question in dispute could be studied by an international commission. These were agreed to in principle by 31 nations but World War I interrupted the movement. In 1913 Bryan went to California, where he urged, unsuccessfully, that the state legislature and the governor should delay action on the proposed Webb antialien land ownership bill, so displeasing to the Japanese government. In 1914 he supported the repeal of the Panama canal tolls bill, which excluded American coastwise shipping from the payment of fees.

Both Wilson and Bryan had stated their opposition to intervention in Latin-American affairs, but they nevertheless took action that was generally regarded in Latin America as interventionist. The most troublesome incident was the expedition sent into Mexico to capture the bandit leader Pancho (Francisco) Villa (*q.v.*) in 1916.

From the outbreak of World War I, Bryan was deeply interested in attempts to restore peace and keep the United States out of the conflict. He opposed war loans to belligerents, but as vigorously opposed an embargo on the shipment of arms as contrary to international law. After the sinking of the "Lusitania" (May 7, 1915) he signed the first strong note of protest to Germany. When the president wrote his second "Lusitania" note, Bryan resigned (June 8, 1915), saying in his letter of resignation, "You have prepared for transmission to the German government a note in which I cannot join without violating what I deem to be an obligation to my country." He continued, after his resignation, to work in the interest of peace; he opposed the Anglo-French war loan; attacked the Navy league and the National Security league, and tried to resist the growing demands for preparedness in America.

However, when war was actually declared he asked to be enrolled as a private, though then 57 years of age; he urged loyal support of the president's war measures, and in his own paper, *The Commoner,* strongly condemned obstruction of the selective draft.

In 1916 Bryan was defeated in Nebraska as candidate for delegate-at-large to the Democratic national convention, but went as a reporter and gave full support to the renomination of Wilson. He was sent as a delegate to the 1920 convention at San Francisco, but when his motion for the introduction of a "dry" plank in the platform was defeated, he took no further interest in the proceedings. The same year he refused the presidential nomination of the Prohibition party, although he had been a tireless worker for the cause for the previous ten years. In 1921 he moved to Miami, Fla., and in 1924 attended the Democratic national convention in New York as a delegate from Florida, but he exercised very little influence in the party councils. As a politician his work was completed. Bryan laboured earnestly for the most important progressive measures adopted by the U.S. during his political career: the popular election of senators, an income tax, the requirements of publication of ownership and circulation of newspapers, the creation of the department of labour, national prohibition and woman suffrage. Their adoption was due in part to his popular persistent appeal.

Bryan's last public appearance was in 1925 at the trial of J. T. Scopes, a schoolteacher of Dayton, Tenn., who was arrested on a charge of violating the state law prohibiting the teaching in public schools of any theories that deny the divine creation of man as taught in the Bible. Scopes admitted to violating the law (*see* SCOPES TRIAL). Bryan, a firm believer in the literal interpretation of the Bible, went to Dayton to assist the prosecution. Widespread popular interest was manifested in the case. In the hands of Bryan and Clarence Darrow, chief defense counsel, it took the form of a contest between fundamentalism and modernism. The outcome was that on July 21, after an 11-day hearing, Scopes was found guilty and fined (later overruled). Bryan was prevented, through the tactics of Darrow, from delivering the elaborate speech which he had prepared in refutation of Darwin's theories. On the conclusion of the trial he was taken ill, and died at Dayton, Tenn., on July 26, 1925.

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BRYAN, a city in Texas, U.S., 85 mi. NW of Houston. The seat of Brazos County, Bryan was founded in 1859 and named for William Joel Bryan, who inherited from his uncle Stephen F. Austin the land on which the city is built.

The city is strategically located between three large metropolitan areas and immediately adjoins Texas A & M University at College Station. The economy, originally based on agriculture, shifted to one founded on higher education and an increasing number of small manufacturing, processing, and distributive industries. Bryan adopted a commission-manager plan of government in 1917. Pop. (1970) 33,719. For comparative population figures *see* table in TEXAS: *Population.* (J. M. NA.)

BRYANSK (BRIANSK), a town and the administrative centre of Bryansk Oblast of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the Desna River, just below its confluence with the Bolva, 210 mi. SW of Moscow. Pop. (1970 prelim.) 318,000. First mentioned in 1146, it was a fortified town on the Bryansk defensive line of the mid-16th century and was occupied by the Germans in World War I. It is now an industrial centre, with a large-scale engineering industry, producing turbines, diesels, refrigerator freight cars, bulldozers, graders and other road-making machinery, and equipment for brick and cement works. Clothing, worsted, shoes, bricks, and reinforced concrete also are made. Bryansk is a railway junction, the focus of six lines, to Moscow, Vyazma, Smolensk, Gomel, Kiev, and Orel. Around Bryansk is a group of industrial towns manufacturing iron castings, glass, cement, phosphate flour, and timber products. The largest, Bezhitsa, is combined with Bryansk.

Bryansk Oblast lies mostly in the broad, shallow basin of the Desna and its tributaries. In the north and east are low, rolling hills. The *oblast* (13,475 sq.mi. [34,900 sq.km.]) is in the zone of mixed forest, and extensive forests remain in the eastern part, but elsewhere they have largely been cleared. Soils are mostly podzols, but richer chernozems occur in central and southeastern areas. The *oblast*, which was formed in 1944, has a population of 1,582,000 (1970 prelim.), of which 750,000 (47%) are urban. Apart from Bryansk itself, most towns are small.

The agriculture of Bryansk Oblast is concerned chiefly with growing grain (rye, buckwheat, and oats), flax, hemp, and potatoes. Some sugar beet and tobacco are also produced. Industry is well developed and includes engineering (transport and agricultural machinery), steel and iron casting, glassmaking, timber working (especially match and papermaking), processing flax and hemp and food, and the production of building materials. Part of the iron ore deposits of the Kursk Magnetic Anomaly lie within the *oblast*. (R. A. F.)

BRYANT, WILLIAM CULLEN (1794–1878), U.S. poet of nature, best remembered for "Thanatopsis," and editor for 50 years of the *New York Evening Post*, was born at Cummington, a farming village in the Berkshire hills of western Massachusetts, on Nov. 3, 1794. He was the son of Peter Bryant, physician and man of scholarship, and of Sarah Snell—both descendants of early Puritan immigrants. At 16 Bryant entered the sophomore class of Williams college, where he was an apt student for a year but from which he withdrew without graduating because of limited finances and in the vain hope that his father might send him to Yale college. The number of his college days is a misleading measure of his training, for he possessed many traits that often are established only by books and academic regimen. On abandoning his hope of entering Yale, he studied law under private guidance at Worthington and at Bridgewater and at 21 was admitted to the bar. He opened an office in Plainfield, presently withdrew from there, and at Great Barrington settled for nine years in the attorney's calling, for which he had an aversion that he never lost. At the age of 26 Bryant married Frances Fairchild, with whom he enjoyed a happy union until her death nearly half a century later. In 1825 he moved to New York city to become coeditor of the *New York Review*. Two years later he became an editor of the *Evening Post*; in 1829 he became editor in chief and part owner, and continued in this position until his death almost 50 years later. His careful investment of his income from the *Post* made Bryant wealthy. Since he was a resident of New York city, he was associated in the public mind with the Knickerbocker group, but in reality he had little in common with these authors. He was an active patron of the arts and letters; in this capacity and as a journalist he made six voyages to Europe.

The religious conservatism imposed on Byrant by his mother and his grandfather Snell in childhood found expression in pious doggerel; the political conservatism of his father stimulated "The Embargo" (1808), in which the 13-year-old poet demanded the resignation of Pres. Thomas Jefferson. But in "Thanatopsis" (from the Greek "a view of death"), which he first wrote in 1811 at the age of 16 and which made him famous when it was published in the *North American Review* in 1817, he rejected Puritan dogma for Deism; thereafter this distinguished apostate from Calvinism was a Unitarian. Turning also from Federalism, he joined the Democratic party and made the *Post* an organ of free trade, workingmen's rights, free speech and abolition. A thoroughgoing liberal, Bryant was for a time a Free-Soiler and later one of the founders of the Republican party. At Cooper union in 1860 he introduced Lincoln to his first New York audience. (*See* Newspapers: *The Party Press.*) As a man of letters Bryant securely established himself at the age of 27 with *Poems* (1821). For a decade he was the most distinguished poet in the United States and, throughout his lifetime, one of the most revered. In his later years he devoted considerable time to translations, particularly from Homer and from Spanish poets.

"I was always," Bryant said, "a delighted observer of external nature." In Massachusetts, his was a joyous and occasionally an ecstatic communion. In New York his disillusionment with the human race increased, as did his need for the consolation of nature, but his communion was now more often sober. As an early figure in the romantic movement in American literature, Bryant wrote also of the American past and that of Europe, of the liberal causes that he defended in the *Post*, and, like numerous English romanticists, of ethical problems. Once freed from his boyish addiction to the heroic couplet, he employed a richer variety of verse forms than had any American predecessor. But Bryant will be longest remembered as the poet of the Berkshire hills and streams, in such poems as "Thanatopsis" and "To a Waterfowl"—in Whitman's phrase, "bard of the river and of the wood, ever conveying a taste of open air." Bryant died in New York city on June 12, 1878.

Bibliography.—The last edition of Bryant's poems that passed through his own hands is *The Poetical Works* (1876). Parke Godwin, Bryant's son-in-law and fellow editor, collected much of Bryant's prose and verse in volumes iv–vi of *The Life and Writings of William Cullen Bryant*, 6 vol. (1883–84). The Roslyn edition of *The Poetical Works* (1903) ed. by H. C. Sturges and R. H. Stoddard is the most inclusive one-volume collection. Useful are the biographical volumes by Parke Godwin, *see* above; John Bigelow, *William Cullen Bryant* (1890); W. A. Bradley, *William Cullen Bryant* (1905). *See* also F. L. Pattee, *Side Lights on American Literature* (1922); Alan Nevins, *The Evening Post: a Century of Journalism* (1922); Norman Foerster, *Nature in American Literature* (1923); W. L. Phelps, *Howells, James, Bryant and Other Essays* (1924); Gay W. Allen, *American Prosody* (1935); Tremaine McDowell (ed.), *William Cullen Bryant: Representative Selections*, with introduction, bibliography and notes (1935). (T. McD.)

BRYAXIS was one of the four sculptors who, according to Pliny and Vitruvius, worked on the mausoleum of Halicarnassus (*c.* 350 B.C.). His most famous statue was a colossal seated Sarapis, which perhaps survives in numerous Roman copies. None of the other works attributed to him by ancient writers, including an Apollo at Daphne, a group of Asklepios and Hygieia at Athens and a portrait of Seleucus Nicator, can be even tentatively identified. The signature of Bryaxis on a sculptured base found in Athens in 1891 may refer only to the lost statue surmounting it.

See G. Lippold, *Die griechische Plastik*, pp. 257–60 (1950). (G. M. A. R.)

BRYCE, JAMES BRYCE, 1st Viscount (1838–1922), British statesman and scholar, whose great learning and wide experience of many countries made him indispensable in the counsels of the Liberal party, and who was an especially successful ambassador to Washington, was born at Belfast, Ire., on May 10, 1838, of a Scottish Presbyterian family. His father, James Bryce (1806–77), was a schoolmaster, and moved in 1846 to Glasgow, where the son attended the high school and university. In 1857 Bryce went to Trinity college, Oxford, as a scholar—the first one who did not take the Anglican oaths. His brilliant Oxford record included three first classes and five major prizes; he was elected a fellow of Oriel in 1862. When he began to read for the bar, after a year at Heidelberg, he had already published his famous prize essay, *The Holy Roman Empire* (1864). In 1870 Bryce became regius professor of civil law at Oxford, a chair he held until 1893. There he was successful in reviving the study of Roman law. "Bryce, who had sat at the feet of Van Vangerow in Heidelberg, conceived it," says his biographer, H. A. L. Fisher, "to be part of his duty to awaken an interest in the civil law not as an antiquarian curiosity, but as a great power in the moulding of European thought and history." Many of his Oxford lectures were published in his *Studies in History and Jurisprudence*, two volumes (1901).

Bryce made the first of numerous visits to the United States in 1870 and laid the foundations of his knowledge of American institutions and life. A lifelong interest in the affairs of the Armenians began when he visited the Caucasus for a climbing holiday in 1876. He stood for parliament without success at Wick in 1874, but later sat as Liberal member for the Tower Hamlets (1880–85) and for South Aberdeen (1885–1907). Bryce never carried in the house of commons the weight of less able men with the true "parliamentary gift." This gift apart, he had much in common with Gladstone, not least on the literary side; both were friends of Lord Acton, with whom Bryce founded the *English Historical Review* in 1885. In the short government of 1886 Bryce was undersecretary of state for foreign affairs. He was chancellor of the duchy of Lancaster in the Liberal cabinet of 1892 and was president of the board of trade in the reconstructed government of 1894–95. He presided over an important commission on secondary education in 1894, which advised that a central education authority should be set up under a responsible minister.

After the Liberal defeat of 1895 he visited South Africa. He protested against the handling of negotiations with the Boer republics in the following years, and in the split in the Liberal party which followed the outbreak of the South African War in 1899 Bryce ranged himself with Sir Henry Campbell-Bannerman in the campaign against Joseph Chamberlain and his policy. Throughout the war Bryce was uncompromisingly on the unpopular side. In the Campbell-Bannerman cabinet of 1905 Bryce was chief secretary for Ireland, and in 1907 was sent as ambassador to Washington.

For six years Bryce was the interpreter of Great Britain to the American people. The appointment of a politician, outside the diplomatic service, was as usual criticized; but it was a most happy one. Bryce had many friends in political, learned, and literary circles in America, and was known throughout the United States as the author of *The American Commonwealth*, the most authoritative work on the structure and working of the American constitution. To this book, begun in 1883 and published in 1888, which remains a classic in its field, Bryce brought not only historical knowledge and legal training, but the sympathy of a friend of the American people and an admirer, on the whole, of their institutions. As ambassador, many of the problems he had to deal with concerned the relations of the United States with Canada, and in this connection he paid several visits to Canada to confer with the governor-general and his ministers. At the close of his mission he said that probably three-fourths of the business of the British embassy at Washington was Canadian, and that 9 out of the 12 treaties he had signed had related to Canadian affairs. He could boast that he had left Canada and the United States on excellent terms.

For his services he was created a viscount after he retired in 1913. He was made a member of the International Court at The Hague in 1914. He was extremely reluctant in the last days of July 1914 to contemplate the possibility of war with Germany, but the violation of Belgian neutrality decided him. He was chairman of the committee that considered the evidence of German atrocities in Belgium and France, and was much saddened by its work. He was appointed president of a conference on the reform of the house of lords in 1917 and, believing in the importance of an active second chamber, worked hard on a problem both parties were inclined to shirk. Otherwise he devoted the rest of his life to forwarding the establishment of the League of Nations and to the continued study of democracies. The democratic process fascinated him, and he traveled over almost all the habitable earth to observe it. Unfortunately, *Modern Democracies*, two volumes (1921) in which he summed up his conclusions in a number of actual case studies, did not have the dazzling charm of his conversation, in which he seemed "to have been everywhere, known everybody, and read everything." He received no fewer than 31 honorary degrees.

He had married, in 1889, Elizabeth Marion, daughter of Thomas Ashton and sister of the 1st Lord Ashton of Hyde; they had no children. His last speech in the house of lords, on the Irish treaty of Dec. 1921, was made within a few weeks of his death at Sidmouth, Devon, on Jan. 22, 1922. Bryce's other works include *Studies in Contemporary Biography* (1903) and *International Relations*, two volumes (1922).

See H. A. L. Fisher, *James Bryce*, 2 vol. (1927). (M. R. D. F.)

BRYCE CANYON NATIONAL PARK, in southern Utah, U.S., was established in 1928 to protect an area of 36,010 ac. of colourful eroded limestone and sandstone formations. Five years earlier, part of the present park, 7,040 ac., had been set aside as a national monument. The canyon was named for Ebenezer Bryce, an early settler in the region.

The area is most accurately described as a series of amphitheatres, rather than a canyon, below which stands an array of white- and orange-coloured columns and walls sculptured by wind, rain and frost. The geologic story of Bryce Canyon is related to that of nearby Grand Canyon (*q.v.*) and Zion National parks (*q.v.*), the stone of all three having been laid down while the region was inundated by a shallow sea or lake; but the sandstone and limestone beds of Bryce canyon were formed during a more recent period (*see* EOCENE AND PALEOCENE).

The high rim country of the park is part forest and part grass and sage, with white fir, Douglas fir, ponderosa pine, bristlecone pine and trembling aspen the dominant species. At lower, drier altitudes, piñon pine and Utah juniper predominate.

Some of the mammals that dwell in this sanctuary are mule deer, gray foxes, porcupines, marmots, mountain chipmunks and ground squirrels. A prairie dog town beside the park road interests visitors. Mountain chickadee, Townsend's solitaire, Clark's nutcracker, long-crested jay and Rocky mountain and pygmy nuthatches are some of the birds that inhabit the park throughout the year. They are joined by mountain and chestnut-backed bluebirds, juncos, violet-green swallows, white-throated swifts and other migrants during warmer months. Like most national parks, Bryce Canyon has a museum and information centre. A rim road has spurs that lead to outstandingly scenic overlooks such as Sunrise point and Inspiration point; a trail system descends from the rim to wind among the formations. (Dx. B.)

BRYDGES, SIR SAMUEL EGERTON (1762–1837), English genealogist and writer, and editor of rare Elizabethan texts, was born at Wootton, Kent, on Nov. 30, 1762. He studied at Queens' college, Cambridge, and was called to the bar at the Middle Temple in 1787. In 1789 he persuaded his elder brother that their family were the heirs to the barony of Chandos, being descended from a younger branch of the Brydges who first held the title. The case was tried and lost, but Brydges never gave up his claim, and used to sign himself *Per legem terrae* B.C. of S. ("By the law of the land Baron Chandos of Sudeley"). He re-edited A. Collins' *Peerage*, inserting a statement about his supposed right. In 1814 he was made a baronet. In 1818 he went to live abroad, mainly near Geneva where he died on Sept. 8, 1837.

Brydge's numerous works include *Poems* (1785); *Censura Literaria*, ten volumes (1805–09); *The British Bibliographer*, four volumes (1810–14), with J. Haslewood; *Restituta*, four volumes (1814–16), containing accounts of old books; and *Autobiography, Times, Opinions and Contemporaries of Sir Egerton Brydges* (1834). From 1813 to 1822 he edited a number of rare Elizabethan texts, including Edward Phillips' *Theatrum poetarum* (1800), Robert Greene's *Groatsworth of Wit* (1813) and works by Nicholas Breton (1815).

BRYENNIOS, PHILOTHEOS (1833–1914), Eastern Church theologian and discoverer of the Didache manuscript, was born in Istanbul in 1833. He was educated at Chalcis, Greece, and at the universities of Berlin, Munich and Leipzig. In 1861 he became a professor at Chalcis and in 1863 director of the school there. He was made head of the Great School of the Nation in Istanbul in 1867 and kept that position until 1875, when he was selected metropolitan of Serrai, Greece. In 1877 he became metropolitan of Nicomedia, in Turkey. Bryennios discovered in Istanbul in 1873 manuscripts containing the Didache (or "Teaching of the [Twelve] Apostles"), the two espistles of Clement to the Corinthians and other important religious documents. He published from these the first complete text of Clement's epistle (1875) and the *Teaching of the Twelve Apostles* (1883), both with valuable notes of his own. The discovery and publication of the manuscripts and Bryennios' commentaries are regarded as important contributions to theological literature and scholarship.

BRYENNIUS, NICEPHORUS (1062–1137), Byzantine soldier, statesman and historian, wrote a history of the imperial Comnenian family in the 11th century A.D. He was born in Adrianople in 1062 and died in Constantinople in 1137. He had gained the favour of the emperor Alexius I Comnenus and in 1097 married his daughter Anna and was given the title of Caesar. Bryennius successfully defended Constantinople against Godfrey of Bouillon (1097); conducted the peace negotiations between Alexius and Bohemund, prince of Antioch (1108); and played an important part in the defeat of Malik Shah, Seljuk sultan of Iconium (1116). After the death of Alexius, he refused to enter into the conspiracy set on foot by his mother-in-law and wife to depose John, the son of Alexius, and raise himself to the throne. His wife attributed his refusal to cowardice, but it seems from certain passages in his own work that he really regarded it as a crime to revolt against the rightful heir. He was friendly with the new emperor John, whom he accompanied on his Syrian campaign (1137), but was forced by illness to return to Constantinople, where he died the same year. It was at the suggestion of his mother-in-law, the empress Irene, that he wrote the history (called by him *Materials for a History*), dealing with the fortunes of the Comnenian family in the 11th century, particularly during the years 1070–76. This work has been described as a family chronicle rather than a history. He intended to include the activities of the emperor Alexius, but died before he could complete his work. In addition to information derived from older contemporaries (such as his father and father-in-law) and from official sources, Bryennius used the works of Michael Psellus, Joannes Scylitza and Michael Attaliata. His views are influenced by personal considerations and his intimacy with the imperial family, which at the same time, however, afforded him unusual facilities for obtaining material. His model was Xenophon; he abstained from an excessive use of simile and metaphor, and his style is concise and simple.

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BRYMNER, WILLIAM (1855–1925), Canadian landscape and figure painter, whose work and teaching exerted a considerable influence on Canadian art, was born in Greenock, Scot., Dec. 14, 1855, the son of Douglas Brymner. He went to Canada while he was still a small child and was educated in the province of Quebec. In 1878 he went to Paris, where he studied under Adolphe William Bouguereau and Tony Robert-Fleury. He subsequently exhibited his work at the Paris *Salon*, the Royal Academy in London and at a number of expositions in the U.S., where he frequently won prizes. He was president of the Royal Canadian Academy from 1909 until 1917. He died June 18, 1925, in England.

BRYNMAWR (BRYN-MAWR), an urban district of Brecknockshire (Breconshire), Wales, in the Brecon and Radnor parliamentary division, is 10 mi. E.N.E. of Merthyr Tydfil and 9 mi. W.S.W. of Abergavenny by road. Pop. (1961) 6,471. It lies in the extreme southeastern part of the county and on the northern edge of the south Wales industrial area and is on the main road between the English midlands and southwest Wales. Unlike the long, straggling townships in the narrow valleys of south Wales, Brynmawr (meaning "great hill") is a compact community at 1,100–1,300 ft. on the edge of Llangattock mountain (Mynydd Llangatwg) overlooking the Monmouthshire valley of the Ebbw Fach. Linked by road and rail with the industrial valleys, and close to the agricultural areas of southeast Breconshire and to the natural sources of coal, ironstone and limestone, the town became a considerable business and social centre. Of early 19th-century origin, it grew rapidly when coal came into general use in the iron-smelting industry. With the decline of ironworking and the exhaustion of its own mines, Brynmawr depended more on other mining centres to the south and on the steel industry at Ebbw Vale. This led during the periods of industrial depression (1925–35) to severe unemployment. A few small factories were established at that time, and the Society of Friends organized housing and alternative employment. After World War II additional and larger factories were introduced; by the early 1960s only a small percentage of the working population was engaged in mining and steel. (C. M. S. W.)

BRYONY (*Bryonia dioica*), a twining plant of the gourd family (Cucurbitaceae, *q.v.*), native to Europe and western Asia. It has a large white root, large palmate leaves, pale yellow flowers in axillary clusters and red berries. The black bryony (*Tamus communis*), a climbing plant of the yam family (Dioscoreaceae), of similar range, bears a black root, shining, heart-shaped leaves and scarlet berries. Bryony has been used as a cathartic and as a diuretic.

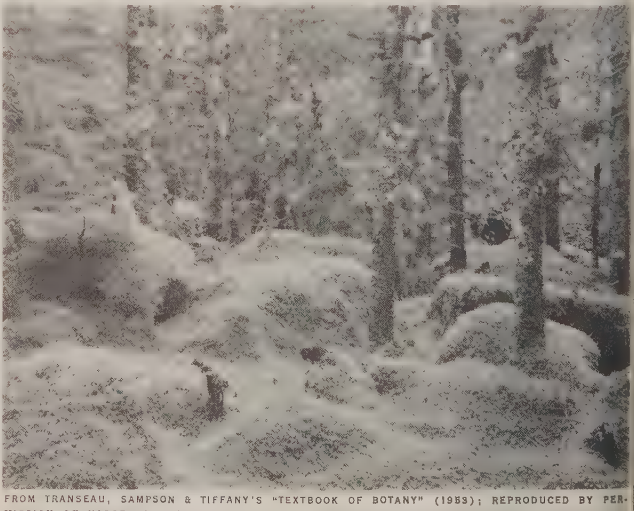
BRYOPHYTA, the botanical name of a division or phylum of the plant kingdom, usually placed between the algae and ferns. It is composed of liverworts and mosses which are usually small plants growing on trees, logs, rocks, soil and in fresh water. They grow best in warm areas of high precipitation and humidity but are also found under desert and tundra conditions.

The Bryophyta are variable in size and form. Some cannot be seen without a magnifying lens and a few may be a foot or more in height or length. Although usually a subordinate part of the vegetation they may form the ground cover of the northern coniferous forest or even dominate the vegetation of some bogs and tundras. A few may be found along shores. None, however, is marine.

The Bryophyta as a group are less aquatic and more complex than the algae, although many algal seaweeds are much larger. The two groups of plants are separated on a basis of their sex organs: the sex cells (gametes) of the algae are enclosed in a simple cell wall while those of the Bryophyta are contained in a single-layered jacket of cells.

Although some of the ferns and their relatives are mosslike in general appearance, the usually smaller Bryophyta are distinguished by the lack of true roots, stems and leaves and a vascular system through which plant sap can move.

The division, Bryophyta, is subdivided into two, three and sometimes more, groups. They are separated into the liverworts and mosses on a basis of differences in their spore-bearing structures (sporophytes). The spore case (capsule) of the mosses has a cylinder of sterile tissue (columella) in the centre surrounded by spores and usually opens by a definite lid (operculum). In contrast, the liverwort capsules either have no sterile tissue (except Anthocerotae) or more frequently have sterile slender cells (elaters) among the spores. Moreover, the capsules split longitudinally into two or more valves or rupture irregularly. The liverwort capsules have a compact wall of at most two layers of cells surrounding the spores while those of the mosses have a jacket several cells in depth, many of which may form a spongy tissue. Also the liverworts are more dorsiventral in growth form and some of them are almost ribbonlike. Mosses are more often erect and



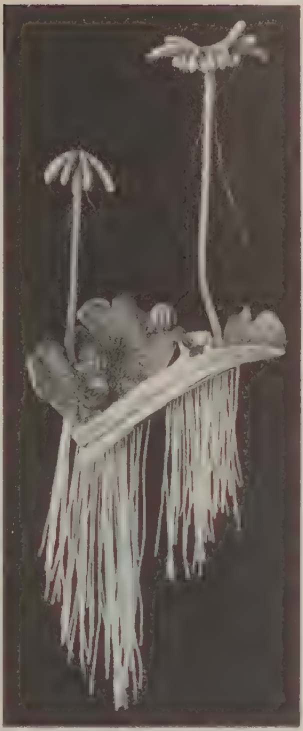
FROM TRANSEAU, SAMPSON & TIFFANY'S "TEXTBOOK OF BOTANY" (1953); REPRODUCED BY PERMISSION OF HARPER & BROTHERS

FIG. 1.—MOSS-COVERED TERRAIN IN A HEMLOCK FOREST GROWING ON A TERMINAL MORAINE AT THE MOUTH OF GLACIER BAY, ALASKA

radial in construction.

As a group Bryophyta have little economic significance; certain mosses are exceptions. All may play a part in reducing rocks, logs and stumps to soil, in initiating plant occupancy of bare soil and in retarding the erosion of soils. The bryophytes often serve as nest-building materials for birds and rodents as well as food and homes for insects, mites and other minute animals.

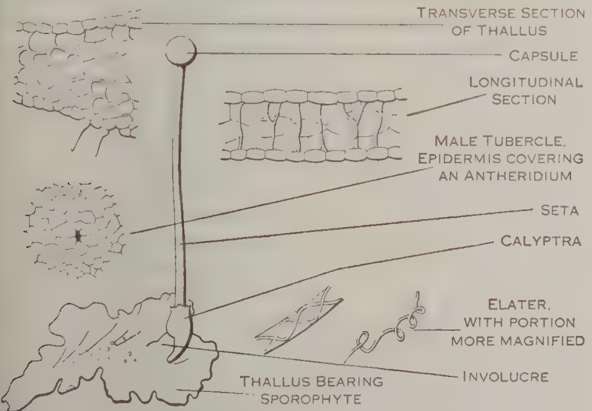
No other group of plants demonstrates so well the two (haploid and diploid) generations of the life cycle exhibited by sexual plants. Minute spores shed from the capsules grow into green plants (haploid gametophytes with a single set of chromosomes) of varying form, which bear the sex organs: male (antheridia) and female (archegonia). Mature sperms which are formed in the antheridia may swim under moist conditions into the archegonia and one may fertilize the egg in the enlarged base (venter) of the archegonium. The fertilized egg (zygote) produced by this fusion may then grow through embryonic stages into the spore-bearing plant (diploid sporophyte with two sets of chromosomes) with the capsule at the apex. Special cells in the capsule by reduction division (meiosis) give rise to the minute spores which initiate the cycle all over again.



BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

FIG. 2.—FEMALE PLANT OF MARCHANTIA POLYMORPHA, A COMMON LIVERWORT

See Liverworts; Moss.


TRANSVERSE SECTION OF THALLUS
CAPSULE
LONGITUDINAL SECTION
MALE TUBERCLE, EPIDERMIS COVERING AN ANTHERIDIUM
SETA
CALYPTRA
ELATER, WITH PORTION MORE MAGNIFIED
INVOLUCRE
THALLUS BEARING SPOROPHYTE

FROM "THE STUDENT'S HANDBOOK OF BRITISH HEPATICS"

FIG. 3.—GENERAL STRUCTURE OF THE PELLIA EPIPHYLLA, A COMMON THALLOID LIVERWORT

Bibliography.—H. C. Bold, *Morphology of Plants* (1957); D. H. Campbell, *Mosses and Ferns* (1918); G. M. Smith, *Cryptogamic Botany,* 2nd ed., vol. ii (1955); F. Verdoorn, *Manual of Bryology* (1932); E. V. Watson, *The Structure and Life of Bryophytes* (1964).

(A. J. Sh.)

BRYOZOA, a name of Greek derivation meaning "moss animals," refers to certain tiny aquatic animals that live in plantlike colonies. The many common names applied to bryozoans—moss animals, corallines, sea mats, sea or horn wrack—testify to their diverse appearance. Some of the colonies resemble small, delicately branched seaweeds; others are single-layered encrustations on rocks and other submerged objects; and still others are relatively large balls or irregular gelatinous masses attached to the stems of underwater plants, debris and the like.

The controversy as to the taxonomic position of these tentacled, bloodless invertebrates is reflected in the scientific names given the group. Linnaeus called them Zoophyta ("plantlike animals"). The term Bryozoa has been widely used by most zoologists; the British, however, prefer the term Polyzoa, which emphasizes the individuals that make up the colony.

Since 1869 the broad group has been divided into two clearly defined subgroups, called Entoprocta and Ectoprocta, on the basis of the position of the anus (see *Classification,* below). Some zoologists favour discarding the terms Bryozoa and Polyzoa entirely, and elevating Entoprocta and Ectoprocta to phylum rank. Entoprocta (*q.v.*) is treated in its own article; only the Ectoprocta are dealt with here, according to the following outline:

I. Introduction
    1. Historical Background
    2. Impediments to Study
    3. Economic Importance
    4. Distribution and Collection
    5. Study and Experimentation
II. General Characteristics
    A. The Colony
        1. Size and Colour
        2. Colony Origin
    B. Individuals (Zooids)
        1. Terminology
        2. General Anatomy
        3. Body Wall
        4. Polypide (Living Tissue)
        5. Reproduction
III. Class Phylactolaemata (Fresh-Water Ectoprocts)
    1. Description and Distribution
    2. Colony Form
    3. Polypide Structure
    4. Reproduction
IV. Class Gymnolaemata (Chiefly Marine Ectoprocts)
    A. Extinct Orders
        1. Order Trepostomata
        2. Order Cryptostomata
    B. Order Cyclostomata (Stenolaemata)
        1. Description and Distribution
        2. Polymorphism
        3. Polypide Structure
        4. Reproduction
    C. Order Ctenostomata
        1. Description and Distribution
        2. Body Wall
        3. Polypide Structure
        4. Colony Form
        5. Reproduction
        6. Polymorphism
        7. Cheilo-Ctenostomata
    D. Order Cheilostomata
        1. Description and Distribution
        2. Colony Form
        3. Body Wall
        4. Tentacle Protrusion and Retraction
        5. Polymorphism
        6. Reproduction
V. Fossil Distribution
VI. Classification
    1. Zoophyta
    2. Bryozoa *v.* Polyzoa
    3. Ectoprocta and Entoprocta

I. INTRODUCTION

The Ectoprocta (so named because the anus is outside the row of tentacles surrounding the mouth) number about 4,000 recent and about 15,000 fossil species. They are widely distributed in time and space but are not always recognizable except by specialists. These colony-building animals abound in present-day waters and in fossil deposits from many geologic strata (see *Fossil Distribution,* below).

Although often encountered by laymen, Ectoprocta colonies are usually mistaken for corals, sponges, hydroids, mosses, seaweeds, slime, pebbles and other animate or inanimate encrustations. Because most species are sessile, rather small or inconspicuously nondescript to the naked eye and lack the power of locomotion, they evoke little interest or recognition.

At present they have no exploitable commercial value and heretofore were considered as of minor importance except as fouling or stratigraphic organisms (see *Economic Importance,* below).

Their geological importance, however, may become greater as their identification becomes easier. Ordinarily they cannot be accurately identified without examination under a compound microscope.

There are few animal groups to compare with Ectoprocta for enchanting designs and geometric patterns.

1. Historical Background.—Bryozoans, sponges, seaweeds and coelenterates (corals, sea anemones, hydroids) usually grow in the same marine habitats, sometimes resemble each other superficially and are likely to show up together in a naturalist's collection. Consequently, during the 17th to early 19th centuries naturalists gradually began to study these organisms together, grouping them according to their texture and general growth habit (see *Taxonomic Position,* below).

These early workers had at their disposal microscopes that would be regarded today as little better than good hand lenses. Because classification and understanding of all species of bryozoans depends upon a good compound microscope, obviously the early workers were unequipped to study carefully and comprehend the nature of their specimens.

Theories.—It is inevitable that conflicting theories (mineralogical, botanical, zoological) should arise to explain the nature of these aquatic formations.

Little support was given the mineralogical theory, which maintained that the stony bryozoans, algae and corals were mineral formations resulting from sedimentation, agglutination or crystallization of calcareous and clayey matter. Supposedly by chance these deposits were fashioned into plantlike forms.

Predominant for many years was the botanical theory. The tiny bryozoan and coelenterate polyps with delicate tentacles spread out like the petals of a flower and the plantlike branching of some colonies lent support to this theory.

In time it became evident that the polyps possessed a far greater sensitivity, range of behaviour and complexity of structure than did ordinary plants, and the suspicion arose that perhaps they were animals.

2. Impediments to Study.—During the 19th century microscopical equipment improved; better methods of specimen preservation and preparation for microscopic study were devised; and the study of these minute organisms was begun in earnest by both amateur naturalists and professional biologists. Specimen collections, both fossil and recent, marine and fresh-water, were brought back from far and near. Cabinets of museums began to fill with specimens, some of which remain unstudied to this day.

Because bryozoans flourish in all seas and fresh waters, specimens are readily obtainable. But since they are difficult to keep alive and healthy for any length of time in the laboratory, most of the observations on them have been made on either freshly collected, dead, dried or preserved material. Moreover, in the majority of bryozoans the soft animal parts are encased in calcified exoskeletons, so the anatomy and physiology of the soft parts cannot be easily studied unless the exoskeleton is somehow removed. As of the early 1960s no successful method had been devised for removing the exoskeleton (zooecium) without harm to the living tissue inside. Because of these mechanical difficulties most of the bryozoan publications on the more heavily calcified types have been of a taxonomic nature (identification and description of species), and comparatively few papers have been produced on histology, physiology, embryology and development.

Early attempts to classify bryozoans were crude and based on what was evident to the unaided eye. Species and sometimes genera were erected on the basis of whether the colonies were stony, fleshy, slimy or fibrous; and whether they were encrusting, meshlike, arborescent, laminated or nodular. Little attention was given to the tiny polyps (zooids) that constituted the colony.

Species descriptions were usually brief, sometimes unaccompanied by any illustrations. The result has been chaos. It is impossible to say to which species some of these early names apply, or to determine the limits or validity of early genera and species. Present-day taxonomy is seriously handicapped by this early work.

As more collections were examined it became evident that there were many different bryozoan species, and that growth habit was a poor criterion for differentiating colonies. Colony size, shape, growth habit and texture can be influenced by factors such as age of colony, nature and extent of the substratum and other environmental conditions. New criteria for identification had to be found.

The beautifully illustrated works of A. D' Orbigny (1839–52), G. Allman (1856) and G. Busk (1852–86) stressed the importance of anatomical and skeletal details of individual zooids. These helped to turn the taxonomists away from preoccupation with mere colony growth form as the main criterion for classification. Bryozoologists also began stressing such features as ornamentation of the exoskeleton and the shape, size, number, direction and location of different structures.

The current problems facing taxonomists concern the range of variation of these external structures, how much of the variation is due to heredity and how much to environment. Other problems concern polymorphism, life cycles and larvae. There is an urgent need for more intensive study of the morphology, embryology, physiology and behaviour of the already known species.

3. Economic Importance.—Ectoprocta are not important in the food cycle of other organisms but may be ingested (more by accident than selection) by ducks, fish, sharks and invertebrate filter feeders. Statoblasts (asexual germinative bodies) of fresh-water species of *Plumatella* and *Pectinatella* are ingested with food by fish and amphibians, sometimes passing undigested through the vertebrate gut.

J. V. F. Lamouroux (1816) relayed accounts of Icelanders chewing "*Eschara*" (a *Flustra* species or retepore?) like tobacco, and S. F. Harmer (1929) surmised that bryozoans were undoubtedly used in medicine and as a dentifrice in classical times.

The fresh-water *Plumatella, Fredericella* and *Paludicella* have in the past fouled drinking water and irrigation systems. If filters through which water enters pipes are lacking or ineffective, statoblasts, larvae or colony fragments may enter the pipes. Here they may attach and develop into colonies, thus interfering with the flow of water, clogging valves, aiding bacterial growth, forming a base or home for other fauna and flora, and by decay polluting the water.

Bryozoans have been troublesome in the water supply systems of many places including Belgium, Burma, Germany, Great Britain, the Netherlands, the Malay peninsula and some U.S. cities (Boston, the borough of Brooklyn, etc.); and in the irrigation pipes of Benton county, Washington.

Marine bryozoans are also common fouling organisms growing on ship bottoms, buoys, submerged objects and shells of dead or living mollusks, crustaceans and other sessile organisms. Ectoprocta larvae may pre-empt the settling space of oyster spat, thus seriously interfering with the settling and development of oysters, as R. C. Osburn (1944) and P. Korringa (1956) reported for Chesapeake bay and for South Africa, respectively.

Some Ectoprocta are toxic. Colonies of *Lophopodella carteri* and *Pectinatella gelatinosa,* if torn or damaged, release substances that are lethal to nearby fish.

R. S. Bassler (1922) reported that fossil Ectoprocta, particularly abundant in American Paleozoic strata, should be the fossils upon which to rely in correlation work, but that they had not yet received the attention they merit as key stratigraphic species. They preserve well, are of convenient size (only small fragments are necessary for identification) and are represented by numerous species, some of which do not have too great a vertical range—all features that characterize good stratigraphic species.

M. K. Elias and G. E. Condra (1957) reported that bryozoan reefs are known from the Silurian to the Late Tertiary age and that Soviet scientists recently discovered that the massive oil-producing knolls *(shikhany)* in the west central Urals were built principally by bryozoans, which evidently provided an intricate framework on which other organisms became attached.

4. Distribution and Collection.—Most Ectoprocta are marine. Only about 50 species inhabit fresh water. Bryozoans occur in all the oceans, from icy polar waters to the tropic seas. Those of the arctic, antarctic and temperate regions have been more intensively collected and studied than those of the tropics.

Shells and the protected surfaces of rocks are favourite sites for bryozoan attachment. Muddy and sandy bottoms are far less favourable. Marine species can be scraped off ship bottoms, algae and other substrates, or can be brought in on coral, ascidian tests, hydroids, worm tubes or crab carapaces. Fresh-water species dwell in stagnant pools, shallow sloughs only a few inches deep, lakes or running waters, on water lilies, pond weeds, submerged objects and occasionally in water pipes.

The families Penetrantiidae and Immergentiidae bore into shells of living snails and dead bivalves, riddling the shells with criss-crossing stolons. L. Silén (1947) suggested that phosphoric acid is the likely boring medium used by *Penetrantia*.

Ectoprocta occur from surface water level down to abyssal depths. The greatest depth from which a fresh-water bryozoan has been reported is 214 m. (about 700 ft.) for *Fredericella sultana* from Swiss lakes by F. Forel (1885). The deepest marine record is 3,125 fathoms or 5,719 m. (about 18,750 ft.) for four bryozoan species collected by the "Challenger" expedition (Busk, 1884). Current deep sea research may break this record.

Shore forms can be gathered without any special equipment other than containers for water and specimens; deeper species must be dredged for.

Since bryozoans are benthic and sessile (except during the brief pelagic larval stage), in collecting specimens it is often necessary to bring in the substratum (algae, rocks, shells, etc.) to which the colonies are attached. Separation from the substratum without destruction of the colonies is impossible in those cases where the species form a fragile, one-layered, entirely adherent crust over the substratum.

The colonies of the fresh-water *Fredericella*, *Lophopodella* and *Plumatella* can be more easily scraped off the substratum than can calcareous marine species, because the former adhere less firmly or closely and have a more open mode of growth.

5. Study and Experimentation.—*Methods of Study.*—Whenever possible, specimens should be studied alive soon after collection. In some species tentacle number is significant; it ranges rom 8 to 106, depending on the species, being constant in some, variable in others. By treatment with chloral hydrate or other anesthetics the tentacles can be fixed in an extended position before the colonies are placed in 70% alcohol preservative.

Soft species may be thus treated and stored; but hard species, *i.e.*, those with a thick, opaque, calcareous exoskeleton, lend themselves to other techniques, particularly if one is unconcerned with saving the soft internal tissues. Hard species can be kept in a dry state.

Fossil species may have to be sectioned in several planes to reveal hidden internal structures. Also, small fragments can be etched out of larger blocks of fossiliferous limestone by 3% hydrochloric acid solution (Bassler, 1953). Bryozoans also have been studied under polarized light and with X-rays.

Experimentation.—Since dependable methods of long-continued indoor cultivation of bryozoans have not been developed, extensive experimental work has not been undertaken on this group.

Most of the experiments, in addition to the observations on the normal behaviour, have been concerned largely with the study of responses of larvae, individuals and colonies to (1) different forms of stimulation (mechanical, thermal, photic, chemical, rheotactic); (2) alteration of the environment; or (3) the presentation of miscellaneous (treated or untreated) substrates for larval attachment or selection. The culture media have been varied by changing the pH, salinity and other chemical or nutrient constituents. The addition of assorted solutes and suspensions to cultures has permitted he study of ciliary action, storage of materials by cells, routes followed by ingested or excreted particles in zooids and the effects on larval behaviour and metamorphosis. A detailed account of he experimental results is summarized in the work of L. H. Hyman (see *Bibliography*).

II. GENERAL CHARACTERISTICS

A. The Colony

Bryozoans form sessile (attached) colonies called zoaria, which over stones, shells, submerged objects and organisms with stony, leathery, fibrous, mossy, fuzzy or gelatinous encrustations, depending upon the species.

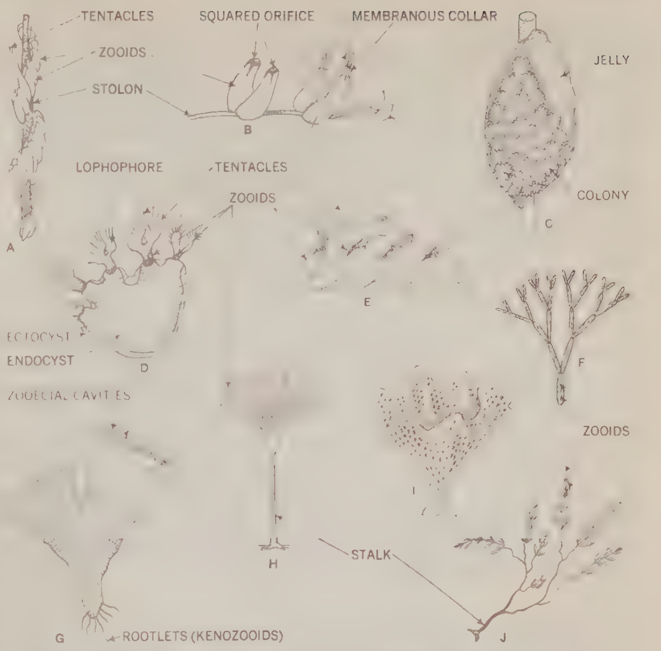


FIG. 1.—GROWTH FORMS OF BRYOZOAN COLONIES OF THE GROUPS: (A, B) CTENOSTOMATA; (C, D, E) PHYLACTOLAEMATA; (F, G, H, I, J) CHEILOSTOMATA

(A) *Amathia*, tentacles evaginated on one zooid; (B) *Bowerbankia*, two zooids evaginated and two retracted; (C) jelly ball (*Pectinatella magnifica*) growing around twig; (D) Lophopodid colony (*Lophopus* or *Lophopodella*), polypides suspended in common sac; (E) *Plumatella* with four zooids evaginated; (F) *Cellaria*, showing dichotomous branching, nodes and internodes; (G) *Cellarinella* which forms a flat calcareous slab or flabellate colony; upper right diagram is end view of flat blade; (H) *Kinetoskias* with zooids in fernlike sprays atop stalk; (I) calcareous "sea lace" (*Retepora*); (J) *Bugula* colony

1. Size and Colour.—*Size.*—In some instances colonies attain considerable bulk (a globular Trepostomata colony measured 19.7 in. in diameter) or form cobwebby sheets several square feet in area (*Membranipora* species). However, the individuals, called polyps or zooids, that make up the colony are microscopically minute, ranging from about 0.25 mm. to 4 mm. in length. It is not strange that early naturalists mistook these encrustations for crystallized mineral matter, coral, seaweeds, aquatic moss or slime (see *Historical Background*, above).

P. MacGillivray (1880) described a colony of *Dictyopora (Adeona) cellulosa*, shaped like a head of lettuce, 9 in. high and 16 in. in circumference. G. Johnston (1847) confirmed D. Landsborough's observations on the thin "web of silvery lace," *Flustra (Membranipora) membranacea*, which could attain a length of five feet and a width of eight inches on a blade of the brown seaweed *Laminaria;* such a colony perhaps consisted of over 2,000,000 zooids. K. Reichert (1870) described a soft *Zoobotryon* colony that formed a mass 18 in. high and 3 to 4 ft. in circumference. Bassler (1953) mentioned a massive fossil Trepostomata colony more than a foot and a half in diameter.

Pectinatella magnifica, the fresh-water jelly ball, sometimes forms gelatinous, clammy masses larger than a man's head, with hundreds of star-shaped colonies covering the surface and many bloodworm larvae boring through.

Many bryozoans form single-layered crusts less than one millimetre thick, but others, such as *Smittina* species, can develop into multilayered, fist-sized, lightweight, porous "rocks" or nodules.

The number of zooids in a colony may be few *(Hippothoa distans)* or exceedingly large (some *Membranipora*), depending on the species, ecological conditions or the amount of suitable substrate. If the substratum is extensive and conditions are favourable (as for example on a large laminarian frond), a number of colonies might develop side by side and coalesce, their boundaries merging.

Colour.—Bryozoa exhibit all degrees of translucency, from glasslike transparency to utmost opacity. They also have a considerable colour range, from iridescent white to ivory, buff, tan, yellow, amber, pale orange, brown, rose or purplish red. The colour of some species may be determined genetically, whereas in others it may depend on diet, age or environmental conditions.

Bioluminescence, claimed for several bryozoan species, appears to be due to agents other than the bryozoans themselves, except possibly in the case of *Acanthodesia serrata.*

2. Colony Origin.—All Ectoprocta are colonial. Most of the colonies develop by asexual budding from an ancestrula, the initial zooid or parent of the colony. The ancestrula originates from the sexually produced larva.

New zooids are budded laterally and distally, producing colonies of definite shape and growth habit. Some organic continuity exists between neighbouring zooids through tiny pores present in their lateral and end walls (see *Interzoidal Communications,* below).

Fresh-water species have developed additional asexual ways of initiating colonies—by hibernacula and statoblasts. *Paludicella* produces hibernacula (chitin-encased resting buds), whereas the Phylactolaemata produce statoblasts (chitin-encapsuled seedlike bodies). Each germinates by splitting open and thrusting out a new zooid from between the two separated valves.

B. Individuals (Zooids)

1. Terminology.—Early workers in the 18th to mid-19th centuries used the word "cell" for the individual zooids or compartments that constitute a colony. In 1865 F. Smitt replaced cell with the word "zooecium." In 1892 H. Prouho suggested that zooecium be used only for the protective external envelope or exoskeleton of each individual of the colony and that a new word "bryozoïte" be used for the entire complex of soft internal organs and hard exoskeleton of a single individual. In time "bryozoïte" became "bryozooid," "bryozoid," and now it is simply "zooid" or "zoid." Many terms have been coined for various parts of a zooid and of a colony. The terminology developed for fossil species is truly formidable.

An Ectoprocta colony usually has many zooids, like a building that has many apartments. The zooids may be all of one kind or may be polymorphic, *i.e.,* of two or more different types, functionally and structurally. Not all species have all types.

Autozooids.—The most numerous zooids of a colony are the self-maintaining ones, called autozooids to distinguish them from other kinds of zooids (heterozooids) that might also occur in the same colony. Sometimes the distinction between autozooids and heterozooids is not very great. Other times there can be no mistaking the different types.

Heterozooids.—These are individuals or chambers in which there is no polypide (gut and tentacular crown) or only a vestige of polypide and some or no musculature. Heterozooids, which will be discussed in detail under the sections on classes and orders, include gonozooids (for reproduction or brooding); kenozooids (rootlets, spines, stolons, chambers), nanozooids (dwarfs), avicularia, vibracula and ancestrulae. Some bryozoan species have only autozooids in the colony. Other species may have one or more heterozooid types in addition, but no species contains all the different kinds of zooids known.

2. General Anatomy.—A typical autozooid consists of two major parts, the polypide and the body wall.

The polypide consists of the movable, living inner soft parts—the tentacular crown, digestive tract and nerves and muscles associated with the gut and tentacular crown.

3. Body Wall.—The body wall and its exoskeletal products are given a variety of names: cystid, zooecium, ectocyst, endocyst, cryptocyst, gymnocyst, pleurocyst, tremocyst, etc., depending upon their position, nature, composition or origin.

The exoskeleton secreted by the soft layer of the body wall in a few species is gelatinous, in others cuticular, chitinous or siliceous, but in the vast majority it is calcareous. Each little box housing a polypide is generally termed a zooecium. After a polypide dies and degenerates, shrinking to a lump called a brown body, its zooecium may sometimes be reoccupied by a new, regenerated polypide. A colony may be dead at its point of origin, where its zooecia are empty of polypides, but may be flourishing at the periphery, where new polypides are developing and new buds forming continually.

4. Polypide (Living Tissue).—Ectoprocts are tentaculate coelomates having specialized musculature, nervous and reproductive systems and a Y-shaped digestive tract between whose two approximating ends is located the ganglionic centre of the nervous system. The coelom is ciliated in spots and sometimes traversed or cluttered with loose tissue (parenchyma) or tissue strands (funicular strands), muscle fibres and gonadal products. Circulatory and respiratory systems are absent. Whether any excretory organs are present is debatable.

Tentacular Crown.—The tentacular crown consists of a single row of ciliated hollow tentacles borne on a flexible fold of skin, the lophophore. The lophophore sits atop the tubular introvert (tentacular sheath) and surrounds the mouth. Great retractor muscles attach to the lophophore base. They pull the tentacular crown downward into the body cavity when occasion demands or when something disturbs the zooids. Simultaneously the tentacular sheath turns outside in, like a glove, forming a tubular cover or sheath for the retracted tentacles. Tentacle extrusion is accomplished by various methods, depending on the species and on the construction and flexibility of the body wall.

Digestive Tract.—The autozooid gut consists of the mouth, pharynx, esophagus, stomach (which is divided into the cardia, caecum and pylorus), rectum and anus. A gizzard appears in some ctenostome species. The mouth and anus are close together at the top of the polypide.

The caecum is anchored to the body wall by a funiculus in fresh-water species. A funiculus does not seem to be common in marine forms (Harmer, 1915).

Except for the funicular attachment the gut is suspended freely in the body cavity. When the tentacular crown is withdrawn into the body cavity the gut folds up or twists around in whatever coelomic space is available.

The mouth, pharynx and part of the pylorus are ciliated. The beating of cilia that cover certain areas of the tentacles, lophophore and mouth creates a current that sweeps food into the gullet.

The food consists of microorganisms: protozoa, bacteria, algae, larvae, crustacea, etc. Undesirable or overly large particles may be rejected by ciliary action and by flicking of the tentacles. Sometimes hardy organisms such as rotifers may be deposited in the fecal pellets, unharmed, after a sojourn in the gut.

The anus opens outward below the tentacular crown and outside it.

The bryozoan gut is embryologically peculiar in that it originates from the colony's body wall, which is ectodermal and mesodermal in origin. No entoderm cells take part in the formation of the gut.

5. Reproduction.—Zooids can reproduce in two ways: asexually by budding off new zooids to increase the population of the colony and sexually by production of larvae that develop from fertilized eggs. Some bryozoan species are hermaphroditic (having both male and female organs in the same zooid); others are dioecious (having separate sexes).

III. CLASS PHYLACTOLAEMATA (FRESH-WATER ECTOPROCTS)

The scientific name, derived from the Greek meaning "guarded gullet," refers to the flap of body wall (epistome) that overhangs the mouth. Statoblasts are produced and the lophophore is bilateral, usually horseshoe-shaped.

1. Description and Distribution.—There are approximately 50 Phylactolaemata species, all inhabitants of fresh water and of world-wide distribution. Their spread to new regions is facilitated by statoblasts, which can be transported by aquatic birds, amphibia, reptiles, aquatic vegetation, boats, floods, winds or other agencies. Statoblasts cling to bird feet or plumage or can be eaten by ducks, frogs, salamanders and turtles. A small percentage of such ingested statoblasts can survive passage through the vertebrate digestive tract, emerge in the feces and still germinate (C. Brown, 1933).

Species of *Cristatella, Lophopus, Lophopodella* and *Pectinatella* can be easily differentiated from each other by the characteristic arrangement and number of rows of spines on their statoblasts. These four genera are alike in having a clear, gelatinous, colourless outer body covering called the ectocyst. They are sometimes known as the lophopodid type of Phylactolaemata, as opposed to the plumatellid type.

The plumatellid Phylactolaemata are the genera *Plumatella, Fredericella* and *Stolella*. In these the ectocyst is firmer, coloured and usually chitinized. Sometimes sand grains or debris cling to its surface. The statoblasts of these Phylactolaemata are spineless. The plumatellid species are very hard to tell apart from each other, and it is uncertain just how many of them are valid and how many are merely phenotypes. M. Toriumi's experiments on Phylactolaemata indicate that variation in this group is far greater than early workers suspected.

The genera *Hyalinella, Gelatinella* and *Stephanella* are intermediate between the two above-mentioned groups. Their ectocyst is more of the lophopodid type, whereas their statoblasts are of the spineless, plumatellid type.

2. Colony Form.—A lophopodid colony is somewhat like a glove. Its zooids protrude, like glove fingers, from the common colonial body cavity and can withdraw their tentacular crowns and sheaths into it when necessary. Thus the basal attached part of the colony is a large, hollow, sometimes lobed but not partitioned, sac in which are suspended the polypides whose tentacular sheaths and crowns protrude from the free surface of the colony. The body cavity is cluttered with the dangling digestive tracts, strands of retractor muscles, funiculi, statoblasts and sometimes larvae, like scaffolding inside a room.

The number of zooids per colony ranges from a few to about 45 in *Lophopus* and *Lophopodella*.

Pectinatella magnifica forms a large central mass of jelly covered by a thin layer of numerous adjacent star-shaped colonies whose sizes range from 5 to 30 mm. Each colony contains about 18 zooids (or fewer). The composition of the jelly is 99.7% water. The remaining 0.3% contains various salts, protein, chitin, etc. (K. Kraepelin, 1887).

Cristatella forms a narrow gelatinous colony that has been likened to a hairy caterpillar because it looks fuzzy and can creep a bit. Young colonies of other lophopodid genera can also creep short distances. *Cristatella* colonies may reach a length of 30 cm. and a width of 1 cm., but are usually much smaller.

The plumatellid colony is more plantlike, its firm brownish zooids branching like twigs. There is greater separation between successive zooids. If a large number of statoblasts germinate in a small area, the resulting colonies may become densely matted, with their zooecial tubes cemented together and only their tips remaining free.

3. Polypide Structure.—*Epistome.*—The epistome is a ciliated, flexible fold of skin arising from the lophophore between mouth and anus. It overhangs the mouth. Muscle fibres pass anteroposteriorly across its cavity, the protocoel. When food particles are whirled down toward the mouth, the epistome aids in warding off the undesirable particles.

Tentacular Crown.—The tentacular crown consists of a row of 16 to 106 hollow tentacles borne on the lophophore. In *Fredericella* the lophophore is orbicular to oval, surrounding the mouth. In the remaining Phylactolaemata the lophophore, laterally prolonged into two free arms, is horseshoe-shaped, with the mouth in the bend of the horseshoe. The single circular row of tentacles is thus bent into a double horseshoe-shaped row, with the tentacles in front of the mouth constituting the outer row and those behind the mouth the inner row.

The lophopodid zooid generally has more tentacles than the plumatellid zooid. The tentacle number varies more in the Phylactolaemata than in the class Gymnolaemata (*see* below). The ancestrula, or initial zooid of the colony, may have fewer tentacles than succeeding zooids. The tentacle number within a given colony may vary too.

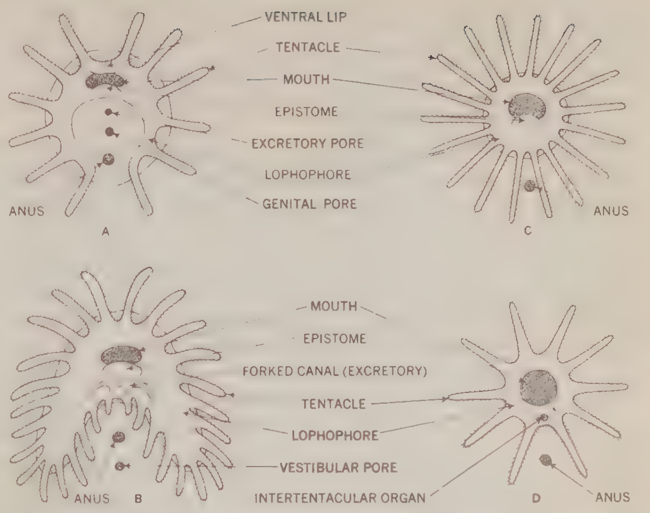


FIG. 2.—DIFFERENCES IN BRYOZOAN TENTACULAR CROWNS, TOP VIEWS

(A) Representative entoproct; (B-D) ectoprocts: (B) *Plumatella* (Phylactolaemata); (C) *Fredericella* (Phylactolaemata); (D) ctenostome or cheilostome (Gymnolaemata)

The very flexible lophophore and tentacles are supplied with nerves and muscle fibres. Each tentacle tip has a small pore or canal. Whether the function of these pores is excretory or whether they are for equalization of internal body pressure is not certain. Perhaps they serve both purposes.

Coelom.—The extensive body cavity is lined with a tiny membrane, the peritoneum, and filled with fluid containing phagocytic amoeboid cells, suspended digestive tracts, attached funiculi, bundles of retractor muscles and sometimes sperms and larvae. It is incompletely partitioned into at least three communicating cavities: mesocoel, metacoel, protocoel.

The mesocoel is the space around the pharynx and extending into the lophophore. It is sometimes called the ring canal or the subtentacular canal. The metacoel is the largest and the main body cavity. The protocoel is the cavity of the epistome.

Two ciliated canals, one from each lophophore arm, converge around the epistome and open sometimes first into an enlarged vesicle, other times directly into the cavity of the median tentacles back of the mouth. The function of these so-called forked canals is uncertain.

Muscular System.—The musculature is of the smooth type in Phylactolaemata. The body wall has a circular and a longitudinal muscle layer, but the digestive tract has only a circular muscle layer. The tentacles have longitudinal fibres, but circular ones are absent.

In addition to the muscle layers or fibres of the body wall, gut and tentacles there are special groups of muscles and ligaments: retractors, vestibule dilators, diaphragmatic sphincter and duplicature bands.

The retractors are the most conspicuous muscles of the zooid. They are two bundles of long muscle fibres, a bundle along each side of the digestive tract. One end of the retractors attaches to the body wall. The other end attaches to the polypide from the esophagus upward to the lophophore. Contraction of the retractors pulls the polypide and tentacular crown into the body cavity, folding the tentacular crown as one would close an umbrella.

Healthy polypides do not remain retracted in the body cavity for long. Their normal position is one of expansion or protrusion, with the tentacles reasonably spread so that feeding can take place. Retraction occurs when there is a disturbance in the surrounding medium or when other organisms attack the bryozoan.

Emergence is facilitated by several structures and activities. When the vestibule dilators, consisting of single muscle fibres, contract and the diaphragmatic sphincter (*see* below) relaxes, the polypide is pushed out because of the coelomic pressure exerted on it by the contraction of the body wall musculature.

The diaphragmatic sphincter surrounds the base of the tentacular sheath. It attaches to the body wall by the radiating ligamentous duplicature bands. When the polypide is retracted and the tentacular crown is withdrawn into the inturned tentacular sheath, the diaphragmatic sphincter contracts like a drawstring to close the sheath above the tentacles.

Nervous System.—The central nervous system (lophopodid type) consists of a large central ganglion from which arise two main lophophoric nerve trunks (also called ganglionic horns) and a number of small nerves.

The ganglion is located in a closed sac in the mesocoel between the pharynx and anus. The ganglion is kidney-shaped; its core is fibrillar, and its surface layer ganglion-celled.

The two tubular ganglionic horns arising from the sides of the ganglion supply the tentacles and lophophore arms. They also give off nerve fibres that form an epistomial ring and a circumoral ring to supply the epistome and the tentacles.

The ganglion gives off independent nerves that directly supply the epistome, tentacular sheath, pharynx and the rest of the gut. The tentacular sheath and gut nerve supply form a plexus that is connected to a nerve plexus in the body wall.

Special sense organs are unknown.

4. Reproduction.—*Sexual Reproduction.*—Phylactolaemates are hermaphroditic, so far as is known. They have gonads, of peritoneal origin, but no gonoducts. The ovary is attached to the body wall at or near the vestibule, close to an asexual bud. The testes develop on the funiculus in most species; in *Cristatella* they may also develop on the partial septa in the metacoel.

Motile sperms, shed into the body cavity, are aided in their movement by the circulation of the coelomic fluid. Fertilization is internal.

Oval ciliated "larvae" (actually, very young colonies, 0.42–2 mm. long, depending on the species, consisting of a sac containing a developing polypide or two) develop internally. Later they dislodge from their attachment to the body wall and rotate about in the coelom of the mother colony for a short time before release.

Upon release the young colonies swim about actively in the water before attachment and metamorphosis. The covering cilia are shed in patches. The outside larval covering peels back while the internal polypide-producing membrane with its polypides is extruded. In a short time the fast-shrinking larval covering, sucked into the bottom of the new, fast-growing colony, degenerates or is used up during the next two to five days.

Ciliated larvae can be found during the summer and into the early fall, but are far less numerous than the asexually produced statoblasts.

Asexual Reproduction.—The initial zooids of a colony may develop from a sexually produced larva or from an asexually produced statoblast. The resulting colonies, so far as is known, do not differ in any recognizable respect. Succeeding zooids develop by budding. Divided or severed colonies can continue to propagate.

Budding.—This refers to growths that develop internally on the colony body wall. These polypide buds appear in definite locations and in a definite sequence. Between these main buds appear secondary, tertiary, etc., buds that may grow while the main buds are thriving, degenerating or dying.

The amorphous cell mass of a bud speedily differentiates into vaguely outlined lophophore, retractor muscles and gut. Later, tentacle stubs appear. The polypide, which enlarges and differentiates, does not evaginate its tentacles until the digestive tract and tentacles are sufficiently developed so that the polypide can feed.

New buds form and evaginate at a rapid rate if there is sufficient food. Because of difficulties in cultivating, colony development seems to be much slower under laboratory conditions than under natural conditions.

In *Lophopodella carteri* the initial zooid is sometimes sufficiently mature to evaginate on the same day that the statoblast from which it has developed cracks open; at other times it is not ready to evaginate for a week. The second polypide is ready to evaginate the next day; thereafter the budding process is speeded up if nourishment is adequate.

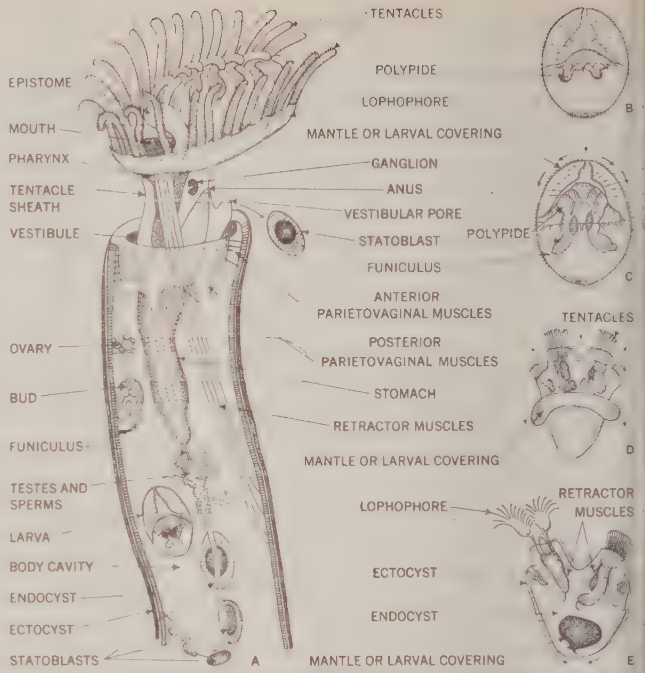


FIG. 3.—REPRODUCTION AND DEVELOPMENT OF PHYLACTOLAEMATA

(A) Mature plumatellid (*Plumatella*) zooid containing all reproductive products, although not all of them actually occur simultaneously at this stage of development; (B-E) stages of a plumatellid (*Hyalinella*) from "larva" (cystid) to young colony showing (B) ciliated larva; (C) later larva with polypides better differentiated (arrows indicate direction along which mantle will fold back as polypides evaginate); (D) larva with mantle peeled down developing into colony; (E) young colony of four zooids with remnants of degenerating mantle sucked into colony body cavity

A laboratory-reared colony of *Hyalinella punctata* evaginated 45 polypides by the 20th day after the original polypide had emerged from the statoblast.

In Phylactolaemata and Cyclostomata (*see* below) colonies a new polypide develops first, then the zooecial, or cystid, wall grows around it and differentiates to house the polypide. The reverse situation prevails in the Ctenostomata and Cheilostomata: in these groups the cystid develops first, forming a hollow chamber within which a polypide will develop later.

Statoblasts.—Phylactolaemata alone among the bryozoa produce statoblasts. These chitin-encased, brownish germinative bodies, formed in great numbers during most of the life of the colony, are extremely useful in identification. Some bryozoans can be identified from a single statoblast. They pass out of the colony through a special scarcely detectable vestibular pore located ventral to the anal region (E. Marcus, 1941).

Statoblasts are released in large numbers during the growing season (spring to autumn). Many of them float to the surface of the water, sometimes forming noticeable drifts at the water's edge. Brown (1933) reported drifts one to four feet wide, half a mile in extent, along the shores of Douglas lake, Michigan, in spring and late autumn—drifts composed mainly of statoblasts.

Special names are given to different types of statoblasts. Statoblasts provided with a buoyant float of air cells but no spines are called floatoblasts. Statoblasts provided with a buoyant float and with spines are spinoblasts. Both types may float to the surface of the water. Statoblasts that remain permanently attached to the inside of zooecial tubes or to the substratum, and that lack a float or have only a vestigial annulus instead, are called sessoblasts. Piptoblasts are without a float but are not permanently attached; they lack spines.

Although statoblasts normally germinate shortly after release (except when they overwinter), they can withstand drying or chilling for considerable periods of time, up to 4½ years for *Lophopodella*, and still remain viable.

Statoblasts develop on the polypide funiculus along with the testes, though not always at the same time. When together, the testes are closer to the polypide gut, while the statoblasts, strung below the testes like a row of diminishing discs, are closer to the body wall (P. Brien and C. Mordant, 1956).

The very youngest statoblasts appear as opaque, white swellings on the funiculus. As they develop, their colour and shape change, from white to yellow to brown and from a small lump to a thick, flattened disc. The capsule, with its germinal material, is distinguishable earlier than the lighter coloured float. As many as eight developing statoblasts may appear in a graded series of sizes on the funiculus, at any one time.

Colonies die out usually at the onset of winter or earlier, their tubes sometimes loaded with statoblasts. When spring comes, the overwintered statoblasts hatch and start new colonies.

IV. CLASS GYMNOLAEMATA (CHIEFLY MARINE ECTOPROCTS)

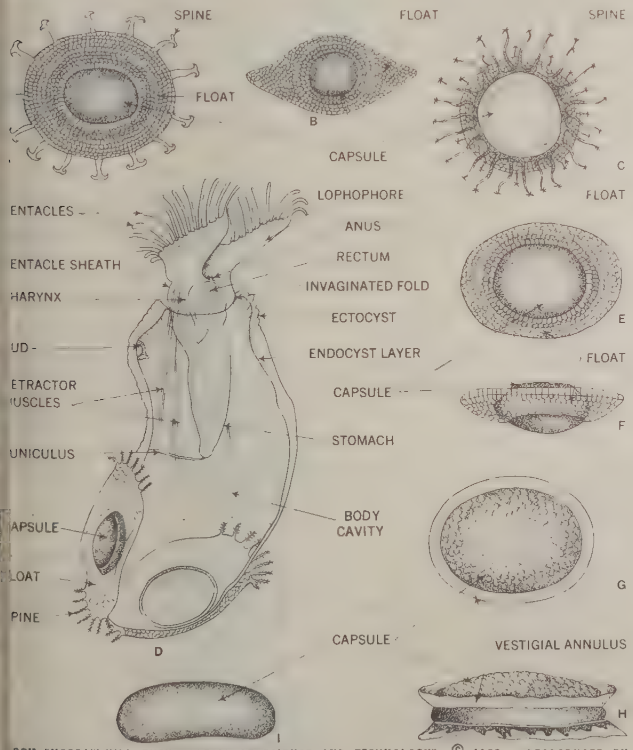
The name of this class, derived from the Greek meaning "naked gullet," refers to the lack of an epistome to guard the mouth. The lophophore is circular. To this class belong most of the 19,000 bryozoan species.

A. Extinct Orders

1. Order Trepostomata.—This is a wholly fossil Paleozoic order, named for the difference in the appearance between the inner and outer zones of the zooecial tubes. The inner, axial part of the tube is thin-walled. The outer, superficial part of the tube is thick-walled. The transition is sudden.

The trepostomes, sometimes called the stony bryozoans, for many years were considered to be fossil corals. They have long calcareous tubes (tubular zooecia) consolidated by branching and growth habit into massive colonies or lamellar fronds.

The zooecial tubes are transversely partitioned by "diaphragms" that may represent floors laid down by successive occupants and builders of the tubes.



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IG. 4.—PHYLACTOLAEMATA STATOBLASTS: (A–D) SPINOBLASTS; (E, F) LOATOBLASTS; (G, H) SESSOBLASTS; (I) PIPTOBLAST

A) *Pectinatella;* (B) *Lophopus;* (C) *Cristatella;* (D) *Lophopodella,* germinated spinoblast showing its two valves forced apart by growing coenoecium or ystid sac containing tentacled polypide; (E, F, G, H) common to *Hyalinella,* *lumatella* and *Stolella;* (I) *Fredericella*

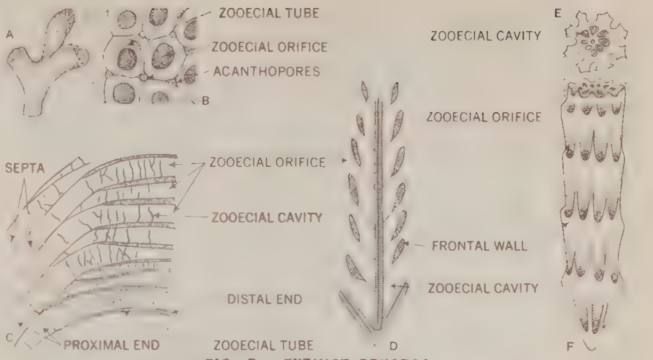

FIG. 5.—EXTINCT BRYOZOA

(A-C) Trepostomata (*Batostoma*) showing (A) fragment of stone colony; (B) enlargement of surface of colony; (C) longitudinal section through colony. (D-F) Cryptostomata (*Ulrichostylus*) showing (D) longitudinal section of colony; (E) end view of colony; (F) side view of colony fragment

Small clumps of elevated "cells" (monticules) are scattered over the colony surface at regular intervals.

Trepostomes, apparently closely related to Cyclostomata, are reported by Bassler (1953) as comprising 105 genera.

2. Order Cryptostomata.—This group is so-named because the zooecial orifice (opening through which tentacles and tentacular sheath are extruded) is concealed at the bottom of a tubular shaft or vestibule. This is also a wholly extinct Paleozoic order.

The colonies are calcareous, but not massive. They form branched stems or delicate reticulated fronds, like a sheet punched full of regularly spaced holes. As in the trepostomes the zooecial tubes have a thick-walled outer zone and a thin-walled inner zone, but the tubes are much shorter than in trepostomes.

Structurally the cryptostomes appear to be related to the Cheilostomata. Bassler (1953) suggests that possibly the Cryptostomata are really Paleozoic cheilostomes. He reports 127 cryptostome genera, but Elias and Condra (1957) have detached the family Fenestellidae from the cryptostomes and have made a new order, the Fenestrata, out of it.

B. Order Cyclostomata (Stenolaemata)

The group is so-named because the zooecial orifice is round and not closed by an operculum.

Because a class of fishlike vertebrates is already named Cyclostomata (hagfishes, lampreys) bryozoologists have suggested other names for the cyclostomatous Bryozoa: Stenolaemata (F. Borg, 1926) and Stenostomata (Marcus, 1938).

Borg's Stenolaemata (meaning narrow gullet) was intended as an order name for cyclostomes and possibly trepostomes, but for etymological reasons his name was rejected by others. Marcus proposed the name Stenostomata (meaning narrow mouth) as being more suitable. Although at present all three names are in use, preference should perhaps be given to Borg's term on the basis of priority.

1. Description and Distribution.—Stenolaemata form simple-looking colonies without avicularia or vibracula. Their zooids, narrow, cylindrical, sometimes very elongated tubes, have calcified walls that in some families (but not in the Horneridae and Lichenoporidae) are provided with minute pores (pseudopores).

Stenolaemates are entirely marine. Fossil cyclostomes appeared in the Lower Ordovician and became the predominant Early and Middle Mesozoic Bryozoa. Bassler (1953) reports about 303 genera of fossil and recent cyclostomes. The cyclostomes, like the Phylactolaemata, are a more primitive or simpler group than the Cheilo-Ctenostomata.

The zooecial orifice is rounded, terminal and closed not by an operculum but by an uncalcified terminal membrane of which the vestibule and tentacle sheath are an inward continuation.

The whole polypide is suspended in a membranous sac seemingly peculiar to the stenolaemates, yet having a hydrostatic function. Embryonic development occurs inside the membranous sac of a fertile zooid. Polyembryony, the formation of several embryos from one egg, occurs among the stenolaemates. Embryos are incubated in special gonozooids (in the family Crisiidae) or in coelomic spaces or brood chambers between zooids (in the Lichenoporidae).

Stenolaemata fall easily into two natural groups: the articulated-jointed, erect Crisiidae and the unjointed, erect or encrusting, remaining families.

The colonies of articulated forms are necklacelike, consisting of short, yellow to brown cuticular nodes (joints) alternating with long, white calcareous internodes. The internodes consist of zooecial tubes branching either in a single series or in a spray. Tubes may be grouped into radial, transverse or longitudinal bundles called fascicles.

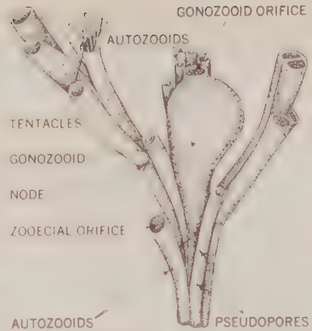

FIG. 6.—PORTION OF CYCLOSTOMATA (STENOLAEMATA) COLONY

Crisia colony showing autozooids (one with tentacles evaginated) and one gonozooid

The colonies of nonarticulated forms are heavier, less elegant. One of these has star-shaped colonies. The other families form fanlike, discoid or rounded colonies.

Arborescent colonies may occur in either articulated or nonarticulated species.

2. Polymorphism.—A stenolaemate colony may contain several kinds of zooids—nanozooids, kenozooids, gonozooids and autozooids.

Nanozooids are miniature tubular zooids of unknown function, interspersed among the regular autozooids. They contain musculature, a membranous sac, a tentacle sheath, a single short, hollow, fingerlike tentacle and a solid mass of cells that Borg (1926) regards as a greatly reduced, nonfunctional alimentary canal.

Kenozooids are of several types including hollow tubes and spines as well as spaces or chambers in which no polypides are ever developed. Kenozooids met with most frequently are rhizoids and spines.

The rhizoids of living stenolaemates are long, slender, articulated rootlets, sometimes branched, having nodes and thin tubular internodes. They sprout from the basal part of the colony. Their tips are membranous. Their internal cavity, like that of the spines mentioned below, contains a network of mesenchyme cells. New colonies or branches may bud from some of the rhizoids. Other rhizoids probably help to fasten the colony more firmly to the substratum.

The spines, also called processus spiniformes, are of two kinds. One is the very long, jointed type, often longer than the autozooids. The other is short and unjointed. The tips of both kinds are calcareous and blunt. Spines are located usually more distally on the autozooids and internodes than are the rhizoids. Their function is unknown.

Spaces or chambers, also called alveoli, occurring between zooecia or in angles formed by diverging or converging zooecial tubes, are regarded as kenozooids.

Gonozooids, or brood chambers, are concerned with reproduction. Their number is small, their capacity large and their position in the colony or along the internodes very definite. Female germ cells develop and embryos are incubated in gonozooids.

In all stenolaemates, except the Lichenoporidae, the gonozooids, also called ooecia or ovicells, are individual zooids transformed into inflated, sometimes vase-shaped brood chambers. Polypides present in gonozooids degenerate as the embryos approach maturity, providing nutriment for the embryo.

In the Lichenoporidae the embryos are incubated in special communal brood chambers rather than in single enlarged zooids. The alveoli and spaces between zooids are roofed over by a calcareous layer to form a large communal nursery or zoarial brood chamber. The calcareous alveolar walls, now internal partitions, are resorbed to make the brood chamber larger.

The gonozooids open to the outside by a single short tube usually like the neck of a bottle. Its opening is the ooeciopore or aperture. In Lichenoporidae there may be two to eight apertures to the brood chamber. Resorption of the calcareous walls about the opening or elsewhere occurs in some species to make the opening larger for the exit of embryos.

Brood chambers, gonozooids and ooeciopores are important in identification of stenolaemate species.

3. Polypide Structure.—The polypide is similar to those of other Bryozoa except that it is suspended in a special membranous sac that seems to have no equivalent in other bryozoan groups. The membranous sac divides the main coelom into two parts—the inner endosaccal and the outer exosaccal part—a coelom within a coelom. These two coelomic cavities have no connection with each other. The regular body wall (cuticular, calcareous and inner epithelial) layers enclose the exosaccal coelom.

The tentacular crown cannot be extended very far out of the zooecium. There are few tentacles, about 8 to 16. In addition to their normal function of directing food into the mouth by ciliary action they probably have a respiratory and excretory function.

Both smooth and striated muscles are present; the polypide retractors and the tentacular muscles are striated, whereas the atrial sphincter and the vestibular extensors are smooth.

Little is known of the peripheral nervous system.

4. Reproduction.—Stenolaemates reproduce asexually by budding and sexually by polyembryony and production of larvae.

Budding.—Colonies develop from a hollow, calcareous-walled, attached primary disc that originates from the metamorphosis of a larva devoid of an alimentary canal (Borg, 1926). The primary disc contains the "common bud," which will produce the succeeding zooids of the colony. Before the upper wall of the primary disc calcifies the common bud sprouts a tube that will become the next zooid. The zooid tip is uncalcified, but in time an oblique calcareous partition begins to grow into the zooid from the basal-

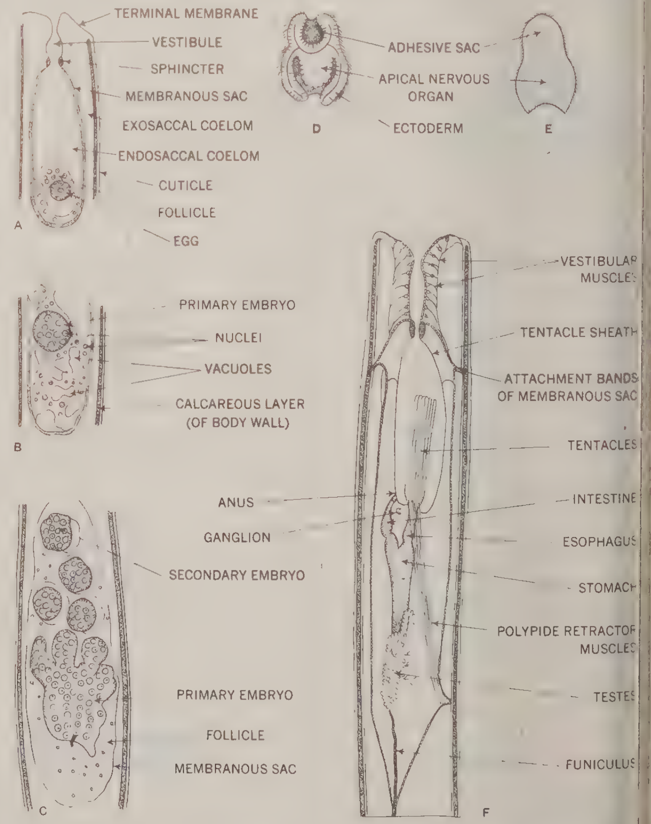

FIG. 7.—REPRODUCTION IN CYCLOSTOMATA (STENOLAEMATA)

(A-C) Polyembryony in *Crisia* showing (A) upper portion of gonozooid with egg enclosed in follicle; (B) egg developed into multinucleate primary embryo (C) enlarging primary embryo budding off secondary embryos (D) longitudina section of cyclostome larva; (E) external view of larva; (F) adult male zooid lateral wall, dividing the tube into two tubes, each of which becomes a zooid. Each zooid contains common bud material that will keep on producing more tubes and new zooids.

The growing zone of the common bud is the distal edge of the terminal membrane. Here new cells originate and cells can detach from it and wander to new locations. Here also originate the new polypides (soft parts of the zooid). The formation of the polypide precedes the differentiation of its zooecium (exoskeleton)—a condition similar to that found in Phylactolaemata but the reverse of what occurs in the Cheilo-Ctenostome groups (*see* below).

Sexual Reproduction.—Harmer (1893) was the first to see stenolaemate spermatozoa. Subsequent studies revealed that some stenolaemates are hermaphroditic (*Berenicea patina, Diplosolen obelia, Stomatopora granulata, Tubulipora* species), whereas others are dioecious *(Crisia occidentalis, Lichenopora verrucaria).* Some Lichenoporidae have male, female and hermaphroditic zooids within the same colony.

Male germ cells are of mesodermal origin. The stenolaemate testis becomes unusually large compared with those of other Bryozoa. Its location is similar to that of the Phylactolaemata. It encases the lower part of the gut (caecum tip) and extends along the funiculus, which attaches the gut to the coelomic wall. Both gut and testis are in the membranous sac, which attaches to the body wall in a few places.

When mature, the sperms are released into the body cavity, moving freely therein and eventually accumulating in great numbers around the atrial sphincter, near the tentacles. It is not known how sperms escape from the body cavity, but Borg postulated that they pass through a break in the tentacle sheath, then out through the vestibular orifice. How they gain entrance into the female zooids or access to eggs has not yet been solved.

Harmer (1893) described polyembryony in *Crisia.* Eggs develop in the common bud or growing zone of the terminal membrane. An egg becomes associated with the potential alimentary canal of a young gonozooid. The gut grows around it, forming the egg follicle. Those germ cells that do not attach to a polypide degenerate. The egg cleaves a number of times, producing a solid mass of undifferentiated cells, *i.e.,* many nuclei imbedded in a protoplasmic mass, the whole of which is called the primary embryo.

Gradually, several finger-shaped cellular processes grow out from the primary embryo. They pinch off transversely into a large number (up to 115) of rounded cellular masses, the secondary embryos. These become two-layered and speedily increase in size by absorption of nutriment from the surrounding tissue in the gonozooid.

The yellowish embryos develop external cilia and escape through the ooeciopore.

The young larva attaches to the substratum by its sucker, then peels back and rolls down its mantle covering toward the attached, flattened base. The larval tissues undergo partial dissolution (histolysis). After this metamorphosis the first polypide develops from the free surface of the flattened remains of the arva, which now is known as the primary disc.

C. ORDER CTENOSTOMATA

The name of this order refers to a "comblike row of setae" found on the flexible fold of body wall that closes the zooecial orifice. This supposed row of setae is really a membranous collar that may fold in definite creases like a fan or umbrella. The early workers sometimes saw the creases but not the membrane stretching between them.

1. Description and Distribution.—Of the about 43 genera of ctenostomes (recent and fossil) most are marine; only a few pecies inhabit brackish or fresh waters.

Seaweeds, hydroids and the green colonial tunicate *Perophora* are favourite substrates for the dainty *Aeverrillia* and *Bowerbankia* colonies. The grayish to brownish *Alcyonidium* and *Flustrellidra* form a thick, rubbery coating over the marine brown alga *Ascophyllum.* A. Lacourt (1949) found *Alcyonidium* forming a mass nearly 11 in. high.

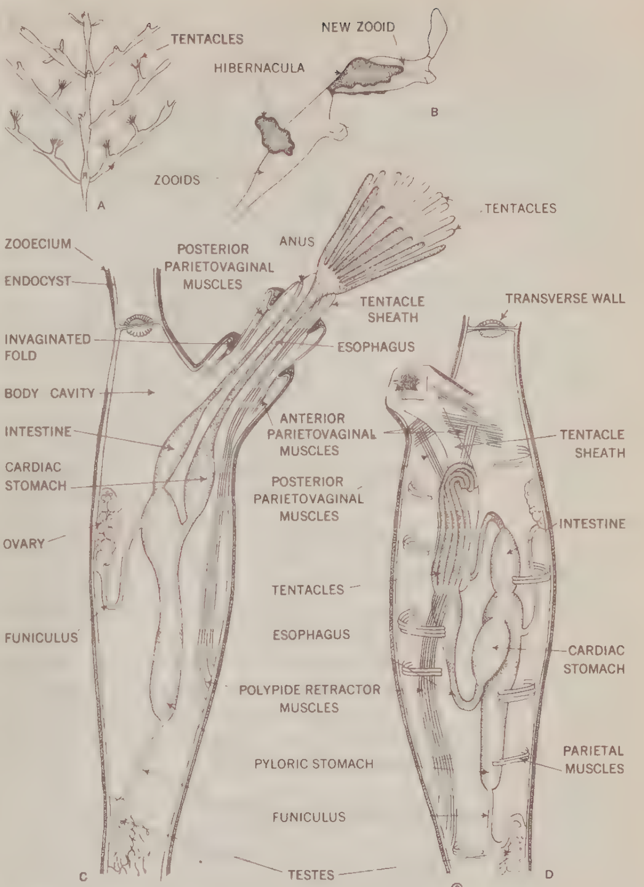

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FIG. 8.—MORPHOLOGY OF CTENOSTOMATA

(A) Colony of *Paludicella articulata* showing growth habit and mode of branching; (B) two hibernacula on old zooecium with new zooid sprouting from upper hibernaculum; (C) zooid with polypide evaginated; (D) zooid with polypide retracted into body cavity

The most famous brackish-water ctenostome is *Victorella pavida,* reported from nearly every continent, from waters of low salinity and on occasion even from fresh water and marine localities (H. Brattström, 1954). R. C. Osburn (1944) reported it to be a fouling and oyster-smothering nuisance in Chesapeake bay, where it formed plushlike mats up to half an inch thick.

Arachnoidea, from central Africa; *Hislopia,* from India; *Pottsiella,* from the U.S.; and *Paludicella,* cosmopolitan, are four fresh-water genera. Although the first three are poorly known and rarely reported, *Paludicella* is common and has been well studied. (See *Fossil Distribution,* below.)

2. Body Wall.—Ctenostomes have soft walls. Their zooecia are membranous, leathery or horny, but not calcareous, although Kraepelin (1887) reported that minute scattered calcareous granules are sometimes present in the chitinous cuticle of hibernacula.

The body wall consists of cuticle, ectodermal epithelium and sparse peritoneal cells, with an occasional small band of circular (transverse) muscle fibres called parietal muscles. In *Paludicella* the parietals are arranged on the right and left sides of the body in several circular bands containing two to six muscle fibres each, lining the body cavity.

The cuticle may be thick or thin, sometimes of several layers, and chitinized.

In ctenostomes the orifice is terminal or nearly so. When pulled in to its utmost its shape may be round, slitlike, square or pentagonal, depending on the species.

Its closing is simple: after the tentacles, tentacular sheath, collar and vestibular wall are all pulled in, the vestibular opening either puckers up or is closed by folds of the body wall, or it is simply plugged by the folded membranous collar.

3. Polypide Structure.—*Introvert.*—The anterior end of the polypide that is capable of turning in is called the introvert. Respective positions of the introverted parts are the tentacular crown, with its 8 to 34 tentacles, at the top of the tentacular sheath; and the membranous collar, surrounding the base of the sheath and diaphragm.

The tentacles, sheath and collar can be extended far out by the combined forces of the contraction of the muscles of the body wall, the pressure of the coelomic fluid and the relaxation or action of the retractors and posterior parietovaginal (vestibular) muscles.

The whole tentacular complex can be introverted by the contraction of the great polypide retractors and the co-ordinated action of the sphincters and the anterior parietovaginal muscles. This description is based on the behaviour in *Paludicella.*

Digestive Tract.—The gut is extremely long in some ctenostomes. Some species have a bulbous gizzard in the cardial part of the stomach. The gizzard wall, a thick layer of circular muscle fibres, bears individual chitinous teeth or two or four denticled shields. The size and thickness of the teeth or denticles vary with age.

The gut is anchored to the body wall by a single funiculus in some species *(Victorella),* by two funiculi in *Paludicella* or by no distinct funiculus in others. Harmer (1915) noted that a funiculus was not common in marine Bryozoa but that there was a more diffuse arrangement of funicular tissue.

4. Colony Form.—Two main types of colony, based on the mode of budding, occur in ctenostomes. Each characterizes a suborder. In suborder Stolonifera the zooids bud from stolons. In suborder Carnosa zooids bud from each other. In both types the colony originates by asexual budding from an ancestrula (see *Colony Origin,* above).

The saclike ancestrulae are of two types. One type, as in *Victorella* and *Pherusella,* contains a polypide. The other type, as in *Walkeria* and *Vesicularia,* apparently does not have a polypide but buds off stolons from which zooids with polypides develop later.

5. Reproduction.—*Sexual Reproduction.*—The number of developing oöcytes in a bryozoan ovary is generally few, but there may be about 30 in *Hypophorella.* Fertilization is internal. In species that brood internally, generally only one fertilized egg is destined to produce an embryo at any given time; the other fertilized eggs presumably dissolve to provide nourishment for the developing embryo. A developing embryo becomes enclosed in a sac, the embryonary, on the body wall near the orifice.

Although the exact mode of escape of embryos or larvae from the zooid has not been observed often, some are known to emerge through a tardily developed channel where the embryonary attaches to the parental body wall; others leave by evaginations of the parental body wall; and still others break through thin spots in the degenerating wall of the parent zooid.

An opening, the coelomopore, close to the anal and tentacular region, has been observed in a few ctenostomes, but whether it serves for exit of eggs or entrance of sperms or perhaps some other function is undetermined.

Fertilization takes place in the body cavity. Cross-fertilization must occur in some species, self-fertilization may presumably occur in others, although actual observations on the latter condition are meagre.

Larvae.—The sexually produced ctenostome larvae vary greatly in appearance and complexity. They may be wedgelike, kidney-shaped, plum-shaped, etc.

Ctenostomes may be hermaphroditic *(Nolella)* or dioecious *(Alcyonidium).* Some species are oviparous, releasing eggs (early embryos). Others are viviparous, giving birth to larvae. Ovicells for incubation of larvae are lacking in ctenostomes.

The eggs of oviparous species become free-swimming so-called cyphonautes larvae that exist for about two months, at the end of which time they settle on a substrate and undergo metamorphosis. Because of a well developed functional ciliary, muscular, nerve and digestive tract apparatus and a protective bivalve shell the cyphonautes is designed for a free living existence of longer duration than are the other bryozoan larvae in which the gut is either not present or vestigial, and which swim about for only a few hours before attachment and metamorphosis. Ctenostomes producing cyphonautes larvae are species of *Hypophorella, Farrella* and *Pherusella.*

The viviparous species *(Alcyonidium polyoum, Bowerbankia)* release larvae, of an unnamed type, that are much shorter lived in the free-swimming state than the cyphonautes. Their gut is incomplete or undeveloped, and metamorphosis must come quickly or the larva will perish.

Asexual Reproduction.—Some ctenostomes have evolved special methods of asexual reproduction and regeneration, such as budding from stolons, formation of hibernacula and of blastogenic branches.

Stolons.—These are mostly delicate partitioned tubes containing mesodermal funicular tissue. They may be basal (creeping); lateral or axial (upright); or branching or anastomosing tubes that sprouted out of an ancestrula. Stolons propagate themselves by further budding and partitioning. They can be very slender *(Aeverrillia)* or very broad *(Zoobotryon).*

New zooids that originate from the stolon may bud off as individual units *(Aeverrillia)* or in clusters from the sides of the stolon *(Bowerbankia)* or even in a spiral around the stolon *(Amathia).* The stolon ectoderm initiates the formation of the zooids by evagination, with mesoderm or funicular cells joining soon after.

Since stolons are without polypides or special internal organs, they are regarded as a special kind of zooid (kenozooid). The ordinary zooids that sprout from them are autozooids, since they contain functional, well-developed internal systems.

Hibernacula.—Ctenostomes of fresh water *(Paludicella)* and brackish water *(Victorella)* can produce, in addition to ordinary buds, special "winter buds" called hibernacula. These are brownish, chitin-encased, variously shaped seedlike bodies containing germinative material. They remain after the parent colony has disintegrated, and germinate when conditions are appropriate.

Paludicella hibernacula are of two types, internal and external, with respect to the autozooids: the internal, cigar-shaped hibernacula are inside the autozooid; the external, irregularly-shaped ones are like stunted, distorted buds sprouting from the autozooids. *Victorella* hibernacula are external.

Blastogenic Branches.—Harmer (1931) reviewed the studies of G. Zirpolo (1922–25) on the production of special germinative branches of *Zoobotryon* colonies around Naples. These branches contained large quantities of yellow, nutritive, "blastogenous" (yolk?) substance. When the colonies disintegrated, the blastogenic stalks sank to the bottom and remained dormant until conditions were suitable for their germination, at which time the branches sprouted new buds (stolons or zooids).

6. Polymorphism.—Ctenostomes exhibit little polymorphism. Only autozooids, occasionally gonozooids and some kinds of kenozooids are present. Ovicells, avicularia and vibracula, which characterize many of the closely related cheilostomes, are absent from ctenostomes.

In the shell-boring *Penetrantia,* saclike gonozooids are present attached to the autozooids. These gonozooids, which contain a rudimentary polypide, serve to incubate the embryo.

The kenozooids include stolons and special spine-bearing pads. The latter occur between the regular autozooids in *Flustrellidra.*

7. Cheilo-Ctenostomata.—Silén (1942) after an extensive study asserted that Cheilostomata and Ctenostomata are so closely allied that they should be classed as a collective group, the Cheilo-Ctenostomata, and that the ctenostome part should be divided into two suborders: Carnosa and Stolonifera.

Carnosa.—Colonies of this suborder are fleshy or chitinous and encrusting. The zooids may be baggy or broadly ovoid to hexagonal, and touch each other on all their sides *(Alcyonidium)* or they may be slender and widely spaced from each other *(Paludicella).*

The zooecial orifice is closed by the membranous collar and by simple circular folds of the body wall. In Flustrellidridae two thick lips replace the folds. Common carnose genera are: *Alcyoni* *dium, Arachnidium, Flustrellidra* and *Paludicella*.

Stolonifera.—This suborder is characterized by thin, erect or creeping, tubular branches called stolons, which sprout from the ancestrula, a scarcely distinguishable membranous sac. By lateral budding the stolons produce a membranous or chitinous colony whose zooids are separate and bottle- or vase-shaped. New stolons bud from the old, thus spreading the colony. New zooids arise from the stolons and not from each other. Internal partitions mark off the stolon segments from each other. Common stoloniferous genera are: *Aeverrillia, Amathia, Mimosella, Penetrantia*. Members of the last-named genus bore into mollusk shells and barnacles, scarring them with pits and delicately etched lines.

D. Order Cheilostomata

The name refers to the movable lip (operculum) that closes the zooecial orifice.

1. Description and Distribution.—Cheilostomes are represented by numerous species, at least 632 genera and 82 families (Bassler, 1953). They are the commonest marine bryozoans encountered, occurring in many localities, from shore level to ocean depths.

2. Colony Form.—Colony growth form is extremely diversified but usually characteristic for the species. It can be bushlike, interconnecting, encrusting, fan-shaped or nodular.

The growth rate of young colonies is fast. S. Mawatari (1951) reported that *Bugula neritina* buds required two days to develop to functional status. J. Orton reported *Bugula flabellata* capable of developing 100 zooids in a fortnight and producing larvae by the eighth week.

As in other bryozoans regenerative processes are great.

3. Body Wall.—The zooecial wall ranges from membranous, chitinous, siliceous to calcareous, the last type being the commonest.

The boxlike zooecia are variously shaped. Their frontal wall is often beautifully sculptured, embossed or pitted. In most cheilostomes the lateral walls of adjacent zooids fuse together to form a double wall, but have interzooidal communication pores. The basal (dorsal) walls are usually imperforate and undecorated, although some exceptions may occur. The end (transverse) walls are single and perforated by pores. Differences in zooecial shape and frontal decoration are often useful in identification of species.

The thickness of the zooecial walls depends on environment, heredity and age. Some species in the families Smittinidae, Celleporidae, etc., as they age, undergo a secondary calcification of the frontal wall that obliterates or fills in many of the distinguishing characteristics and markings, pores, spines, avicularia, zooecial boundaries, ovicell boundaries, etc., by a thick calcareous coat. In such species the lateral and back walls are not affected.

Protrusion or retraction of the polypide are facilitated by special hydrostatic devices, a frontal compensation sac in the suborder Ascophora and a flexible frontal membrane in the suborder Anasca.

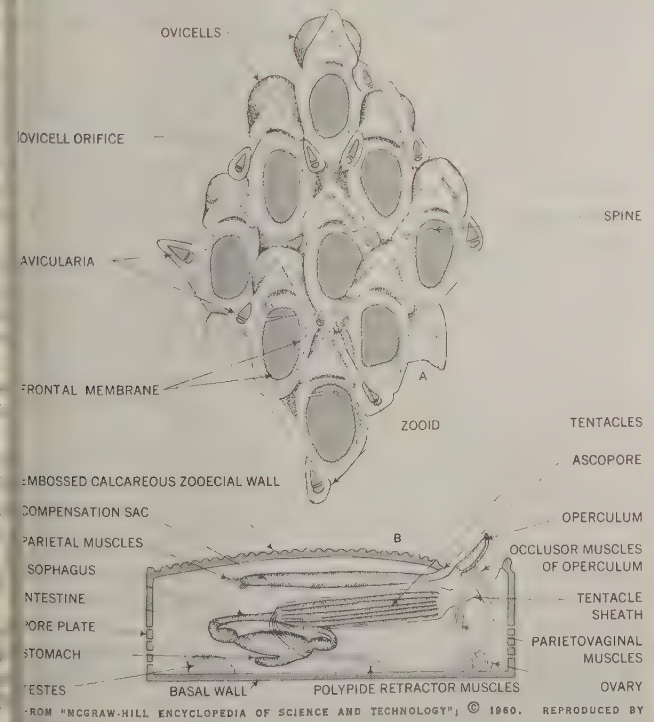

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FIG. 9.—MORPHOLOGY OF CHEILOSTOMATA

(A) Colony fragment of an anascan cheilostome containing nine calcined ovicelled zooids; (B) lateral section of single zooid of an ascophoran cheilostome

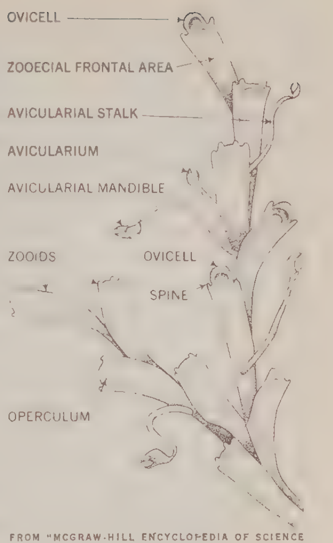

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FIG. 10.—PORTION OF A CHITINOUS DENDRITIC ANASCAN COLONY (BUGULA ABYSSICOLA)

4. Tentacle Protrusion and Retraction.—Tentacles numbering 9 to 32, depending on the species, are protruded through the zooecial orifice that is otherwise closed by a chitinous flap, the operculum. The operculum operates somewhat like a drawbridge by means of special occlusor muscles.

Compensation Sac.—The mechanics of tentacular crown or polypide protrusion in cheilostomes encased in a hard exoskeleton were not clearly understood until J. Jullien's discovery of the compensation sac (compensatrix) in 1888.

The compensation sac, a delicate, almost imperceptible membranous pocket between the rigid exoskeleton and the soft inside body wall of the zooid, has its edges attached to the body wall by groups of parietal muscle fibres. The compensation sac works somewhat like a bellows. When water flows into the sac, pressure is built up in the coelom and the tentacles are forced outward. When water leaves the sac, pressure is reduced and the tentacles have space for withdrawal by the great retractor muscles.

The size of the compensation sac varies with the species. In some it occupies much of the frontal surface. In others it is as small as a bib. It opens to the outside either by an independent pore, the ascopore, or at the base of the operculum of the zooid.

The Cheilostomata are divided into two major suborders, Ascophora and Anasca, on the basis of the presence or absence of the compensation sac.

Frontal Membrane.—Instead of a compensation sac the Anasca have a flexible, uncalcified, frontal membrane to which are attached either small groups of parietal muscle fibres or the two tendons of the depressor muscles. The frontal membrane may cover an uncalcified area of the zooid or it may overlay an internal calcareous but perforated layer (cryptocyst) of variable extent. The cryptocyst gives added protection to the zooid. Through the perforations the two depressor muscle tendons are inserted on the membrane. The contraction of the parietal or depressor muscles lowers the membrane, which in turn creates pressure within the coelomic cavity and forces out the polypide. Relaxation of these muscles permits the retraction of the polypide.

5. Polymorphism.—Polymorphism is developed to a greater degree in Cheilostomates than in other bryozoans. Polymorphic individuals include ancestrulae, autozooids, gonozooids, avicularia, rhizoids, vibracula and spines. Not all cheilostomes have all kinds, but most have several.

Ancestrulae.—In some species the primary zooid of a colony looks very different from the succeeding zooids. It may have an uncalcified frontal area that is covered by a membrane and bordered by 2 to 13 spines, with an operculum at the distal end of the area. The succeeding zooids may have a much smaller uncalcified area (sometimes limited only to the orifice itself) or a smaller number of spines or be generally of larger zooecial size. Such an ancestrula resembles a Membraniporan zooid.

In other species there is little difference in appearance between the ancestrula and the later zooids. The colony may originate from a single ancestrular zooid or from twins.

Usually three buds sprout from the distal end of the ancestrula in cheilostomes. Sometimes buds also sprout proximally and laterally. The growth pattern of the colony is determined by the location of these sprouting zones in the ancestrula and on subsequent zooids. Silén (1942) reported that a spiral growth pattern was very common in a number of species.

Autozooids and Gonozooids.—In some cheilostome species all zooids of a colony look and function alike. There is no differentiation into autozooids and gonozooids. Each zooid feeds and can produce both male and female germ cells.

In others, such as *Terminoflustra membranacea-truncata,* there are hermaphroditic zooids and male and female gonozooids, all in the same colony. The difference between them is very slight.

In still others *(Hippothoa)*, there are asexual (sterile) autozooids and male and female gonozooids, each easily identifiable because of differences in general size, shape of orifice and other features. Asexual zooids have a larger size and larger orifice. Gonozooids are smaller. Female gonozooids have an ovicell and an unusually shaped orifice.

Fertile zooids may develop ovicells either internally or externally. The ovicells of different species vary in size, shape, structure and decoration. Some ovicells are like a hood over the zooecial orifice, opening near or into it *(Osthimosia)*. Others *(Cellaria)* are flattened, with an opening some distance away from the zooecial orifice.

Ovicells develop if there is an egg already forming. The embryos develop at the expense of the parent polypide. After an embryo or larva vacates an ovicell, the ovicell can be used a second or third time, provided a new polypide can regenerate in the zooecium and produce a new batch of eggs.

The transfer of embryos from the zooid body cavity into an external ovicell is accomplished by the embryos squeezing through the coelomopore near the two median tentacles on the anal side (in *Callopora*). In those species that lack ovicells *(e.g., Electra pilosa)* a special, temporarily formed tube, the intertentacular organ, permits the exit of embryos to the outside.

Avicularia.—An avicularium is an appendage, heterozooid or special zooid of striking appearance but obscure function that is present on or among the autozooids and gonozooids of many cheilostomes. It consists of a calcareous or chitinous chamber whose opening is by a cuticular flap, the so-called mandible, homologous to a zooecial operculum.

Avicularia are of prime importance in species identification because in some instances they exhibit a great constancy of position, uniqueness of appearance and uniformity of size and structure. The actively swaying, snapping, stalked avicularia ("birds' heads") of *Bugula* are presumed to be defensive, serving to keep offending organisms or strange larvae and debris from settling down on the colony. This explanation, however, might not apply to some fixed avicularia with extremely weak musculature (the Reteporidae) or those inside the orifice or on the inner surface of the calcareous frontal wall *(Cellarinella)*.

Avicularia look very different from other zooids of the colony. Some are so tiny that they look like pores on the body wall; others may be larger, taller or longer than the regular zooids.

As to location avicularia are either adventitious or vicarious. The adventitious kind is located dependently on autozooids and sometimes also on ovicells, either fused directly to the body wall or attached by a stalk. Some are fastened flat against the regular zooids, others bulge like a tepee (in *Escharoides bubeccata*). *Camptoplites* avicularia are shaped like a bird head and mounted on a very long stalk attached to the autozooid. Other forms are spatulate, rounded, oval or triangular in outline. The number of avicularia per zooid varies from none to several.

Vicarious avicularia, found between regular zooids, are on their own bases or avicularial chambers. The avicularial chamber contains muscles that move the mandible. One set of these, the abductor mandibuli, consisting of a number of isolated smooth fibres, opens the mandible. The other set, the adductor mandibuli, which consists of more powerful, bunched, striated fibres, snaps the mandible shut.

In addition to musculature the avicularial chamber in some cases also contains a vestigial polypide, avicularial glands and a sense organ. The function of these organs is unknown.

Avicularia may be plentiful in some colonies and rare in others of the same species.

Vibracula.—A vibraculum is a heterozooid very much similar to an avicularium except that the mandible has been transformed into a very long, slender, chitinous bristle, seta or whip that is capable of moving in all directions. The seta may be smooth or serrate and many times longer than its vibracular base or chamber. The chamber contains in addition to the vestiges of a polypide the powerful muscles that control the action of the seta.

Spines.—Many autozooids and ancestrulae have spines around the orifice or sometimes elsewhere on the frontal wall. Spines may be mere hollow extensions of the wall or actual jointed kenozooids (degenerate or abortive zooids). Their presence, number, size and shape depend on a number of factors. In some species spines are present in young zooids as temporary structures that become broken off or covered over by secondary calcification as the colony ages. In other species they may be permanent.

Spines are usually needlelike but some may be very stout, bladelike, straight or curved, forked or even antlered.

Rootlets.—These are delicate chitinous tubes produced by many of the dainty arborescent cheilostomes *(Bugula, Cellaria, Camptoplites)*. They occur singly or in groups, and are budded from the zooecia at or near the base of the colony, although in some *Camptoplites* they can sprout anywhere along the colony. Their function is to anchor, attach or support a colony or even to bridge gaps between adjacent substrates.

Interzooidal Communications.—As mentioned earlier some communication is possible between the body cavities of neighbouring and succeeding zooids because communicating pores are present in the intervening lateral and end walls. The pores, however, are loosely plugged by mesenchymal funicular cords that traverse the zooidal body cavities.

The pores may be either single isolated perforations or groups. If the group contains only a few pores perforating a blisterlike chamber of the lateral wall the blister is called a pore plate or rosette plate. If the group contains a large number (two or three dozen pores) puncturing a transverse or end wall it is called a sieve plate.

Silén (1944) made an exhaustive study of interzooidal communications as well as of the nature of the zooecial walls.

6. Reproduction.—Reproduction is asexual and sexual. Gonads develop in the zooid wall from the peritoneum, with ovaries more distal than testes, the latter sometimes in connection with the funiculus. Self-fertilization occurs in some species, as in *Bugula neritina,* but in others cross fertilization between zooids occurs. Sperms presumably exit through coelomopores or interzooidal communication pores. Fertilization in some cheilostomes occurs in the ovary.

Oviparous species release fertilized eggs into the water, some species producing a small number per zooid (*Electra pilosa,* 17), others a large number (*Membranipora membranacea*). Viviparous species incubate fertilized eggs in ovicells until they reach the larval stage. Generally an ovicell contains only one embryo. In a few species however, several developing embryos may be incubated simultaneously in the same ovicell: two to six in *Thalamoporella;* up to seven in *Scruparia.*

The oviparous species seemingly produce a cyphonautes larva, whereas the vivaparous species produce larvae of varied shapes and appearance.

The larvae attach to many kinds of substrates, shed their cilia, metamorphose into an ancestrula and start a new colony. The succeeding zooids of the colony arise by linear and lateral budding, their zooecia (exoskeletons) remaining to a greater or lesser extent in contact with each other through interzooidal communication pores in the lateral and transverse walls.

V. FOSSIL DISTRIBUTION

The earliest fossil Ectoprocta, a supposed trepostomate and a questionable stenolaemate (cyclostome), were reported from the Early Paleozoic rocks of western England and western Canada.

The oldest fossil ctenostome, the threadlike *Marcusodictyon,* was reported from the Ordovician of Estonia. Reports of Mesozoic or Tertiary ctenostomes are not numerous, either because the presumably soft-bodied ctenostomes left few fossils or because the remains are not readily identifiable. Many of the now recognized Paleozoic ctenostomes had been in the past regarded as sponge borings, foraminifera or trilobite eggs (Bassler, 1953).

The only truly fossil fresh-water phylactolaemate, *Plumatellites proliferus,* was reported (1901) from the Cenomanian (Cretaceous, Mesozoic) beds of Bohemia.

The Paleozoic limestones of North America, from which at least 1,500 species have been described, are especially rich in Bryozoa (Bassler, 1922). Europe is as rich in Mesozoic Bryozoa as America is in Paleozoic species.

Bassler (1953) indicates that ctenostomes have been reported from the Ordovician but seem rare in the Mesozoic and Tertiary formations. The stenolaemates likewise begin in the Ordovician and develop to predominance as compared with other bryozoans by the Middle Mesozoic, then assume less importance as cheilostomes surpass them in numbers in the Cretaceous period. The cheilostomes originated in the Jurassic seas of Europe and fast extended their territorial and geological conquest. Today cheilostomes are the dominant ectoproct order all over the world.

The Trepostomata and Cryptostomata are exclusively fossil orders seemingly limited to the Paleozoic era, although some Trepostomata, whose classification in that order is questioned, have been reported from the Triassic. The Cryptostomata appeared in the Ordovician, attained their greatest development in the Devonian and Mississippian and died out in the Upper Permian.

VI. CLASSIFICATION

1. Zoophyta.—Linnaeus in 1758 coined a special term Zoophyta for these creatures that looked like plants and behaved like animals. That Linnaeus was still unsure of their exact nature is evident from a letter he wrote in 1761 to his highly esteemed Irish friend John Ellis, wherein Linnaeus referred to Zoophytes as "vegetables, with flowers . . . yet as they are endowed with sensation and voluntary motion, they must be called, as they are, animals."

Although many scientists of the early 18th century are credited with having the insight that some bryozoans and coelenterates were animals rather than plants, the fact remained to be proved. It was not until the mid-century that Ellis, in his handsomely illustrated "Essay on Corallines . . ." (1755), definitely established the animal nature of zoophytes. From that time onward support began to shift from the mineralogical and botanical theories to the zoological theory of the nature of zoophytes.

The term Zoophyta continued in use for about a century after Linnaeus had coined it for bryozoans, some coelenterates and diverse animals that he grouped into the class Vermes.

2. Bryozoa *v.* Polyzoa.—In December 1830 appeared an innocent but subsequently crucially controversial paper "On Polyzoa, a new animal discovered as an inhabitant of some Zoophytes . . ." written by the Irish naturalist John Vaughan Thompson. Practically upon its heels appeared the C. G. Ehrenberg papers (1831) in which the term Bryozoa was first used. Later (1834) Ehrenberg further elucidated the term, splitting zoophytes into two distinct classes: Anthozoa (mostly coelenterates) and Bryozoa.

Thompson and Ehrenberg apparently had arrived at their discoveries independently and almost simultaneously; but unfortunately, Thompson's term Polyzoa, or Polyzoae, was so vaguely defined that it led to various interpretations and disagreements among subsequent workers. Ehrenberg's term Bryozoa, on the other hand, was more precise. It stood for a definite class of organisms. To this very day the controversy is unresolved. Most British zoologists use the term Polyzoa, while most others use Bryozoa.

H. Milne-Edwards (1843) placed Bryozoa into the group Molluscoidea, where they remained until the 1930s, along with other problematic organisms. The group Molluscoidea was at one time under the phylum Mollusca, then later was considered an independent phylum, and finally "died a quiet death by dismemberment" when Brachiopoda, Bryozoa, Rotifera, Tunicata and other subgroups were gradually removed from it.

3. Ectoprocta and Entoprocta.—As knowledge of bryozoan diagnostic features accumulated, H. Nitsche (1869) was impelled to divide Bryozoa into two groups, Ectoprocta and Entoprocta, on the basis of location of anal opening and other differences. In Ectoprocta the anus is outside the tentacular circle. In Entoprocta it is inside.

Since 1869 Bryozoa became an independent phylum, then was split into two phyla (Ectoprocta and Entoprocta) by various noted zoologists. Some bryozoologists concur with this last division but other bryozoologists still consider Ectoprocta and Entoprocta as belonging to the one phylum, Bryozoa.

Still unsolved are the problems as to where in the animal kingdom these forms belong, to which other animal groups they are related and from which groups they evolved.

The following classification of the ectoprocts is a composite from several sources and viewpoints:

- Subphylum (or Phylum) Ectoprocta
  - Class Phylactolaemata (Lophopoda)
    - Family Fredericellidae
    - Family Plumatellidae
    - Family Lophopodidae
    - Family Cristatellidae
  - Class Gymnolaemata (Stelmatopoda)
    - Order Trepostomata
    - Order Cryptostomata
    - Order Cyclostomata (Stenolaemata or Stenostomata) (common genera: *Crisia, Diastopora, Lichenopora, Tubulipora*)
    - Order Ctenostomata
      - Suborder Carnosa
      - Suborder Stolonifera
    - Order Cheilostomata
      - Suborder Anasca (common genera: *Bugula, Cellaria, Cribrilina, Flustra, Membranipora*)
      - Suborder Ascophora (common genera: *Cellepora, Hippothoa, Microporella, Retepora, Schizoporella, Smittina*)

Bibliography.—R. S. Bassler, "Bryozoa," part G in R. C. Moore (ed.) *Treatise on Invertebrate Paleontology* (1953); P. Brien and C. Mordant, "Relations entre les reproductions sexuée et asexuée à propos des Phylactolæmates," *Ann. Soc. Zool. Belg.*, 86 (2):169–189 (1956); M. K. Elias and G. E. Condra, "Fenestella from the Permian of West Texas," Mem. *Geol. Soc. Amer.*, 70 (1957); L. H. Hyman, *The Invertebrates*, vol. 5 (1959); G. Johnston, *A History of the British Zoophytes*, 2nd. ed., 2 vol. (1847); A. Lacourt, "Bryozoa of the Netherlands," *Arch. Nierland. Zool.*, 8 (3):1–33 (1949); A. Pennington, *British Zoophytes* (1885). (M. D. Ro.)

BRYTHONIC DIALECTS: *see* Celtic Languages.

BRYUSOV, VALERI YAKOVLEVICH (1873–1924), Russian poet, novelist, playwright, translator and critic, a pioneer of Russian modernism, was born in Moscow Dec. 13 (new style; Dec. 1, old style), 1873. His *Russkie simvolisty,* two parts (1894), containing original poems and translations from the French, was an important landmark, and he later became the recognized leader of Russian Symbolism, editing its leading journal, *Vesy* ("Balance"; 1904–09). The most important of his ten volumes of original poetry published between 1895 and 1921 were *Tertia vigilia* (1900), *Urbi et orbi* (1903) and *Stephanos* (1906). Influenced by Verhaeren, whose work he translated, he cultivated urban themes. He also translated other modern European poets, including Verlaine, Rimbaud, Mallarmé, Maeterlinck and D'Annunzio, as well as ancient classics. His prose fiction includes *Ognenny angel* (1908; Eng. trans. *The Fiery Angel,* 1930), a novel about witchcraft in 16th-century Germany; *Altar pobedy* (1911–12), a novel set in 4th-century Rome; and two volumes of stories: *Zemnaya os* (1907; 2nd ed. with four stories added, 1911) and *Nochi i dni* (1913). The former volume contains "Respublika Yuzhnogo Kresta," a fantasy about the decline of a totalitarian state of the future (Eng. trans. of this and some other stories, *The Republic of the Southern Cross,* 1918). Bryusov was an important literary critic and student of Pushkin and Russian verse. After 1917 he joined the Communist party, holding for a time a post in the commissariat for education. He died in Moscow, Oct. 9, 1924.

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BRZOZOWSKI, TADEUSZ (1749–1820), first general of the restored Society of Jesus, was born near Malbork, in Warmia, Pol., on Oct. 21, 1749. In 1765 he joined the Jesuits in Poland. He was ordained priest in Vilnius (Wilno) and taught in Minsk. In 1805, after serving 16 years as secretary and assistant to his predecessors, he was elected superior of the order, which had survived in Russian-annexed Poland and Russia and had been recently revived in the two Sicilies (kingdom of Naples). When Pius VII restored the Society of Jesus throughout the world in 1814, he conferred full powers on Brzozowski, making him the 19th general. During his tenure of office he witnessed the expulsion of the Jesuits from Russia (1815), but also their rapid restoration in the old and new continents. He died in Plock, Pol. on Feb. 5, 1820. Brzozowski translated into Polish C. F. Nonnotte's *Dictionnaire philosophique de la religion*, four volumes (1782).

See C. Sommervogel, *Bibliothèque de la Compagnie de Jésus*, vol. ii, col. 307–309 (1891); S. Zalenski, *Les Jésuites de la Russie-Blanche*, 2 vol. (E. J. Bs.)

BUACHE, PHILIPPE (1700–1773), French geographer who made original contributions to the theory of physical geography and to cartographic technique, was born in Paris on Feb. 7, 1700. He worked for the cartographer Guillaume Delisle (*q.v.*), whose daughter he married. He was appointed *géographe du roi* in 1729, and elected to the Académie des Sciences in the next year. His physiographic system divided the earth's surface into four basins, separated by a "scaffolding" of mountain ranges extending overland and beneath the oceans. This theory was expounded in Buache's *Cartes et tables de la géographie physique et naturelle* (1757), and he applied it particularly to the interpretation of the geography of North America and the Pacific. From the Russian discoveries in Bering strait he deduced the existence of Alaska and the Aleutians. He was an active cartographer and a pioneer in the use of contour lines to express relief in maps. He died in Paris on Jan. 24, 1773. (R. A. Sn.)

BUBASTIS, once an important city in the Nile delta, now a heap of ruins known as Tell Basta. Its beautiful temple, founded during or before the 4th dynasty (*c.* 4000 B.C.), is described by Herodotus. Bubastis became of consequence when the Pharaohs of the 19th dynasty (1320–1200 B.C.) moved their capital from Thebes to the delta, and reached its highest peak of prosperity when its prince, Sheshonk I (the Shishak of the Bible; 952 B.C.), became Pharaoh. Later, however, it shared in the decay of the rest of the country when Egypt became the prey of one foreign invader after another, and fell into utter ruin.

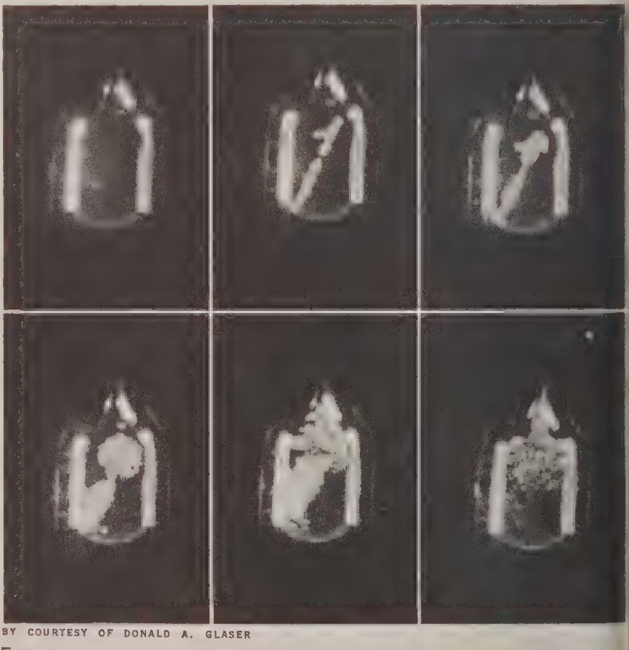
The goddess of Bubastis, worshiped in the form of a cat, was Bast. (The reading of her name as Ubast is not satisfactory, for in none of its forms is there an initial vowel.) All the deities of Egypt worshiped in animal form were indigenous and strictly localized, belonging to that primitive period when Egypt was a congeries of small independent states, each with its own chief and its own deity. Bast was essentially a goddess of the home and greatly beloved. The ritual in the temple and the home is not known, but Herodotus describes her great annual festival, which was of the usual orgiastic type common in ancient religions. In the New Kingdom (1590–*c.* 1200 B.C.) many changes were made in the official religion, and Bast became equated with the lioness war-goddess. Lioness-headed statues labeled Bast were dedicated in the temples by warlike Pharaohs who, perhaps, wished to show an appreciation of the domestic virtues combined with the ideal of military glory. Bast, however, never lost her cat identity nor her hold on popular affection, as is shown by the number of small figures of the goddess evidently intended to be used in home worship or to be worn as amulets on the person.

Bast is represented as a woman with a cat's head; she wears a highly patterned dress and carries a sistrum in her right hand, a so-called aegis in her left hand and has a small bag hung over her left arm. The significance of these emblems is not known. Her cult was carried to Italy by the Romans and traces of it have been found in Rome, Ostia, Nemi and Pompeii. (M. A. M.)

BUBB DODDINGTON, GEORGE: *see* Melcombe, George Bubb Dodington, Baron.

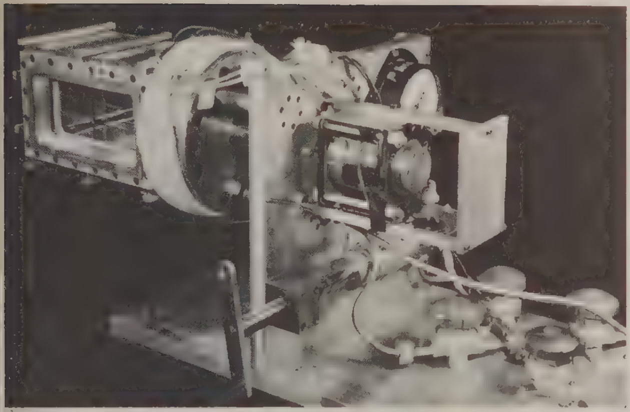
BUBBLE CHAMBER. An instrument used for experiments in nuclear physics, particularly in connection with high energy particle accelerators, to observe collisions of fast charged particles with atomic nuclei. The bubble chamber, developed by Donald A. Glaser at the University of Michigan in 1952, forms precisely localized tracks of particles interacting in a large volume of high density material. It makes use of a pressure-tight vessel, containing liquid heated far above its boiling point and maintained under high pressure so that boiling is prevented. When the pressure on the liquid is suddenly reduced by an expansion device, the liquid becomes highly superheated, with the result that charged particles speeding through it create strings of tiny bubbles along their paths. By taking high-speed photographs of these bubble tracks through the strong glass windows of the chamber, it is possible to make precision measurements of the details of nuclear processes caused by the high-speed particles. Collisions producing rare nuclear events are frequent because of the high density of the liquid. New events can be recorded every few seconds when the chamber is exposed to bursts of high-speed particles from particle accelerators or to showers of cosmic ray particles. The bubble chamber has proven very useful in the study of high-energy nuclear physics and elementary particles. Similar in function to the cloud chamber (*q.v.*), developed by C. T. R. Wilson, the bubble chamber differs in principle of operation and in usefulness for experiments in high-energy physics.

Basic Principle of Operation.—Since charged particles penetrating a liquid or solid medium deposit exceedingly small quantities of energy along their paths, an amplification technique is needed to produce an observable effect from the original microscopically small disturbance. The technique employed in the bubble chamber makes use of the fact that liquids can be heated far above their normal boiling points if they are heated in clean, smooth-walled vessels. Liquids in this condition are called superheated. Superheated liquids are unstable and will begin to boil



BY COURTESY OF DONALD A. GLASER

FIG. 1.—THE FIRST BUBBLE CHAMBER IMMEDIATELY BEFORE AND AFTER PRESSURE REDUCTION



BY COURTESY OF DONALD A. GLASER

FIG. 2.—A LARGER BUBBLE CHAMBER FABRICATED OF GLASS AND ALUMINUM

The chamber itself is on the left; on the right are the expansion valve, which controls the compressed air, and the apparatus for filling the chamber and adjusting the expansion volume. During operation the chamber is surrounded by a small oven to maintain the required operating temperature

violently if foreign bodies with rough edges are introduced into the liquid, or if an excess of heat is added. This irregular, eruptive boiling is called bumping, and can be observed readily by heating clean water in a smooth glass test tube. At first the water gets hotter and hotter without visible boiling, until suddenly it erupts with a violent evolution of vapour, settling down again to repeat the cycle. The first successful bubble chambers were based on the idea that a very pure liquid heated in a clean, smooth glass bottle might become so highly superheated that even the microscopic effect of a high-speed charged particle could trigger the boiling process. High-speed movies of the triggering process reveal that tiny bubbles mark the path of a charged particle during the first few milliseconds of the boiling eruption. Such triggering can be made the dominant cause of boiling in superheated liquids by keeping all foreign bodies and sharp edges from contact with the liquid.

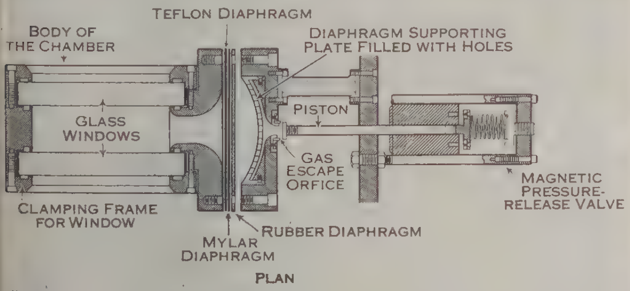


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FIG. 3.—SIMPLIFIED SCHEMATIC DIAGRAM OF A SIX-INCH CHAMBER SIMILAR TO THAT PICTURED IN FIG. 2 AND ITS EXPANSION MECHANISM

The triggering action is explained by the fact that a fast charged particle ionizes and excites the atoms and molecules of the liquid as it collides with them. After the electrons and ions have recombined many atoms are left in an excited state. When these excited atoms collide with their neighbours the excitation energy is converted into the kinetic energy of the rebounding atoms, and the liquid gets hot locally. These local hot spots are thought to cause the growth of the bubbles which are finally observed.

Construction and Operation.—The first bubble chamber was a small glass bottle, containing a few cubic centimeters of diethyl ether, immersed in hot mineral oil at a temperature of about 135° C., and connected with a pressure regulating device by means of a heavy walled glass capillary tube. Boiling of the liquid was prevented by keeping it under a pressure of about 20 atm. This was accomplished by applying compressed air against a flexible rubber diaphragm in the pressure regulating device. When the air pressure was released, the liquid became suddenly superheated and unstable. Since great care was taken in making sure that the glass walls of the bottle were smooth and clean, no boiling occurred for several seconds. This gave time for an ionizing event in the liquid to cause an eruption. After recompression the chamber was ready for a new expansion. This type of bubble chamber is called a "clean" bubble chamber.

To construct large bubble chambers it is necessary to use metal walls with glass windows sealed to the metal by means of gaskets. When the pressure is reduced by expanding the chamber, boiling always begins at the joints and gaskets. By expanding very rapidly it is possible to maintain a low pressure within the bulk of the liquid even though boiling is occurring at the walls. As the boiling at the walls proceeds, the vapour evolved finally raises the pressure throughout the liquid so that it is no longer sensitive to ionizing radiation. The sensitive time of such a chamber is limited, therefore, and may range from a few milliseconds to several hundred milliseconds, depending on the design of the chamber, the expansion device and the properties of the liquid used. Chambers that operate in this way are called "dirty" chambers and may be quite large; dimensions of several feet on a side are feasible. In order to achieve the very rapid expansion required for the successful operation of these dirty bubble chambers it is necessary to reduce the hydrodynamic resistance to the flow of the liquid during

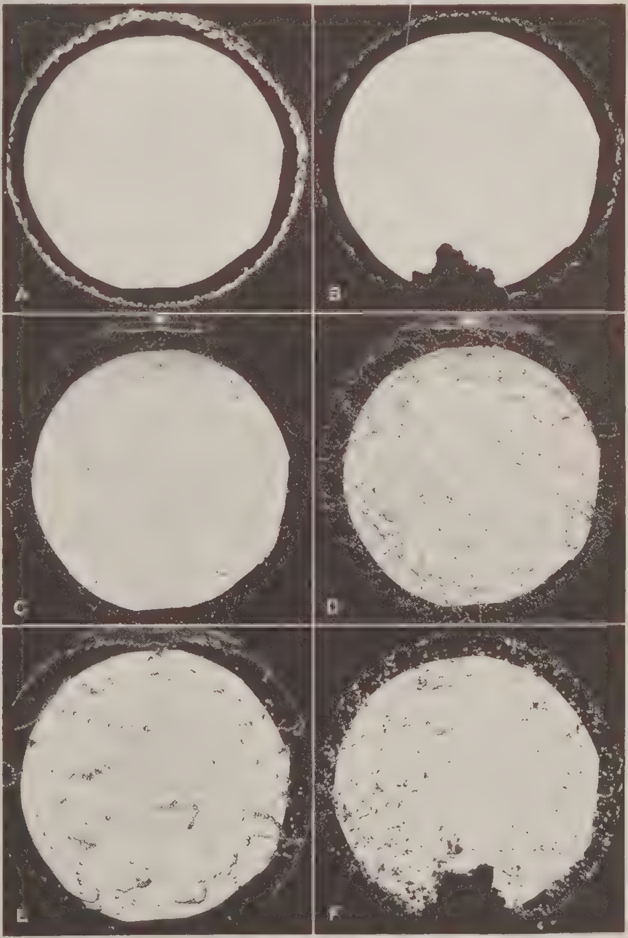

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FIG. 4.—CONDITION OF CHAMBER DURING EXPANSION CYCLE

(A) Violent boiling occurs at the gaskets, but no bubbles form in the interior (11 milliseconds); (B) A jet of vapour shoots out of the expansion orifice at the bottom of the chamber (12.5 milliseconds); (C) With radium source nearby, some bubble tracks become visible and the chamber is at full sensitivity (6 milliseconds); (D) Seven milliseconds after the start of expansion, bubbles on the oldest tracks have grown large and new tracks are being formed; (E) With weak radium source nearby new fine tracks continue to appear, but oldest tracks become too coarse to be useful (8.5 milliseconds); (F) A vapour jet from the expansion orifice causes a sudden pressure wave 12.5 milliseconds after the start of expansion. It distorts the track and abruptly ends the sensitive time

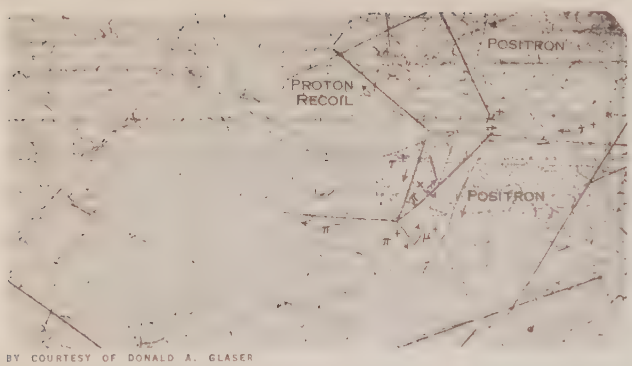

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FIG. 5.—A τ MESON HAS BEEN PRODUCED BY A COLLISION OF A 3,000,000,000 ELECTRON-VOLT PROTON AGAINST A COPPER TARGET. HERE IT ENTERS A PROPANE-FILLED BUBBLE CHAMBER 30 CM. LONG, STRIKES A PROTON IN A PROPANE MOLECULE, AND COMES TO REST AFTER THE REBOUND. THE RECOIL OF THE PROTON CAN ALSO BE SEEN. THEN THE τ MESON DECAYS INTO A NEGATIVE π MESON AND TWO POSITIVE π MESONS. THE POSITIVE π MESONS ARE STOPPED AND DECAY CHARACTERISTICALLY INTO μ MESONS, WHICH ALSO STOP AND DECAY INTO POSITRONS

the expansion process. A simple way of achieving this is to install the flexible diaphragm of the expansion mechanism as one wall of the bubble chamber. By means of this movable, flexible wall the pressure in the chamber can be regulated accurately and changed very quickly.

Bubble Chamber Liquids.—Many pure liquids and some solutions have been used in bubble chambers. Since all the liquids tried seem to work satisfactorily, a wide choice is available to the nuclear physicist. His choice is made on the basis of the type of target material he wishes to study, the kind of particle source he is using and practical convenience. The first large chambers contained diethyl ether, pentane, butane or propane, since these are readily available and operate at convenient temperatures and pressures. These liquids are especially useful because they are rich in hydrogen, which is the simplest possible target nucleus. The nucleus of ordinary hydrogen consists of a single proton.

For experiments requiring a pure proton target, bubble chambers have been run with liquid hydrogen. When it is desired to observe interactions involving neutron targets, bubble chambers filled with liquid deuterium or heavy hydrogen can be used. By comparing results thus obtained with those obtained in ordinary hydrogen bubble chambers it is possible to deduce what portion of the effects seen is due to the extra neutron in the deuterium nucleus. Liquid helium bubble chambers can be used for other special types of experiments.

Uncharged particles do not ionize the atoms of liquid as they fly through it, and hence do not produce tracks. In order to "see" X-rays, gamma rays and uncharged particles a very dense liquid must be used, because only in such a medium does a neutral projectile have a good chance of making a collision that reveals its presence and position. To attain the necessary high density unusual liquids have been used, including stannic chloride, methyl iodide dissolved in propane, tungsten hexafluoride and xenon. These heavy liquid bubble chambers are valuable because they yield information about the electrically neutral part of the submicroscopic world, a part that is inaccessible to many experimental techniques.

Use With Particle Accelerators and in Cosmic Ray Experiments.—When the bubble chamber is used in conjunction with a high-energy particle accelerator, special electronic equipment is employed to synchronize its operation with the production of particle bursts from the accelerator. Since at least several milliseconds are required to expand a bubble chamber to full sensitivity, and the lifetime of the latent image in bubble chambers is very short, certainly less than 0.1 milliseconds, the expansion process is started before the particles are ejected from the accelerator. The chamber is then fully sensitive when the beam of particles arrives. Often high-speed particle counters such as scintillation counters are arranged to count the number of particles passing through the bubble chamber. When a sufficiently large number of such particles is detected, which often takes less than a millisecond, a signal discharges a bright electronic flash. The proper duration of the light flash varies from several microseconds to several milliseconds for different kinds of chambers. Stereoscopic cameras with their shutters open record the tracks illuminated by the light flash. After the flash, a signal is given to apply pressure for recompressing the liquid; at the same time, the film in the camera is advanced in readiness for the next pulse of particles which may arrive in a few seconds.

Because it has been found necessary to expand the chamber before the particles arrive, it is impossible to make counter-controlled expansions, as is done with cloud chambers. There is no disadvantage to this mode of operation for experiments with high-energy particle accelerators, but it makes cosmic ray experiments very difficult to do with bubble chambers. One method that can be used for doing cosmic ray experiments with bubble chambers is to expand and recompress the chamber continuously in a rapid cycle, so that for some fraction of the time, perhaps as high as 40%, the chamber is sensitive to the possible occurrence of an interesting cosmic ray event. Whenever Geiger counters or other types of particle detectors associated with the bubble chamber indicate that such a cosmic ray collision has occurred the camera lights can be triggered and a photograph of the event taken.

Applications of Bubble Chambers.—Several types of measurements can be made with bubble chambers. Energies of particles can be deduced from the depth of penetration required to stop them in the dense liquid. When a chamber is immersed in a

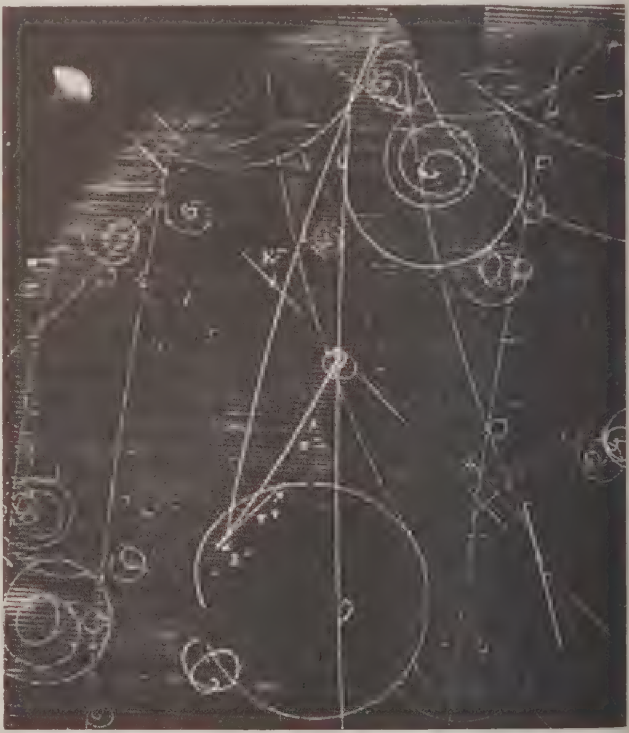

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FIG. 6.—A NEGATIVELY CHARGED K MESON ENTERS A LIQUID HYDROGEN CHAMBER 10 IN. IN DIAMETER IMMERSED IN A MAGNETIC FIELD. THE MESON COMES TO REST IN THE HYDROGEN AND IS ABSORBED BY A PROTON MAKING A NEGATIVE Σ HYPERON AND A POSITIVE π MESON. THE Σ HYPERON GOES ONLY A SMALL DISTANCE BEFORE IT DECAYS INTO A NEUTRON AND A NEGATIVE π MESON. BOTH OF THE π MESONS FINALLY GO TOWARD THE UPPER RIGHT-HAND CORNER OF THE PICTURE. FROM THE CURVATURES OF THE TRACKS IN THIS PICTURE IT IS POSSIBLE TO DEDUCE THE MOMENTUMS OF THE PARTICLES WHICH CAUSED THEM. THE SPIRAL TRACKS OCCURRING HERE AND THERE IN THE PICTURE ARE DUE TO ELECTRONS WHICH ARE LOSING ENERGY AND THEREFORE MOMENTUM AS THEY PENETRATE THE DENSE LIQUID. THE SPIRAL SHAPE RESULTS WHEN THE CURVE OF MOTION OF THE ELECTRONS BECOMES TIGHTER AND TIGHTER AS THEY SLOW DOWN AND COME TO REST

magnetic field the curvature of the particle track can be used to compute the momentum of the particles. From the density of bubbles along a track the charge and speed of the particle can be found. The crookedness or "scattering" of a particle track is a measure of its momentum times its speed. When these measurements are combined with simple geometric measurements of track lengths and angles between tracks, it is possible to calculate the masses, charges and lifetimes of particles observed. For the various types of events that can be seen it is similarly possible to calculate the energy released, the relative frequency of different kinds of processes and the angular distributions of the outgoing particles. Such information is basic to the understanding of nuclear structure and processes.

For a detailed discussion, *see* Y. A. Aleksandrov *et al.*, *Bubble Chambers* (1966). (D. A. G.)

BUBER, MARTIN (1878–1965), Jewish religious philosopher, who made a decisive contribution to 20th-century thought as leading exponent of the philosophy of "dialogue," as translator of the Bible, interpreter of biblical Judaism and re-creator of Hasidic legend and thought, was born in Vienna on Feb. 8, 1878. He studied philosophy and history of art in Vienna and Berlin and served ten years as professor of Jewish religion and ethics at Frankfurt University and then of social philosophy at the Hebrew University in Jerusalem, where he went in 1938 after Hitler's accession to power in Germany. From 1916 to 1924 he was editor of the periodical *Der Jude*.

Buber's philosophy of dialogue finds its classic expression in his poetic masterpiece *I and Thou* (1923), its elaboration in *Between Man and Man*, *Eclipse of God*, and *Pointing the Way*. Central to this philosophy is a distinction between "I-Thou" relations of mutuality, directness, and presentness and "I-It" relations in which persons merely know and use one another as objects of their experience. While Buber's philosophy of dialogue has had a growing influence on education and psychotherapy, his insistence that God is the "eternal Thou" whom one can talk *to* but not *about* has had a radical transforming effect on contemporary religious thought, both Christian and Jewish. In particular, his thought has influenced Protestant theology, as exemplified by Emil Brunner, Reinhold and H. Richard Niebuhr, Paul Tillich, and Karl Barth. His most philosophical work is *The Knowledge of Man* (1965).

In a series of highly significant studies—*Moses* (1952), *The Kingship of God* (1932; 3rd rev. ed., 1956), *The Prophetic Faith* (1950), and *Two Types of Faith* (1950)—Buber develops the thesis that the biblical covenant and messianic redemption mean the realization of the kingship of God in all areas of communal life and that biblical faith is unconditional trust (the Prophets and Jesus) rather than faith with a knowledge content (Paul and John).

Through such works as *The Tales of the Hasidim* (1950), *For the Sake of Heaven* (a chronicle-novel; 1944), and *Hasidism and Modern Man* (1960), Buber transformed the popular communal mysticism of East European Jewry from a little-known sect to one of the recognized great mystical movements of the world. Through his *Tales of the Hasidim* Buber "enriched world literature more than any other living author," wrote the Swiss novelist Hermann Hesse when nominating Buber for a Nobel Prize in Literature in 1949. Many would agree with Ludwig Lewisohn's characterization of Buber as "the most distinguished and influential of living Jewish thinkers," even while questioning his nonadherence to the Jewish law, or his religious Zionism, with its stress on Jewish-Arab cooperation. He died June 13, 1965, in Jerusalem.

See Maurice S. Friedman, *Martin Buber: the Life of Dialogue* (1960), a comprehensive study and systematic analysis and evaluation of Buber's thought, with a bibliography of works by and about Buber complete up to 1960. (M. S. F.)

BUBNA VON LITIC, COUNT FERDINAND VON (1768–1825), Austrian soldier, was born in Zamrsk, Bohemia, Nov. 26, 1768. He was with the Austrian army from 1792 until Napoleon's final defeat in 1815, except for the years 1812–13, which he spent in Paris as Austria's representative. He fought at Austerlitz (1805) and at Wagram (1809), and after the Austrian defeat in the latter battle was one of the ambassadors who traveled to Vienna to negotiate the peace of Schönbrunn. He took part in the battles of Lützen, Bautzen, Dresden and Leipzig in 1813. During the Piedmont uprising of 1821, Bubna led the Austrian troops that put down the insurrectionists.

Bubna died in Milan, June 6, 1825.

BUBONIC PLAGUE: *see* PLAGUE.

BUCARAMANGA, a city of Colombia in South America. It is the capital of Santander department, about 185 mi. N.N.E. of Bogotá at an elevation of 3,340 ft. in the Cordillera Oriental. Growth in the mid-20th century was very rapid. Pop. (1951) 102,887; (1964) 229,748 (mun.). Founded in 1622 near the Lebrija and Sogamoso rivers with several colonial mines nearby, Bucaramanga gained commercial significance at an early date. It is in a coffee- and tobacco-producing area, and its manufactures include cigars, cigarettes, textiles, straw hats and iron products. It is connected by rail with Puerto Wilches on the Magdalena river, by highway with the major cities of eastern Colombia and Venezuela, and has regular air service to Bogotá and the cities of the Caribbean coast. (T. E. N.)

BUCARELI Y URSÚA, ANTONIO MARÍA (1717–1779), Spanish soldier and colonial administrator, was born in Seville on Jan. 24, 1717. After distinguished military service in Italy and Portugal, Bucareli was named governor and captain general of Cuba in 1760 and, in 1771, was promoted to viceroy of New Spain (Mexico), an office he held until his death on April 9, 1779. His administration in New Spain was characterized by rapid economic development and Bucareli enjoyed widespread personal popularity. Among other accomplishments, he founded several charitable institutions, improved the public services of Mexico City, encouraged scientific investigation, reorganized the army and strengthened the defenses of the viceroyalty, and he promoted the expansion of Spanish settlement in California. (L. N. McA.)

BUCCANEERS were English, French and Dutch adventurers of the sea who haunted the Caribbean and the Pacific seaboard of South America during the second half of the 17th century. The chief bond between these "Brethren of the Coast," as they styled themselves, was hostility toward the Spaniards, who at that time regarded those seas as their monopoly. The buccaneers were largely inspired by the example of the seamen of Sir Francis Drake's times, but they are to be distinguished from genuine privateers (*q.v.*) because the commissions that they held were seldom valid. They are also to be distinguished from the outlawed pirates of the 18th century, though some of their actions can indeed be called piratical.

In their own day the buccaneers were usually referred to as privateers, the word "buccaneer" coming into use after the publication in 1684 of *Bucaniers of America*, the English translation of *De Americaensche Zee-Rovers*. The original work, by Alexander Esquemeling (or Exquemelin), was composed in obscure circumstances but achieved international fame after its first publication in Dutch in 1678 and has been the source of many tales about the Spanish Main. The word "buccaneer" is derived from the French *boucan*, a grill for the smoking of *viande boucanée*, or dried meat, for use in ships at sea. The French called their adventurers *flibustiers* (from Dutch *vrijbuiter*, "freebooter"; *see* FILIBUSTER), the Dutch called theirs *zeerovers;* and the Spaniards called them *corsarios*. The earliest buccaneers were hunters in western Hispaniola (Haiti), whence they spread to the island of Tortuga, the French governors of which were liberal in the issue of commissions for attacks on Spanish maritime trade. Jamaica, after its capture by the English in 1655, also afforded a base for their activities. The early bands of these sea rovers were composed of adventurers, escaped servants, ex-soldiers and the logwood cutters of the Gulf of Campeche. They exercised a democratic discipline among themselves when they went off "on the account," electing their captains, marooning mutineers, arranging for the equitable distribution of shares of plunder and drawing up elaborate insurance schemes for injuries suffered. They were brave, cruel, tough seamen, excellent navigators and often first-class shots. Since they attracted to their ranks such remarkable men as William Dampier (*q.v.*), Lionel Wafer and Basil Ringrose, who wrote racy accounts of their adventurous cruises, they exercised a greater influence on subsequent generations than their exploits justified in themselves.

The earliest buccaneers went under assumed names, such as L'Olonnois (properly Jean David Nau) or Rock Brasiliano, a Dutchman who had lived in Brazil. With the appearance of Henry Morgan (*q.v.*), a natural leader, they began to organize themselves into powerful bands which captured Porto Bello in 1668 and Panamá in 1671, where the old town was so thoroughly burned that the Spaniards were compelled to build another, the present city, on a new site nearby. Few of the 2,000 men who accompanied Morgan on this first crossing of the isthmus benefited from the plunder because their leader absconded with most of the loot on their return. As the treaty of Madrid (1670) had only recently been signed to compose Anglo-Spanish differences in those parts, the news of his success at Panamá was not officially welcome. Morgan was arrested and brought back to England, but on the renewal of trouble with Spain he was knighted and sent out again as deputy governor of Jamaica. In this capacity he and his superiors attempted to suppress the buccaneers but, as he told the government at home, this was no easier than suppressing highway robbery. Until a police force of regular naval vessels began to appear in those seas, this policy was therefore not particularly successful. What finally brought buccaneering in the Caribbean to an end was the outbreak of the War of the Grand Alliance (*q.v.*) in 1689, when these freebooters became legitimate privateers in the service of their respective nations. Some of the French, for example, assisted in attacking Cartagena, among them the renowned Louis Granmont (or Grammont) and Laurent de Graff, who is the reputed founder of the city of Mobile.

Sir Henry Morgan died a respectable citizen of Jamaica some months before England entered the war. In his day the buccaneers had certainly enriched and protected the infant colonies, even if their depredations had made legitimate trade with Spain impossible. Morgan also pointed the way into the South seas. His chief followers in this direction were John Coxon and Bartholomew Sharp, who led another party across the isthmus to attack Panamá in 1680. This time they were not so successful. Coxon and 70 others returned across the isthmus. Sharp took a captured vessel, the "Trinidad," south for a cruise off the coasts of Chile and Peru, using as his bases the Galápagos Islands and Juan Fernández Islands (where Alexander Selkirk was marooned on Dampier's third voyage in 1704). A party which included Dampier and Wafer returned overland after a quarrel with Sharp. As a result of an accident, Wafer was left behind with the Darién Indians for some months before rejoining the others; his account of this sojourn and of the habits of the Indians is still of value to anthropologists. Sharp himself later returned to Barbados after a remarkable voyage during which he never sighted land between Juan Fernández and the West Indies; he was the first Englishman to sail around Cape Horn. In order to avoid the attention of the authorities, he escaped to England, where he bought his pardon by presenting the king with the first Spanish charts of the Pacific. He was given a commission in the navy but soon reverted to his old trade of buccaneering. It is not known how or where he died.

Another ship, the "Batchelor's Delight," commanded by John Cook with Ambrose Cowley as his pilot, reached the Pacific by way of Cape Horn in 1684. On Cook's death Edward Davis, the most competent of all buccaneers, took command. Off Panamá they joined other parties under Charles Swan, Townley, John Eaton and a French contingent under Grogniet, which had crossed the isthmus; the adventures of the latter were described by one of their number, Ravenau de Lussan. This was the largest concentration of buccaneers ever seen, a force of about 3,000 men, who attacked Panamá for the third time. They met with little success and soon broke up. Cowley and Eaton returned home around the world, as did Dampier in another vessel; he described his adventures in his first and most popular book, *A New Voyage Round the World* (1697). Others returned home across Nicaragua. One ship with Davis and Wafer on board returned via the Horn to the Chesapeake, where they were arrested; Wafer's fine was used for the building of the College of William and Mary at Williamsburg, Va. Davis probably became a companion of the pirate William Kidd (*q.v.*).

After this period many, like Dampier, became privateers in the War of the Spanish Succession, and the age of the buccaneers came to an end. Historically their importance lies in the influence that they had on the Darién scheme and on the foundation of the South Sea company, as also in the way in which they inspired later and more serious voyages of exploration in the Pacific by the publicity enjoyed by their writings. From a literary point of view the books describing their adventures have been of lasting value from the days of Jonathan Swift and Daniel Defoe to those of Robert Louis Stevenson and John Masefield.

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(C. C. L.)

BUCCLEUCH, DUKES OF. The Scottish dukedom of Buccleuch was created on April 20, 1663, when ANNE SCOTT (1651–1732), countess of Buccleuch in her own right, married James, duke of Monmouth (*see* MONMOUTH, JAMES SCOTT). They were then created duke and duchess of Buccleuch. She was a member of the border family Scott of Buccleuch which traced its descent from Richard le Scott (*c.* 1265–1320) and its power from large grants of land to Sir Walter Scott (1426–69) of Kirkurd and Buccleuch in return for his support of James II of Scotland against the Douglas rebels. The family gained a peerage in 1606 and an earldom in 1619. Anne Scott was the daughter of Francis (1626–51), 2nd earl of Buccleuch. She retained, after Monmouth's execution, those titles which she held in her own right, and was succeeded by her grandson, FRANCIS SCOTT (1694–1751), 2nd duke of Buccleuch, in 1732. His grandson HENRY (1746–1812) became 3rd duke, and on the death of William Douglas, 4th duke of Queensberry, in 1810, succeeded also to that dukedom and its estates. Henry married the daughter and eventual heiress of George, duke of Montagu. He was succeeded by his son, CHARLES WILLIAM HENRY (1772–1819), 4th duke. Alice, the daughter of Charles's great-grandson, JOHN CHARLES MONTAGU-DOUGLAS-SCOTT (1864–1935), 7th duke, married the duke of Gloucester, third son of George V, in 1935. WALTER JOHN (1894–) 8th duke, succeeded his father in 1935.

See Sir W. Fraser, *The Scotts of Buccleuch* (1878).

BUCENTAUR (Italian BUCINTORO), a highly decorated galley formerly used by the Venetians at their annual ceremony of the "wedding of the sea" (*sposalizio del mare*) on Ascension day. This ceremony symbolized the maritime supremacy of Venice and originated about A.D. 1000 in commemoration of the doge Orseolo II's conquest of Dalmatia. It took the form of a solemn procession of boats, headed by the doge's *maesta nave* (from 1311 the Bucentaur), out to sea by the Lido port. In 1177 Pope Alexander III gave to this ceremony, which had originally been placatory or expiatory, a sacramental or nuptial character in recognition of Venice's services against the emperor Frederick I. The pope gave one of his rings to the doge, bidding him cast such a one into the sea each year on Ascension day. Every year thereafter, the doge dropped a consecrated ring into the sea, with the words *Desponsamus te, mare* ("We wed thee, sea"). The last bucentaur, built in 1729, was destroyed by the French in 1798 for the sake of its golden decorations. Remains of it are preserved at Venice in the Museo Civico Correr and in the Arsenal.

BUCER (BUTZER), **MARTIN** (MARTIN KUHHORN) (1491–1551), German Protestant reformer, best known for his ceaseless attempts to make peace between conflicting reform groups, and for his own particular program for reform, was born at Schlettstadt, Alsace, Nov. 11, 1491. In 1506 he entered the Dominican order and was sent to study at Heidelberg. There he became acquainted with the works of Erasmus and Luther. Withdrawing from his order in 1521, Bucer entered the service of the elector palatine, but in 1522 became pastor of Landstuhl, where he married Elizabeth Silbereisen, a former nun. After his excommunication in 1523 he made his way to Strasbourg where his parents' citizenship gave him protection. His personal charm, intellectual abilities and zeal brought him eventually to a position of leadership in Strasbourg and in southern Germany.

Bucer wanted a reform that would be a renewal of the whole of society, church, state, education, morals, etc. Under the influence of Erasmus he had accepted the ideals of Christian humanism and of the Renaissance, which called for a rebirth of the true good, the original rightness, in man and society. When he became a Protestant reformer he envisioned a renewed, converted man and society that would result from the preaching of the true Gospel and the faithful following of the divinely given pattern in the Bible. This reform through conversion, piety and discipline found its fullest expression in the massive program for the reformation of England which he presented to King Edward VI of England in 1551.

Strasbourg lay between the north German area, influenced by the Lutheran reformation, and the south German and Swiss areas, influenced by the reform movement led by Huldreich Zwingli and others. As the leaders in these two reform movements clashed after 1524 over the Lord's Supper, Bucer spent two decades in countless journeys and conferences in an effort to mediate. He was a participant in nearly every conference on religion in Germany and Switzerland in the years 1524 to 1548. In these conferences between Protestants and Catholics, or between German Lutherans and Swiss Reformed churchmen, Bucer often advocated the use of obscure language and ambiguous formulas when explicit agreement became impossible. His justification was that actual reform of the people was the real goal and that doctrinal issues could be worked out later. Conferences held in 1536 produced the Second Confession of Basel (*see* HELVETIC CONFESSIONS) and the Wittenberg Concordat. These seemed to unite the Zwinglians and the Lutherans, but Bucer's evasive approach had concealed the issues. The civil authorities in many south German areas sought his advice and guidance in arranging forced compromises. Since these compromises were regarded by Bucer as of necessity tailored to local circumstances, he soon came to be charged by all parties as having no convictions except that the end justified the means. His defense was that each of these compromises was made only for the time being. Gradually, he hoped, further changes could be made. A better aspect of this policy of agreement by compromise appeared when it was applied to the problem of religious toleration; under Bucer's policies Strasbourg had less persecution of Anabaptists and other minority groups than did most of Europe.

The most controversial of Bucer's pragmatic solutions of problems were in the cases of the Regensburg Book of 1541–46 and the bigamy of Philip of Hesse. Philip was a Protestant prince to whose support Bucer, Luther and many other reformers owed much. Because Philip had serious marital problems, and divorce was impossible for him, Bucer aided Philip in persuading Luther, Melanchthon and others to sanction a second wife for him on the basis of Old Testament plural marriages (*see* PHILIP [the Magnanimous]). Great efforts, even flat lies, were used in a fruitless effort to keep the matter secret, and the venture caused serious harm. Bucer had long dreamed of a healing of the Protestant-Catholic rift. In an effort to bridge these differences he engaged in secret negotiations with certain liberal, reform-minded Catholics as John Gropper and Gasparo Cardinal Contarini. When his rather far-reaching concessions were used at the colloquy of Regensburg (1546) by Charles V as the basis for an official solution of the controversy over the Reformation, Bucer was taken by surprise, and in panic denied all connection with the scheme. Both Catholics and Protestants rejected the Regensburg Book. Charles then broke the Protestant powers by military force and laid down his own compromise scheme, the Augsburg Interim of 1548 (*see* also CHARLES V [Roman emperor]).

Although the Augsburg Interim did not concede much more to Catholicism than some of Bucer's earlier compromise solutions had, he opposed vigorously its acceptance by Strasbourg. His view was that even a poor compromise was justified if it made some progress toward reform, but that for Strasbourg to accept the Interim would mean going backward. The city, however, would not oppose Charles's armies. Finally they discharged Bucer and several other ministers, among them Pietro Martire Vermigli, Paul Fagius and Emmanuel Dryander, all of whom were then invited by Archbishop Thomas Cranmer to come to England. There Bucer supported solidly the official, cautious reform program of Cranmer and Nicholas Ridley against the more radical program urged by John Hooper and John Knox. The Second Prayer Book (1552) and the Anglican Ordinal of 1550 owed much to Bucer's counsel. He died in England Feb. 28, 1551.

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(L. J. T.)

BUCEROTIDAE, a family of birds characterized by a brightly coloured horny growth, or casque, on their large bills. *See* HORNBILL.

BUCH, CHRISTIAN LEOPOLD VON, BARON (1774–1853), German geologist and geographer, a member of an aristocratic Prussian family, was born at Stolpe, Pomerania, on April 26, 1774. In 1790–93 he studied at the mining school of Freiberg under A. G. Werner (*q.v.*), one of his fellow students there being Alexander von Humboldt. He completed his education at the universities of Halle and Göttingen. In 1797 he met Humboldt at Salzburg, and with him explored the geological formations of Styria and the adjoining Alps. A visit to Italy in 1798 shook his faith in the Wernerian Neptunist theory of the aqueous origin of igneous rock, of which he had been the outstanding exponent. In 1799 he paid his first visit to Vesuvius, and again in 1805 he returned to study the volcano, accompanied by Humboldt and Gay Lussac, when they witnessed an eruption which supplied Von Buch with data for refuting many erroneous ideas then held regarding volcanoes. In 1802 he explored the extinct volcanoes of Auvergne. The scientific results of his investigations he embodied in his *Geognostische Beobachtungen auf Reisen durch Deutschland und Italien* (1802–09). Von Buch spent two years among the Scandinavian islands; he showed that many of the erratic blocks on the north German plains must have come from Scandinavia. He also established the fact that the whole of Sweden is slowly but continuously rising above the level of the sea from Frederikshald to Åbo. The details of these discoveries are given in his *Reise durch Norwegen und Lappland* (1810). In 1815 he visited the Canary Islands (*q.v.*) in company with Christian Smith, the Norwegian botanist, to study their volcanic origins. His classic physical description of the Canary Islands was published at Berlin in 1825. After leaving the Canaries, Von Buch proceeded to the Hebrides and the coasts of Scotland and Ireland. He published in 1832 the magnificent *Geological Map of Germany,* 42 sheets. He also helped to establish the stratigraphy of the Jurassic system. He died at Berlin on March 4, 1853. A complete edition of his works was published in 1867–85, edited by J. W. Ewald and others.

BUCH, JEAN III DE GRAILLY, CAPTAL DE (1321–1376), the chief vassal and officer in Gascony under the English king Edward III and Edward (the Black Prince), was a shining example of 14th-century chivalry, frequently extolled by Froissart for his valour in battle, for his courage and for his loyalty. His great-grandfather, the Savoyard noble Jean I de Grailly (or Grilly), went to England and was on three occasions appointed seneschal of Gascony for Henry III and Edward I, who gave him the viscountcies of Benauges and Castillon. Jean III's father, Pierre II de Grailly, by his marriage with Assalide de Bordeaux acquired the *captalat* of Buch; *i.e.,* the principal seigniory in the *pays* of Buch, the chief town of which was La Teste de Buch (on the edge of the Arcachon basin). Jean was the son of Pierre's later marriage to Blanche, daughter of Gaston V of Foix. Jean de Grailly remained steadfastly loyal to Edward III who increased his hereditary possessions by the addition of the county of Bigorre and made him a knight of the Order of the Garter.

Jean de Grailly was, with Sir John Chandos, the chief agent of the Black Prince's victory at Poitiers in 1356. In 1357 he went with his cousin Gaston Phoebus of Foix on a crusade against the pagans in Prussia. On returning to France (1358), the two cousins released the dauphine (Jeanne de Bourbon) and the duchesse d'Orléans (Blanche de France), whom the rebels of the Jacquerie were besieging in Meaux. In 1364, however, he commanded the Navarrese army which was defeated by Bertrand du Guesclin at Cocherel. He then took part in the battle of Nájera in Castille (1367), when the Black Prince defeated Du Guesclin. In 1371 he was nominated constable of Aquitaine by the Black Prince, but was taken prisoner by French troops near Soubise in Saintonge. Obstinately refusing to serve Charles V, he died in the Temple prison in Paris in 1376. (Y. R.)

BUCHAN, EARLS OF. The earldom of Mar and Buchan was one of the seven original Scottish mormaorships; later Buchan was separated from Mar and passed with an heiress to the Comyns, of whom ALEXANDER (d. 1290) and JOHN (d. 1308) were both constables of Scotland. John's wife, Isabel, crowned Robert I (the Bruce) at Scone in 1306, and was afterward imprisoned by the English in a cage at Berwick. After John's death (1308), the earldom was claimed by HENRY, LORD BEAUMONT (d. 1340), husband of John's niece and coheiress, ALICE COMYN; but although summoned to parliament in England as earl of Buchan, his title was not recognized in Scotland and Alice's younger sister, MARGARET, who married Sir John Ross, may in that country have been styled countess of Buchan. But the title was not claimed by the issue of either sister, and SIR ALEXANDER STEWART (d. *c.* 1405), called "the wolf of Badenoch," a son of King Robert II, became earl of Buchan (*c.* 1382). The earldom was then held for about 150 years by the Stewarts, of whom one of the most important was Sir Alexander's nephew, JOHN (*c.* 1380–1424), who became constable of France and was killed fighting for Charles VII at the battle of Verneuil. Subsequently the title passed twice through heiresses: first to ROBERT DOUGLAS (d. 1580) and his son James (d. 1601) and then in 1617 to JAMES ERSKINE (d. 1640), a member of the family which retained it thereafter.

Most celebrated of the later earls of Buchan was DAVID STEUART ERSKINE (1742–1829), 11th earl. His pertinacity was instrumental in effecting a change in the method of electing Scottish representative peers, and he founded the Scottish Society of Antiquaries (1780). Among his many correspondents was a reluctant Horace Walpole, and he wrote *Essays on the Lives of Fletcher of Saltoun and the Poet Thomson* (1792). He died at Dryburgh abbey on April 19, 1829. DONALD CARDROSS FLOWER ERSKINE (1899–) succeeded his cousin, as 16th earl, in 1960. (T. I.)

BUCHAN, ALEXANDER (1829–1907), the most eminent British meteorologist of the 19th century, was born at Kinnesswood, Kinross-shire, Scot., on April 11, 1829. He took up teaching as a profession and botany as a hobby. In Dec. 1860 he was appointed secretary of the Scottish Meteorological society and edited and largely wrote the society's journal, thereby gaining an international reputation. In 1887 he was made a member of the Meteorological council and in 1898 was elected a fellow of the Royal society. In 1902 he received the first award of the Symons medal as the most eminent British meteorologist. He had a full share in the opening, in 1883, of the Ben Nevis observatory and in the discussion of the observations until it closed in 1904. Buchan died in Edinburgh on May 13, 1907.

In 1867 Buchan published his *Handy Book of Meteorology,* for many years a standard textbook. In 1869 he contributed to the Royal Society of Edinburgh a paper on "The Mean Pressure of the Atmosphere and the Prevailing Winds Over the Globe, for the Months and for the Year" which secured for him a pre-eminent place among meteorologists. He contributed memoirs on "Atmospheric Circulation" (1889) and on "Oceanic Circulation" (1895) for the "Challenger" expedition reports.

Buchan Spells.—In papers contributed to the *Journal of the Scottish Meteorological Society* (1869) on "Interruptions in the Regular Rise and Fall of Temperature in the Course of the Year" Buchan discussed temperature records for the years 1857–66 which suggested that there were nine periods each year, in six of which the temperature was below the seasonal normal and in three of which it was above, but he made no claim that they would always recur and did not again refer to this paper. In 1927 statisticians began to reconsider the evidence for the cold and hot spells which came to be called "Buchan spells." The modern view is that nonseasonal temperature fluctuations are very largely of a random nature. (E. M. WN.)

BUCHAN, ELSPETH (1738–1791), religious fanatic and founder of a Scottish sect called Buchanites, proclaimed in 1783 that the second coming of Jesus Christ was at hand, that she herself was the woman predicted in Rev. xii and that the Rev. Hugh White of Irvine was her man-child who would rule the earth with a rod of iron. The magistrates of Irvine expelled her followers, who settled in Dumfriesshire, in a farmhouse called Buchan hall, where they practised peculiar rites, during which Mrs. Buchan "breathed" the Holy Ghost upon them. After her death in May 1791 they soon disappeared, the last adherent, Andrew Innes, dying in 1846.

See J. Train, *The Buchanites From First to Last* (1846); J. Cameron, *History of the Buchanite Delusion, 1783–1846* (1904). (H. WA.)

BUCHAN, JOHN: *see* TWEEDSMUIR, JOHN BUCHAN.

BUCHANAN, FRANKLIN (1800–1874), U.S. naval officer, was born in Baltimore, Md., Sept. 17, 1800, grandson of Thomas McKean, a Delaware signer of the Declaration of Independence. He became a midshipman Jan. 28, 1815. George Bancroft, the historian, then secretary of the navy, appointed him the first superintendent of the United States Naval academy, opened at Annapolis, Md., on Oct. 10, 1845. He commanded the U.S.S. "Susquehanna," flagship of Commodore M. C. Perry, in Japan, 1852–54. Believing that Maryland would secede from the Union, he resigned his commission on April 22, 1861, while in command of the Washington navy yard. He tried to recall this resignation, but was dismissed May 14 and entered the Confederate States navy. He commanded the ironclad ram "Virginia" ("Merrimack") when she sank the Union ships "Cumberland" and "Congress" in Hampton Roads, March 8, 1862; his brother McKean Buchanan, was an officer on board the "Congress." Promoted to the rank of admiral on Aug. 26, 1862, Buchanan was the senior officer of the Confederate navy thereafter. In Mobile bay, Aug. 5, 1864, he fought Farragut's ships with the ram "Tennessee" after other vessels of his own squadron were disabled or captured. He was wounded on board the "Virginia" and again on the "Tennessee." He died May 11, 1874. (J. B. HN.)

BUCHANAN, GEORGE (1506–1582), Scotland's greatest humanist, was born in Feb. 1506, near Killearn, Stirlingshire. His father, who claimed descent from the house of Lennox, was poor and died early; but George, having showed great promise, was sent by his uncle in 1520 to the University of Paris. There he began a course in arts, but in 1522 his uncle's death recalled him to Scotland. In 1525 he resumed his studies, at St. Andrews, attracted no doubt by the fame of John Major. He completed his B.A. in 1526 and returned to Paris as a bursar in the Scots college. After a period of penury he graduated master in 1528, and became a regent (teacher) in the enlightened Collège de Ste. Barbe. Rejecting the old-fashioned grammar of Alexandre de Villedieu, he taught Latin according to the method of Thomas Linacre, whose book, in English, on Latin grammar he translated into Latin (1533). His reputation grew and he was entrusted with the education of James Stewart, the eldest of James V's natural sons.

While still with Cassillis he had attacked the Franciscans in *Somnium*—little more than a translation of a poem by William Dunbar—and in 1537 he produced the still more bitter satire *Franciscanus*. He was attacked as a heretic in 1539, and escaped through the window of his prison in St. Andrews.

Suspect, he was unwelcome both in England and in Paris and accepted an invitation from his Portuguese friend, André de Gouvêa principal of the Collège de Guyenne in Bordeaux, who was introducing the new method of education. There Montaigne was one of his pupils. Buchanan found diversion in translating Euripides *Medea* and *Alcestis* in Latin, and in writing two original dramas *Jephthes* and *Baptistes,* the latter a thinly veiled attack upon persecuting tyranny. Of the years which followed his departure from Bordeaux in 1542 or 1543 little is known, but 1547 found him in

Portugal, where Gouvêa had become head of a new college in the University of Coimbra. Gouvêa, himself a Roman Catholic, held liberal views but on his death Buchanan and other teachers were accused of heresy. After having been immured in a monastery for instruction, he was allowed to leave Portugal in 1552. In captivity he had composed a paraphrase of the Psalms which, published in the 1560s, was long used to instruct Scottish youth in Latin.

Once more in France, he acted for a time as tutor to the son of Marshal Brissac. In this congenial employment he began what he thought would be his magnum opus. This was the *De Sphaera*, a poem in five books which, although in distinguished Latin, was but a defense of the old Ptolemaic system and remained unpublished until after his death. Among other poems written at this time was the *Epithalamium* on the marriage of Mary Queen of Scots with the dauphin (1558) from which he hoped great things; but the dauphin's death (Dec. 1560) and the recrudescence of persecution disillusioned him and he returned to Scotland in 1561.

There he was at once recognized as *Poetarum nostri seculi facile princeps* ("unquestionably the foremost poet of our generation"). He had become Protestant, but since Mary pursued a *politique* course he was able to commend himself to both kirk and crown. He reconciled himself to the queen's Catholic marriage in 1565 probably because her bridegroom, Henry, Lord Darnley, was a scion of his own house of Lennox. In 1566 he was made principal of St. Leonard's college.

After the murder of Darnley in 1567 he became Mary's bitter enemy and served each of the regents who ruled after her enforced abdication—Moray, Lennox, Mar and Morton. He helped Moray to prepare the case against Mary presented to Elizabeth I, and in 1571 published the *Detectio* which gave Europe a lurid version of the queen's conduct. Under Lennox (1570–71) he became tutor to the young king and was made director of chancery and keeper of the privy seal. These offices he continued to hold, though he resigned the seal in 1578, but his influence declined because of his waning health and perhaps because his political opinions did not commend themselves to the authoritarian Morton. He died on Sept. 29, 1582, and was buried in Edinburgh. *De jure regni apud Scotos* (1579), the most important of his political writings, and immensely popular, was a resolute assertion of limited monarchy in dialogue form and on the classical model; and *Rerum Scoticarum Historia* (1582) (which he was completing at the time of his death), though it accepted the 108 kings from the mythical Fergus and superabounded in patriotism, was strongly coloured by his theories.

By the partisans of Mary, Buchanan has been regarded as an unprincipled turncoat who repaid benefits with black ingratitude, but generally he survives in Scottish tradition as a hero of Protestantism, reform and liberty. This is at first sight odd. He wrote, almost entirely, not in Scots but in Latin; he became a Protestant only about 1560; for long he was known throughout Europe as a scholar and a poet, who composed among other things *erotica;* his astronomical theories were outmoded; his political ideas were not new; his *History,* compared by his admirers with Caesar, Livy and Sallust, was, according to modern ideas, uncritical. It might be thought that he should instead be regarded as essentially a humanist, who wrote with the first pen in Europe.

Yet there is justification for the traditional view. He could not, like Erasmus, regard with easy tolerance views and institutions with which he disagreed. He set himself to destroy what he regarded as corrupt and inefficient; he expressed himself with power and eloquence; and his disregard of convention made him the colourful figure who survives in many exaggerated stories. With all his shortcomings he was a fearless champion of truth as he saw it and he well deserves his place in Scottish tradition.

The standard complete edition of Buchanan's works is by T. Ruddiman (1715). His writings in Scots were edited for the Scottish Text society by P. Hume Brown (1892). The most useful translation of his history is that used by James Aikman as the foundation of his *History of Scotland,* six volumes (1827–29). *De jure regni apud Scotos* was translated by C. Flinn Arrowood (1949).

Bibliography.—The best bibliography of Buchanan's works is *George Buchanan,* "Glasgow Quatercentenary Studies" (1906), which includes valuable articles on the material. The *Life of Buchanan* in Mackenzie's *Lives of Scots Writers,* 3 vol. (1708–22) is not reliable. D. Irving, *Memoirs of the Life and Writings of George Buchanan,* 2nd ed. (1817) is useful, but the standard biography is P. Hume Brown, *George Buchanan, Humanist and Reformer* (1890); this must be supplemented by later material, notably G. J. C. Henriques, *George Buchanan and the Lisbon Inquisition: the Records of His Trial With a Translation Thereof Into English* (1906). (Jn. D. M.)

BUCHANAN, JAMES (1791–1868), 15th president of the United States, was born near Mercersburg, Pa., on April 23, 1791. Both parents were of Scottish-Irish Presbyterian descent. He graduated from Dickinson college, Carlisle, Pa., in 1809 and studied law at Lancaster for two years. He was admitted to the bar in 1812 and served in the lower house of the state legislature, 1814–16. From 1821 to 1831 he served in the U.S. congress. As chairman of the judiciary committee he conducted the impeachment trial (1830) of Judge H. Peck, led an unsuccessful movement to increase the number of supreme court judges and to relieve them of their circuit duties, and succeeded in defeating an attempt to repeal the 25th section of the Judiciary act of 1789, which gave the supreme court appellate jurisdiction by writ of error to the state courts in cases where federal laws and treaties were in question. After the dissolution of the Federalist party, of which he had been a member, he came to be definitely associated with the Democrats. He represented the United States at the court of St. Petersburg from 1832 to 1833 and there negotiated an important commercial treaty. He was a Democratic member of the U.S. senate from Dec. 1834 until March 1845, ardently supporting President Jackson, and was secretary of state in the cabinet of President Polk from 1845 to 1849—a period marked by the annexation of Texas, the Mexican War and negotiations with Great Britain relative to the Oregon question. After four years of retirement, following his failure to secure the Democratic nomination for president, he was appointed by President Pierce minister to Great Britain in 1853.

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JAMES BUCHANAN, PHOTOGRAPH BY MATHEW BRADY

Sometime in the 1830s Buchanan had begun developing a consuming ambition for the presidency. He realized that as a northern man he must impress the southern party leadership with his respect for the constitutional safeguards of slavery. He felt that the institution was morally wrong, but held that congress could not interfere with it in the states in which it existed, and ought not to hinder the natural tendency toward territorial expansion through a fear that the evil would spread. He voted for the bill to exclude antislavery literature from the mails, he supported the Compromise of 1850 (*see* Compromise of 1850) and opposed the Wilmot proviso. Fortunately for his career he was abroad during the Kansas-Nebraska debates, hence did not share in the unpopularity which attached to Stephen A. Douglas as the author of the Kansas-Nebraska bill and to President Pierce as the executive who was called upon to enforce it. At the same time, by joining with J. Y. Mason and Pierre Soulé in signing the Ostend manifesto (*q.v.*) in 1854, Buchanan retained the good will of the south. This "manifesto," which was bitterly attacked in the north, was agreed upon (Oct. 18, 1854) by the three ministers after several meetings at Ostend and at Aix-la-Chapelle. These meetings were arranged in pursuance of instructions from President Pierce to aid in mobilizing powerful financial influences in the European capitals to bring pressure on Spain for the sale of Cuba so that Spain would have the money to pay some of its debts long due these financiers. These diplomats, as far as is known, did nothing toward this end. Rather they spent their time in drafting a report, largely the work of Buchanan, which recommended that the United States purchase the island. In view of the fact that many feared that the Negroes might take over Cuba as they had Haiti, the diplomats added a caution. Such action would be a menace to the southern states, where it might encourage a slave uprising. The diplomats expressed their view that if such "Africanization" took place, the United States might then, had Spain refused to sell, have to take over Cuba in self-defense. Spain would not sell and the island did not come under Negro rule, so the document served no practical purpose. However, the rising Republican press proclaimed it a "manifesto" pointing a gun at Spain and saying "sell it or we seize it," a partisan interpretation not warranted by the facts.

On Buchanan's return from England in 1856 he was nominated by the Democrats as a compromise candidate for president and was elected, receiving 174 electoral votes to 114 for J. C. Frémont, Republican, and 8 for Millard Fillmore, American or "Know-Nothing." Buchanan's character, the breadth of his legal knowledge, and his experience as congressman, cabinet member and diplomat, would have made him an excellent president in ordinary times; but he lacked the soundness of judgment, the self-reliance and the moral courage needed to face the slavery crisis. His idea of saving the Union was to prevent northern agitation and to enforce the fugitive slave law. At the beginning of his administration he appointed Robert J. Walker, of Mississippi, territorial governor of Kansas and assured him of his determination to adhere to the popular sovereignty principle. The president, however, lost patience with the "free state" Kansans when they refused to participate in making the Lecompton constitution. He then tried to force through the admission of Kansas under that constitution so that the slavery agitation might cease. He believed that the citizens could eliminate the proslavery features of the document soon after admission. His Kansas policy was dictated by his sincere desire to get the issue out of congress.

Also he was at odds with both Douglas and Walker because they would not recognize him as party leader. The panic of 1857 was disastrous in the north but affected the south little and thus gave the southerners a false impression of their economic independence. The religious revival of 1858 and John Brown's raid in 1859 stirred up emotions that made the south fearful that Yankees were plotting to destroy their society. Nothing of importance that Buchanan attempted in domestic or foreign policy succeeded. The Democratic party split in two and the way for Lincoln's election was cleared.

The election of Lincoln in 1860 convinced many southerners that the Republican party was now in a position to send more John Browns to stir up slave revolts. In Dec. 1860 South Carolina began a secession movement that soon involved seven states. Buchanan denounced secession but could find no means to stop it. He would not surrender any of the forts that he could hold. The most notable example was Ft. Sumter in Charleston harbour. He permitted its commander, Maj. Robert Anderson, to strengthen his position in the harbour and sent him supplies in the "Star of the West" in Jan. 1861. When that ship was fired on (Jan. 9) and turned back, he awaited the outcome of a truce. Nothing came of it but neither did hostilities break out, so Buchanan held the second relief expedition to await Major Anderson's call. When word came that aid was needed it was too late to act, and Buchanan turned over the problem to the new administration.

On the expiration of his term of office (March 4, 1861) he retired to his home, named Wheatland, near Lancaster, Pa., where he actively supported the Union until his death on June 1, 1868. He was never married. His mistakes as president have been so emphasized as to obscure the fact that he was a man of unimpeachable honesty, of the highest patriotism and of considerable ability. *See* also AMERICAN CIVIL WAR; UNITED STATES (OF AMERICA): *History*.

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(R. F. N.)

BUCHANAN, ROBERT WILLIAMS (1841–1901), English poet, novelist and playwright, chiefly remembered for his attacks on the Pre-Raphaelites, was born at Caverswall, Staffordshire, Aug. 18, 1841. *London Poems* (1866) established him as a poet. His first novel was *The Shadow of the Sword* (1876); and he continued to pour out poems, novels and melodramas of which *Alone in London* (1884) may be taken as typical. His own forcefulness and moral fervour led him to criticize Swinburne and other contemporary poets, and his attacks culminated in an article "The Fleshly School of Poetry" published pseudonymously in the *Contemporary Review* (1871). This provoked a violent literary argument: Rossetti's reply, "The Stealthy School of Criticism," appeared in the *Athenaeum* (1871), and Swinburne's as a pamphlet *Under the Microscope* (1872). Buchanan died in London, June 10, 1901.

BUCHAREST (Rum. BUCUREȘTI), an administrative and economic region of southeast Rumania, is located between the Olt and the Danube. Area 20,480 sq.km. (7,907 sq.mi.). Pop. (1963 est.) 1,681,599. It is divided into 19 administrative districts. The chief towns are Bucharest, the capital of Rumania and administrative centre of the region, Giurgiu, Oltenița, Roșiorii-de-Vede and Alexandria. The region comprises a part of the Rumanian plain and a portion of the Danube water meadow and is drained by the Danube and its tributaries, the Olt, Arges, Ialomița and Dîmbovița. A steppe vegetation prevails.

With 75% arable land, Bucharest is the grain centre of Rumania. It grows wheat, maize (corn), vegetables, rice, sunflower and tobacco, and has 14% of the country's vineyards. Industries include food processing and textiles. There are important oil and natural gas deposits.

BUCHAREST (Rum. ORAȘUL BUCUREȘTI), the capital of Rumania and the administrative centre of the Bucharest region, lies in a shallow depression in the middle of the slightly undulating Walachian plain, 82 m. (269 ft.) above sea level. It is traversed by the Dîmbovița river from northwest to southeast, and much the larger part of the city is situated on its right bank. Bucharest is subject to extremes of climate, summer heat (up to 85° F.) being followed by cold winters (down to 20° F. below zero). The population, which more than doubled after World War I, was estimated at 1,236,065 in 1963.

The most thickly populated part of the city lies between the left bank of the Dîmbovița and the chain of lakes to the north. There are the largest buildings of the modern city among which stand the few surviving old buildings, the earliest of which is the Curtea Veche (Old Court) church, the former chapel of the princely palace, built by Prince Mircea Ciobanul in 1545–59. Outstanding among other old buildings are the Coltea church, which dates from the end of the 17th century, the St. Gheorghe Nou (1707), Stavropoleos (1730) and Kretulescu (1722) churches. The most typical buildings of the medieval town stand on the right bank of the Dîmbovița, which used to mark the southwestern limits of the 16th-century town. Three churches crown the hills close beside the river: the centre one, the metropolitan cathedral, was built in the middle of the 17th century; the church of the former Prince Mihai monastery stands to the west, built in 1594 by Prince Michael the Brave. Beyond the medieval settlement, Bucharest began to spread out in the second half of the 17th century. Two famous monastic settlements were established—the Antim monastery, founded in 1715, and the Văcăresti monastery, built in 1718–22; both are characteristic of the architecture of the 18th century.

The aspect of the town in the early 1960s was that of a modern metropolis. Amid the irregular network of the older, narrow and tortuous streets, there are several broad thoroughfares, the two main ones intersecting each other almost at right angles and dividing the city into four sections of roughly equal area. One of these thoroughfares (called in succession boulevards Ardeal March the Sixth and Republic) crosses the city from east to west Along its western end lie the botanical gardens and near the centre the Cismigiu gardens. In this street, too, are some of the city's outstanding modern buildings including the faculty of medicine built in 1902 in the neoclassical style, some ministerial buildings

BY COURTESY OF "RUMANIA TODAY"

ART MUSEUM OF THE RUMANIAN REPUBLIC, FORMERLY A ROYAL PALACE, BUCHAREST; 1935–37

the opera house and ballet theatre (1953), the new university (1935) and the old university (1863), the central body of which was destroyed during air raids in 1944. The second thoroughfare (boulevards Ana Ipatescu, Magheru, Bălcescu and 1848, joined in 1965 with the North-South Magistral) is lined with administrative buildings and apartment houses, mostly built from 1922 to 1966.

The main street is Calea Victoriei, named in honour of the victory won in the war of independence (1877). Along and close to this street, which runs from south to north, and beginning from the left bank of the Dîmbovița, are many of the most noteworthy buildings of the modern city: the palace of justice, an imposing building in the French neo-Renaissance style built in 1895; the palace of the post office (1900); the palace of the Athenaeum (1888); the central university library; the Cantacuzino palace (1910; actually the G. Enescu museum); and the palace of the council of ministers (1938). Calea Victoriei continues as the famous Kiselev avenue constructed in 1832, at the end of which is the Scinteia printing house, the largest building in Bucharest (1950–55). Gardens extend along Kiselev avenue to Lake Herăstrău where in 1936 a village museum was arranged. From different parts of the country original and characteristic specimens of houses were brought there, together with auxiliary buildings and many household utensils required in daily life, in order to help visitors to understand and study the life of country folk.

Bucharest has many institutions of higher education including the college of engineering (founded in 1850), the university (1864) and the institute of pharmacy and medicine (1869). It has also some notable museums, specializing in archaeology, popular art and military matters. The art museum includes a national art gallery and sections devoted to both western and oriental art. Bucharest is well endowed with sports facilities, and possesses three large stadiums and the modern Floreasca sports complex.

The public transport system includes streetcars, buses and trolley buses. Communication with provincial towns and other European countries is by rail and air. The city has four railway stations and an airport at Băneasa, 7 km. (4½ mi.) from the centre. There are many modern factories, making textiles, farm machinery and automobiles. The city also possesses tanneries, shoe factories, oil refineries and engineering works and produces more than 20% of Rumania's gross industrial output.

History.—Although excavations suggest that the site has been inhabited since Paleolithic times, Bucharest was probably founded in the second half of the 14th century. Situated on trade routes from Constantinople, it was in a position of some strategic importance. It is mentioned in 1368 under the name of Cetatea Dimbovitei (fortress of the Dîmbovița). The name Cetatea Bucureştilor first appears in a document signed by Vlad IV (Tepeş) in 1459, when the city, which shared the position of capital with the more ancient Tîrgoviște, extended along the left bank of the Dîmbovița. Tîrgoviște was the seat of the princes and metropolitan archbishops until 1660.

Gradually the town achieved greater importance, especially after Michael the Brave had driven out the Turks at the end of the 16th century (*see* RUMANIA: *History*). In the 17th century Bucharest steadily spread out across the right bank of the Dîmbovița, around the big Radu Vodă and Mihai Vodă monasteries. The city experienced a remarkably flourishing period both in commerce and in the arts in the time of Şerban Cantacuzino (1678–88) and Constantin Brancovan (1688–1714).

Concurrently with the structural changes initiated in Rumanian society in the first half of the 19th century, and under the influence of western ideas and trends in art, a start was made in modernizing the city. In the 1960s Bucharest attained one of its highest points of development in the pace of construction as well as in town planning. Besides a great number of cultural, administrative and industrial buildings, many large apartment houses, located in new districts and microdistricts, were built. Included in these complexes are day nurseries, schools, stores, parks, etc., resulting in considerable expansion of the built area of the city.

Bucharest became the capital of united Walachia and Moldavia in 1859 and the capital of the kingdom of Rumania in 1862.

Bucharest was occupied by the Russians from 1828 to 1834, during 1848–51 and in 1854. The Austrians occupied it during the Crimean War (1854–56). In World War I the Germans entered the city on Dec. 6, 1916, and remained there until Nov. 30, 1918.

In World War II the Germans moved into Rumania in Sept. 1940 as allies, but on Aug. 23, 1944, the capital was the scene of a successful *coup d'état:* war was declared on Germany and the Soviet army entered Bucharest as an ally. (GR. I.)

BUCHER, LOTHAR (1817–1892), German publicist and one of Bismarck's most trusted assistants, was born at Neustettin, Pomerania, on Oct. 25, 1817. A member of the Prussian national assembly in 1848 and of the Prussian second chamber (in which he sat with the extreme left) in 1849, he was sentenced in 1850 to 15 months' imprisonment for organizing a movement against the payment of taxes. Fleeing to London, he worked there as correspondent of the *National Zeitung* (1850–61). On his return to Berlin, Bucher continued writing for the *National Zeitung* and collaborated with Ferdinand Lassalle. In 1864 he was given a position in the Prussian foreign office by Bismarck, whose complete confidence he soon won. He drew up the text of the constitution of the North German confederation (1867), was sent on confidential missions to Spain in connection with the Hohenzollern candidature for the Spanish crown (1870), assisted Bismarck at the final negotiations for the treaty of Frankfurt at the end of the Franco-German War (1871) and was *secrétaire archiviste* to the congress of Berlin (1878). He was also responsible for Bismarck's relations with the press and for "inspired" articles in newspapers and magazines. His special relationship with Bismarck, however, aroused the animosity of some of the most influential Prussian aristocrats, and this led to his resignation from the foreign office in 1886. After Bismarck's dismissal in 1890, Bucher assisted him at Friedrichsruh in the composition of his memoirs, the *Gedanken und Erinnerungen.* Bucher died at Glion, Switz., on Oct. 10, 1892.

BUCHEZ, PHILIPPE JOSEPH BENJAMIN (1796–1865), French philosopher and politician who was a precursor of the modern Christian socialist movement. Born on March 30, 1796, in the Flemish village Matagne-la-Petite, he studied medicine at Paris and obtained his doctorate in 1825. A bitter opponent of the Bourbon restoration, in 1821 he founded the *Charbonnerie française,* modeled on the Italian Carbonari (*q.v.*). After 1825, attracted by the social philosophy of Henri de Saint-Simon (*q.v.*), he became a supporter of Saint-Simonism and a contributor to its magazine, *Le Producteur,* but he left the movement at the end of 1829 in opposition to its pantheistic tendencies. He remained faithful, however, to Saint-Simonist doctrine and presented his views in a new magazine, *L'Européen,* which appeared intermittently from 1831 to 1838. During these years he also published his three most important works, *Introduction à la science de l'histoire* (1833), *Histoire parlementaire de la Révolution française* (1833–38) and *Essai d'un traité complet de philosophie au point de vue du catholicisme et du progrès* (1839–40). Following the revolution of Feb. 1848, he was elected to the constituent assembly and became its first president. Under the second empire, having previously opposed the rise of Louis Napoleon, he prudently withdrew from politics. He died, while visiting Auvergne, at Rodez on Aug. 11, 1865.

See A. Cuvillier, *P. J. B. Buchez et les origines du socialisme chrétien* (1948).

BUCHHOLZ, JOHN THEODORE (1888–1951), U.S. botanist who made important contributions to the study of gymnosperms. He was born in Polk County, Neb., on July 14, 1888. He attended Iowa Wesleyan College, Mount Pleasant; the State University of Iowa, Iowa City; and The University of Chicago, where he received a Ph.D. degree in plant morphology in 1917.

Buchholz headed the science department at Arkansas State Normal School, Conway, 1911–18, and was professor of botany at the University of Arkansas, Fayetteville (1919–26), the University of Texas, Austin (1926–29), and the University of Illinois, Urbana (1929–51). He was for 20 years visiting investigator at the department of genetics of the Carnegie Institution, Cold Spring Harbor, N.Y., and served as president of the Botanical Society of America in 1941. In 1947–48 he studied botanical problems in New Caledonia. Buchholz wrote numerous botanical articles, including those concerning the morphology and embryology of conifers and the genetics of *Datura.* He died on July 1, 1951, at Champaign, Ill.

BUCHNER, EDUARD (1860–1917), German chemist who specialized in research in fermentation and enzyme action and won the Nobel prize for chemistry in 1907, was born at Munich, May 20, 1860. He was professor at Berlin (1898), Breslau (1909) and Würzburg (1911). In 1897 he was able to confirm Traube's theory by demonstrating that the active cause of alcoholic fermentation is the action of different enzymes contained in yeast and not the yeast cell itself. Concerning the physiological nature and meaning of fermentation he showed that a ferment (zymase) can be extracted from yeast cells which causes sugar to break up into carbon dioxide and alcohol. Buchner was killed in World War I on Aug. 24, 1917. *See* FERMENTATION: *Buchner: Cell-Free Fermentation.*

BÜCHNER, GEORG (1813–1837), German dramatist, a forerunner of the Expressionists of the 20th century, was born at Goddelau near Darmstadt on Oct. 17, 1813, the son of an army doctor, and studied medicine at Strasbourg and Giessen. At Giessen he was caught up in the revolutionary movement inspired by the Paris rising of 1830; he published a revolutionary pamphlet, *Der hessische Landbote* (1834), and founded a radical society, Die Gesellschaft der Menschenrechte. He escaped arrest by fleeing to Strasbourg. He became a lecturer in natural science at Zürich in 1836, and died there of typhoid fever on Feb. 19, 1837.

The three plays Büchner wrote during his short life, clearly influenced in style by Shakespeare and the *Sturm und Drang* movement, were in content and form far ahead of their time. In short, abrupt scenes, they combine extreme naturalism with visionary power. His first play, *Dantons Tod* ("Danton's Death," 1835; first performed in Berlin, 1902), is a drama of the French Revolution, suffused with deep pessimism. *Leonce und Lena* (1836; performed at Munich, 1885), a romantic comedy, shows the influence of Alfred de Musset and Clemens Brentano. His last work, *Woyzeck* (1836; performed 1913), which remained a fragment, anticipates the social drama of the 1890s with its compassion for the poor and oppressed. Except for *Dantons Tod* and the fragment of a novel, *Lenz* (1839), Büchner's writings appeared only after his death, *Woyzeck* not until 1879, when the manuscript was deciphered and edited by K. E. Franzos. It served as libretto for Alban Berg's opera *Wozzeck* (1925).

Büchner exercised a marked influence on the naturalistic drama of the 1890s and, later, on Expressionism. He is now recognized as one of the outstanding figures in German dramatic literature.

Büchner's *Werke und Briefe* were edited by F. Bergemann (6th ed., 1953); *The Plays of G. Büchner* (1952) is an English translation by G. Dunlop.

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BÜCHNER, LUDWIG (1824–1899), German physician who became one of the most popular exponents of "crude" materialism, was born at Darmstadt on March 28, 1824. He began teaching medicine as *Privatdocent* at the University of Tübingen, but the outspoken materialism of his masterpiece, *Kraft und Stoff* (1855; 2nd Eng. trans. from 10th Ger. ed., *Force and Matter,* 1870), caused such an outcry that he had to retire to his home town and practise as a doctor there. He continued, however, to expound his materialistic and atheistic views in numerous publications, including *Natur und Geist* (1857), *Aus Natur und Wissenschaft,* two volumes (1862–84), *Die Stellung des Menschen in der Natur . . .* (1869; Eng. trans., *Man, Past, Present and Future,* 1872), *Der Gottesbegriff und dessen Bedeutung in der Gegenwart* (1874), *Der Fortschritt in Natur und Geschichte im Lichte der Darwin'schen Theorie* (1884), *Fremdes und Eigenes aus dem geistigen Leben der Gegenwart* (1890), *Gott und die Wissenschaft* (1897), *Am Sterbelager des Jahrhunderts* (1898). Rejecting all distinction of mind from matter, he appealed strongly to contemporary freethinkers but was condemned as "bourgeois" by dialectical materialists, especially after he had accepted competitive capitalism as exemplifying the Darwinian "struggle for survival." Büchner died at Darmstadt on April 30, 1899.

See the memoir by his brother Alexander appended to the posthumous selection of essays by Ludwig Büchner, *Im Dienste der Wahrheit* (1899).

BUCK, PEARL (née SYDENSTRICKER) (1892–), U.S. author, was awarded for her novels and biographies the Nobel prize in literature in 1938.

She was born in Hillsboro, W.Va., on June 26, 1892, but spent her youth in Chen-chiang, China, where her parents were Presbyterian missionaries. She received her early education in Shangha and was graduated from Randolph-Macon Woman's college, Lynchburg, Va., in 1914; she returned to China and later became a university teacher in Nanking. Her articles and stories about Chinese life first appeared in U.S. magazines in 1923, but it was not until 1931 that she reached a wide audience with *The Good Earth,* which described sympathetically the struggles of a Chinese peasant and his slave-wife to gain land and position. This novel awarded the Pulitzer prize (1932) and widely translated, was followed by *Sons* (1932) and *A House Divided* (1935); the trilog was published as *The House of Earth* (1935).

In 1934 she was divorced in the United States from John L Buck, a missionary in China whom she had married in 1917. In the following year she was married to Richard J. Walsh, a New York publisher, and thereafter lived in the United States. She continued to write under the name Pearl Buck.

Mrs. Buck turned to biography with lives of her father Absalom Sydenstricker, *Fighting Angel* (1936), and her mother Caroline *The Exile* (1936). Her later books include *The Patriot* (1939) *Other Gods* (1940), *Dragon Seed* (1942) and *Imperial Woma* (1956), novels; *The First Wife* (1933) and *Far and Near* (1947) short stories; *The Child Who Never Grew* (1950), concerning he retarded daughter; and an autobiography, *My Several World* (1954). (W. L. Ps.; X.)

BUCK, in zoology, the male of several animals: deer (excep the genus *Cervus,* males of which are called stags), antelope, goat hare, rabbit, rat, etc. It is often used, especially in England, t indicate the male fallow deer (*q.v.*). The names of many an telopes (*q.v.*) contain the term buck: bushbuck, prongbuck, black buck, reedbuck, etc.

BUCK BEAN (Bog Bean; *Menyanthes trifoliata*), a member of the family Gentianaceae (*q.v.*), a bog plant with a creeping stem, alternately arranged large leaves each with three leaflets and spikes of white or pink flowers. The plant, widely distributed through the north temperate zone, makes a useful bog-garden subject, as a ground cover.

BUCKEYE: *see* Horse Chestnut.

BUCKFASTLEIGH, an urban district of Devon, Eng., best known for the abbey at Buckfast (1 mi. N.), is situated 21 mi. E.N.E. of Plymouth by road, above Totnes on the river Dart which provides trout and salmon. Pop. (1961) 2,558. The original Benedictine abbey, founded in 1018, was refounded and rebuilt in the 12th century as a Cistercian house which became very prosperous. After the Dissolution it became a ruin and remained so for 300 years, but in 1882 a group of French Benedictine monks acquired the site and with their own hands re-erected the abbey on its original foundations, the work being completed in 1937. There were rarely more than six monks engaged on the work at any one time and four worked almost continuously for 32 years. Cruciform in plan, with choir and central tower, the building, largely of local limestone, is impressive. The high altar, of wrought metal, gilded and enameled, is an excellent piece of craftsmanship. There are 15 altars and behind the high altar an ambulatory with six chapels. The tower contains a fine peal of 14 bells, the largest weighing eight tons. The monks, long famous for their tonic wine, are also well-known for beekeeping.

Serge and blankets are manufactured in the urban district; other activities are dealing in hides, quarrying and agricultural engineering. The parish church stands on a limestone hill riddled by ancient caves containing numerous bats. (Fr. M. S.)

BUCKHAVEN AND METHIL, a small burgh and port of Fife, Scot., lies on the north side of the Firth of Forth, 8 mi. NE of Kirkcaldy. Pop. (1961) 21,102. The burgh takes its name from two villages that were united in 1891. There is a system of modern docks at Methil. The coal mine in the burgh has closed but coal is still exported. Imports include raw fertilizers and pulp for papermaking. The chief industries are the production of steel, plastics, and fertilizers, and several new industries have developed. (E. S. Y.)

BUCKIE, a small burgh and fishing town of Banffshire, Scot., on the Moray firth, at the mouth of Buckie burn which runs into sandy Spey bay, lies about 20 mi. W. of Banff by road. Pop. (1966) 6,900. It is the centre of a fishery district and the harbour for one of the largest Scottish fleets in the herring season, and is also the chief centre of line fishing in Scotland. The harbour, with an outer and inner basin, covers an area of 30 ac. It was considerably extended in 1921. Besides the fisheries and fish-curing trade, ship repairs, malting, whisky distilling and the making of barrels and food products are carried on. The burn (stream) divides the town into Buckie and Buckpool. Portgordon, 2 mi. W., is a thriving fishing village; its harbour was built by the duke of Richmond and Gordon in 1874. Rathven, 2 mi. E., lies in a fertile district, where there are several antiquities.

BUCKINGHAM, EARLS, MARQUESSES AND DUKES OF. The origin of the earldom of Buckingham (to be distinguished from that of Buckinghamshire [*q.v.*]) is obscure. According to J. H. Round (in G. E. C.'s *Peerage*) there is some charter evidence for its existence under William Rufus; but the main evidence for reckoning Walter Giffard, lord of Longueville in Normandy, who held 48 lordships in the county, as the first earl, is that of Orderic Vitalis, who describes Walter as "Comes Bucchingehamensis," in 1097 and at his death in 1102. After the death of Walter Giffard, 2nd earl, in 1164, the title was assumed by Richard de Clare, earl of Pembroke ("Strongbow"), great-grandson of Richard de Clare (d. 1090) who had married Rohese, daughter of Walter Giffard, the 1st earl; it died with him in 1176. In 1377 Thomas of Woodstock (duke of Gloucester) was created earl of Buckingham at the coronation of Richard II (July 15), and the title of Gloucester having after his death been given to Thomas le Despenser, his son Humphrey bore that of earl of Buckingham only. On Humphrey's death, his sister Anne became countess of Buckingham in her own right. She married Edmund Stafford, earl of Stafford, and on her death (1438) the title of Buckingham passed to her son Humphrey Stafford, earl of Stafford, who in 1444 was created duke of Buckingham. This title remained in the Stafford family until the attainder and execution of Edward, 3rd duke, in 1521 (*see* Buckingham, Henry Stafford, 2nd Duke of).

In 1617 King James I created George Villiers earl, in 1618 marquess and in 1623 duke of Buckingham (*see* Buckingham, George Villiers, 1st Duke of). The marquessate and dukedom became extinct with the death of the 2nd (Villiers) duke in 1687; but the earldom was claimed, under the special remainder in the patent of 1617, by a collateral line of doubtful legitimacy claiming descent from John Villiers, 1st Viscount Purbeck. The title was not actually borne after the death of John Villiers, styling himself earl of Buckingham, in 1723. The claim was extinguished by the death of George Villiers, a clergyman, in 1774.

In 1703 John Sheffield, marquess of Normanby, was created "duke of the county of Buckingham and of Normanby." His collected *Works* were published in 1723 (*see* also his *Miscellanea*, 1933). He was succeeded by his son Edmund, who died in Oct. 1735 when the titles became extinct.

The title of marquess and duke of Buckingham in the Grenville family (to the holders of which the remainder of this article applies) was derived, not from the county, but from the town of Buckingham. It originated in 1784, when the 2nd earl of Temple was created marquess of Buckingham "in the county of Buckingham," this title being elevated into the dukedom of Buckingham and Chandos for his son in 1822.

George Nugent Temple Grenville, 1st marquess of Buckingham (1753–1813), the second son of George Grenville, was born on June 17, 1753. Educated at Eton and Christ Church, Oxford, he was member of parliament for Buckinghamshire from 1774 to 1779. In the house of commons he was a sharp critic of the American policy of Lord North. In Sept. 1779 he succeeded his uncle as the 2nd earl of Temple; in July 1782 he became a member of the privy council and lord lieutenant of Ireland in the Rockingham ministry. On his advice the Irish Judicature act of 1783 was passed, which supplemented the legislative independence granted to Ireland in 1782. By royal warrant he created the Order of St. Patrick in Feb. 1783, with himself as the first grand master. Temple left Ireland in 1783 and again turned his attention to English politics. He enjoyed the confidence of George III, and having opposed Fox's East India bill, he was authorized by the king to say that "whoever voted for the India bill was not only not his friend, but would be considered by him as an enemy," a message which ensured the defeat of the bill. He was appointed a secretary of state when the younger Pitt formed his ministry in Dec. 1783, but resigned two days later. In Dec. 1784 he was created marquess of Buckingham "in the county of Buckingham." In Nov. 1787 he was appointed lord lieutenant of Ireland under Pitt, but his second tenure of this office was hardly as successful as the first. He was denounced by Grattan for extravagance; was censured by the Irish houses of parliament for refusing to transmit to England an address calling upon the prince of Wales to assume the regency; and he could only maintain his position by resorting to bribery on a large scale. He resigned in Sept. 1789 and subsequently took very little part in politics, although he spoke in favour of the union with Ireland. He died at Stowe house, Buckinghamshire, on Feb. 11, 1813.

His elder son, Richard Grenville, 1st duke of Buckingham and Chandos (1776–1839), was member of parliament for Buckinghamshire from 1797 to 1813 and, as Earl Temple, took an active part in politics. In Feb. 1813 he succeeded his father as marquess of Buckingham, and having married the only child of the 3rd duke of Chandos, he was created duke of Buckingham and Chandos in 1822. Because of financial embarrassments the duke lived out of England for some time, and in 1862 an account of his travels was published as *The Private Diary of Richard, Duke of Buckingham and Chandos*.

He was succeeded by his only child, Richard Grenville, 2nd duke of Buckingham and Chandos (1797–1861). Educated at Eton and at Oriel college, Oxford, he was known as Earl Temple and subsequently as marquess of Chandos. He was member of parliament for Buckinghamshire from 1818 to 1839 and was responsible for the "Chandos clause" in the Reform bill of 1832. He was lord privy seal from Sept. 1841 to Jan. 1842 and, partly because of his opposition to the repeal of the Corn laws, was known as the "farmers' friend." In 1847 his residences were seized by his creditors and the duke left England for a time. He died in London on July 29, 1861.

He wrote *Memoirs of the Court and Cabinets of George III* (1853–55); *Memoirs of the Court of England During the Regency* (1856); *Memoirs of the Court of George IV* (1859); and *Memoirs of the Courts and Cabinets of William IV and Victoria* (1861).

RICHARD GRENVILLE, 3rd duke of Buckingham and Chandos (1823–89), the only son of the 2nd duke, was educated at Eton and Christ Church, Oxford and, as marquess of Chandos, was Conservative member of parliament for Buckingham from 1846 to 1857; in 1859 he contested the University of Oxford seat, but was defeated by Gladstone. Between February and December 1852 he was a junior lord of the treasury in the administration of Lord Derby. He became chairman of the London and North-Western railway in 1853, and served in that capacity until his resignation in 1861. After succeeding to the dukedom in that same year, he became lord president of the council and subsequently secretary of state for the colonies in the Conservative government of 1866–68. From 1875 to 1880 he was governor of Madras, where his term in office coincided with the famine of 1876–77; he met the emergency energetically, organizing large-scale public relief measures, and he encouraged the collection of relief funds in England. In 1886 he succeeded Lord Redesdale as chairman of committees in the House of Lords. He devoted considerable time and effort to the settlement of his father's numerous debts. He left no son and the dukedom became extinct on his death.

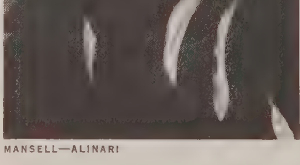
BUCKINGHAM, GEORGE VILLIERS, 1ST DUKE OF (1592–1628), English royal favourite and statesman, whose vast influence during the reigns of James I and Charles I contributed to the unpopularity of their governments and was therefore among the long-term reasons for the English Civil War, was born on Aug. 28, 1592, at Brooksby, Leicestershire. His father, Sir George Villiers, was sheriff of the county; his mother, a woman of beauty who was married three times and was later known as Lady Compton and as countess of Buckingham, ambitiously pushed her good-looking son forward. George was educated at a school in Billesdon "where he was taught the principles of music and other light literature," and at the age of 18 he was sent to complete his studies in France, where he met Sir John Eliot (*q.v.*) to whom he was later to act as patron.

Villiers was introduced to James I in Aug. 1614, when the king was hunting at Apthorpe in Northamptonshire. Always susceptible to handsome young men, James took an immediate liking to Villiers. He was appointed cupbearer in 1614, and knighted and made a gentleman of the bedchamber in 1615. He had a sponsor in George Abbot, archbishop of Canterbury, but at first his advance was resisted by the reigning favourite, Robert Carr, earl of Somerset. After Somerset's fall (Oct. 1615), however, Villiers' progress was swift. In Jan. 1616 he was appointed master of the horse, in May he was made a knight of the Order of the Garter and in August he was created Baron Whaddon and Viscount Villiers. In 1617 he became earl of Buckingham and a privy councilor, receiving grants to the value of £15,000. Sir Francis Bacon, the lord keeper, then warned him: "You are as a new risen star, the eyes of all men are upon you; let not your negligence make you fall like a meteor."

The star continued to rise: with the king's infatuated help, he forced an heiress, the daughter of Sir Edward Coke, to marry his half-witted brother, John; in 1618 he himself was created marquess, in 1619 lord high admiral, and in 1620 he married Lady Katherine Manners, daughter of the earl of Rutland. Unlike Somerset, Buckingham aspired to be both an active statesman and administrator. But his many occupations and the necessity for dancing attendance on the king prevented his doing much, although he was by no means an incompetent lord high admiral.

Buckingham played his first important part in politics in 1623 when he accompanied Prince Charles (afterward Charles I) on an incognito visit to Madrid in an attempt to win the hand of the infanta. The mission failed, Buckingham proving himself to be an arrogant and unrealistic diplomatist, but the breakdown of the negotiations in Spain was inevitable and when Buckingham (raised to a dukedom while in Spain) returned to England with Charles he found himself unexpectedly a public hero. In Feb. 1624 he addressed both houses of parliament, accusing the Spaniards of duplicity. He took a highhanded line with James, blamed him for temporizing, demanded war against Spain and, to further it, advocated the marriage of Charles to Henrietta Maria, sister of Louis XIII of France. Parliament wanted a war against Spain at sea, on the Elizabethan model, but Buckingham's ideas were more grandiose: he urged war on land as well and an alliance with the Dutch. James was induced to accept his schemes and England, allied with Denmark as well as with the Dutch, went to war against both the Austrian and the Spanish Habsburgs. Meanwhile, negotiations were completed for the marriage with Henrietta Maria, but Buckingham, who was personally responsible for the treaty with France, was unable to persuade the French government to take any open part in the war for the recovery of the Palatinate and antagonized the French on his embassy of 1625 by publicly flirting with Anne of Austria, the French queen.

Buckingham retained his position as "grand vizier" after the accession of Charles I in March 1625. But the war, for which Buckingham was largely responsible, strained English resources to the breaking point. He proved himself a poor military organizer and when in the autumn of 1625 a combined naval and military expedition against Cadiz turned into a disastrous failure, parliament refused to grant any more subsidies if he remained responsible for the conduct of the war. He had intended to lead the expedition to Cadiz in person but Charles had sent him as special ambassador to The Hague, where he concluded a treaty promising new subsidies to the Dutch and the Danes (*see* THIRTY YEARS' WAR). The king had not the money to give; in Feb. 1626 he was obliged to call a parliament. There an assault upon Buckingham, on whom the fiasco at Cadiz was blamed, gathered momentum; it was led by his former friend, Sir John Eliot. "All the king's council rides on one horse" it was said, and Buckingham was opprobriously compared to the royal favourites of the middle ages. Vainly Buckingham defended himself in a plausible speech, but a virulent criticism of his conduct by John Digby, earl of Bristol, formerly English ambassador in Madrid, added fuel to the flames. A bill of impeachment was introduced; to save him Charles dissolved parliament in June. Buckingham was acquitted in the Star Chamber of the charges brought against him.



MANSELL—ALINARI

GEORGE VILLIERS, 1ST DUKE OF BUCKINGHAM, PORTRAIT BY ANTHONY VAN DYCK

Meanwhile England also had become involved in war with France. Buckingham threw himself into this conflict with his usual resilience, personally taking command of a large expedition to relieve La Rochelle, held by French Protestants against their king (1627). The Île de Ré, two miles from the city, was occupied but the English intervention was resented by both French parties and, after a long campaign in which Buckingham showed bravery and a comprehensive ignorance of the arts of war, the expeditionary force was compelled to withdraw, shattered and demoralized.

Once again parliament was called (1628) and met in an angry mood. It devoted itself to drawing up a petition of right, but the commons were determined to force the king to dismiss Buckingham. "I think," said Sir Edward Coke, "the duke of Buckingham is the cause of all our miseries." But Charles was unflinchingly loyal to his friend; together they pushed on with their plans to relieve La Rochelle. In August Buckingham, who seems to have been pessimistic, made his will and went to Portsmouth to organize the preparations there. On Aug. 23, 1628, he was stabbed to death by John Felton, a naval lieutenant with a grievance, who had served at Cadiz and Ré and lost the use of his left arm. Charles I always blamed Buckingham's assassination on the political agitation against him in the house of commons led by Eliot.

Buckingham was a man of immense charm, "one of the handsomest men in the world, generous and brave," and of an "imperious nature and careless munificence." He was a discerning collector of paintings and manuscripts. Though he received much money, he contributed a great deal of it to the royal service and died heavily in debt. He was too haughty and tactless as a diplomat, too inexperienced as a general. His foreign policy was inconsistent and overambitious. His disloyalty to his friends was a weakness of character: he contributed to the fall of Sir Walter Raleigh and of Francis Bacon, he betrayed Lionel Cranfield, earl of Middlesex, and he treated Eliot carelessly. Judged by these other figures of his age, he seems puny; but he was a magnificent failure.

Bibliography.—M. A. Gibb, *Buckingham, 1592–1628* (1935); Hugh Ross Williamson, *George Villiers, First Duke of Buckingham* (1940); Philip Lindsay, *For King or Parliament* (1949); Philippe Erlanger, *George Villiers, Duke of Buckingham*, Eng. trans. (1953). For his early life, *see* Sir Henry Wotton, *Reliquiae Wottonianae* (1651). *See* also R. H. Tawney, *Business and Politics Under James I* (1958); H. Hulme, *The Life of Sir John Eliot, 1592 to 1632* (1957).

(M. P. A.)

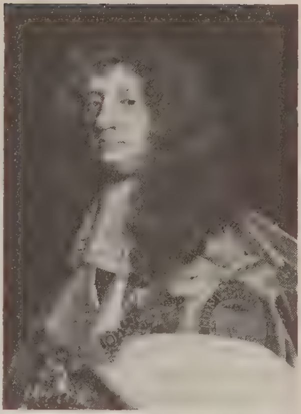
BUCKINGHAM, GEORGE VILLIERS, 2nd Duke of (1628–1687), English politician, member of the Cabal at the court of Charles II, was born on Jan. 30, 1628, at Wallingford House, near Whitehall in London. His father, the all-powerful 1st duke, was the most intimate of Charles I's friends and upon the duke's assassination (Aug. 23, 1628) Charles made it his business to rear the favourite's family with his own. Thus from infancy George Villiers was brought up with the future kings, Charles II and James II.

In 1641 he and his younger brother Francis went to Trinity College, Cambridge; but two years later they ran off to join the royalist forces in the Civil War. They were promptly sent abroad for their safety and spent three years in Rome and Florence. In Paris by 1646, they rejoined the young Prince Charles, whom George allegedly debauched with "all the vices and impieties of the age."

Early in 1647 the brothers returned to England in an effort to safeguard their inheritance, but on July 7, 1648, Francis was killed in a skirmish with parliamentary forces, and George was lucky to escape capture three days later. Fleeing to The Hague, he resumed his companionship of Charles (king from Jan. 30, 1649), on whom his influence, for all his appointment as privy councilor on April 6, 1650, was regarded as corrupt and irresponsible by older counselors. Charles II's desperate Scottish adventure of 1650 was attributed to his prompting. If so, Buckingham had cause to regret it, for he and Charles quarreled, and the final defeat of their forces at Worcester on Sept. 3, 1651, ended an episode which had seriously damaged his friendship with the king.

Buckingham now pursued an independent course. He flirted with English republican and Leveller plotters, forming contacts which he maintained for the rest of his life. Indeed, by 1657 he was allowed to return to England, and, in an extraordinary maneuver to recover his estates, married Mary, daughter of the parliamentary general Thomas, Lord Fairfax, to whom most of the lands had now gone. Cromwell was not deceived by this, and Buckingham was sent to the Tower of London. Released in February 1659, he was later to claim that only Cromwell's death had saved him from execution. This smacks of self-dramatization, but he certainly threw himself into the dangerous work of Restoration and assisted Gen. George Monck's army in its march on London. He was at Dover to meet the king.

It was far from certain that Charles would welcome his former friend. Yet before long Buckingham was in favour at court, with posts in the household, as gentleman of the bedchamber (July 9, 1661), and on the privy council (April 28, 1662). With his cousin, Barbara Villiers (later duchess of Cleveland), now mistress to the king, Buckingham resumed his old mischief-making, pleasure-seeking role. His decade-old conflict with Edward Hyde, earl of Clarendon, who had always opposed his influence, was now pursued in the more deadly world of English politics. It was typical of Buckingham that he should recklessly prejudice his opportunities. His brawls with other courtiers were notorious, and in February and March 1667 rumours of his meddling with the royal horoscope led to his dismissal, pursuit, and arrest for treason. Since his influence with the House of Commons was now strong he was lucky to be released from the Tower in July, in time to exploit the attack on Clarendon.



BY COURTESY OF THE NATIONAL PORTRAIT GALLERY, LONDON

GEORGE VILLIERS, 2ND DUKE OF BUCKINGHAM, PORTRAIT BY SIR PETER LELY

Clarendon's impeachment and flight in the autumn of 1667 brought Buckingham's personal and political influence to its highest point and put him in a position rivaling that of the secretary of state, Lord Arlington. Late in 1667 he outlined to Charles a program that would secure the king all the taxation he required from the House of Commons, at the price of some measure of toleration for dissenters. But the scheme broke down in parliamentary faction fights and the "Buckinghamians" were made to look foolish. Yet again, Buckingham prejudiced his chances by a murderous duel with the earl of Shrewsbury in January 1668; the subsequent death of Shrewsbury, whose wife was openly the duke's mistress, shocked even that tolerant age.

After this the rivalry of Buckingham and Arlington proceeded on an unequal footing, because Arlington, as a responsible statesman, enjoyed Charles's confidence, and Buckingham did not. Nominally a member of the Cabal, Buckingham was its least significant member, and although he was sent on a mission to France in 1670 he was thoroughly duped by Charles. The treaty he concluded and signed in December 1670 was an elaborate bluff; it was Arlington who had signed the Secret Treaty of Dover on May 22 (old style; June 1, new style).

Buckingham scored a few personal triumphs. He was chosen chancellor of the University of Cambridge; and his most effective satirical composition, *The Rehearsal*, first performed in December 1671, successfully parodied Dryden's work. But his assets were nearly exhausted. He was heavily in debt, he had deeply angered Charles again, and in January 1674 he fell foul of Parliament. Attacked with other members of the Cabal, he impetuously sought a hearing by the Commons and made a disastrous impression. At the request of both Houses he was dismissed from all his posts.

After this he had to fall back on charm and intrigue in opposition. He worked up his old Nonconformist and parliamentary contacts and made as much trouble for official policies as he could. In 1677 he argued that the long prorogation since 1675 of the corrupt Cavalier Parliament had technically ended its existence, and for this impertinence he was sent to the Tower. By now he had moved close to the equally embittered earl of Shaftesbury whom, on his release, he joined in the politics of the Popish Plot. But he took no real part in the campaign for the Exclusion Bill against James, duke of York, and he kept clear of the critical battles of 1680 and 1681. Now very near financial ruin, he withdrew to his Yorkshire estates. He died on April 16, 1687, after catching a chill in the hunting field.

The futility of Buckingham's career has a tragic consistency. Nothing he touched seemed to prosper. Easily self-deceived, he dabbled in chemistry and thought he had discovered the philosopher's stone; he dabbled in war and believed himself a general;

he dabbled in politics and believed himself a statesman. The frivolous variety of his pursuits was suspect in itself, and Dryden could revenge himself with his lines on "Zimri" in *Absalom and Achitophel* (1681):

> Stiff in opinions, always in the wrong,
> Was everything by starts and nothing long;
> But in the course of one revolving moon
> Was chymist, fiddler, statesman, and buffoon.
> Then all for women, painting, rhyming, drinking,
> Besides ten thousand freaks that died in thinking.

A more sympathetic age would have appreciated Buckingham's zest for life. He was the sparkling centre of a brilliant circle and his excesses were colourful and unconcealed. His belief in religious toleration may have been one of the few genuine things about him. But all his ventures were curiously sterile. Lucky only in his wife's forbearance, he left no legitimate heirs. His mortgaged estates were sold up: "And Hemsley [*sic;* Helmsley, Yorkshire], once proud Buckingham's delight,/Slides to a Scriv'ner or a City Knight" (Pope, *Imitations of Horace*, 1733).

See H. W. Chapman, *Great Villiers* (1949); M. du P. Lee, *The Cabal* (1965). (H. G. Ro.)

BUCKINGHAM, HENRY STAFFORD, 2ND DUKE OF (*c.* 1454–1483), was the son of Humphrey, earl of Stafford, killed at St. Albans in 1455, and the grandson of Humphrey, 1st duke of Buckingham (created 1444), killed at Northampton in 1460, both fighting for Lancaster. The 1st duke, earl of Buckingham in the right of his mother, was the son of Edmund, 5th earl of Stafford, and Anne, daughter of Thomas of Woodstock, duke of Gloucester, the youngest son of Edward III. Henry's mother was Margaret, daughter of Edmund Beaufort, 2nd duke of Somerset, grandson of John of Gaunt. Her three Beaufort brothers, Henry, Edmund and John, were all killed by the Yorkists (1464–71).

In 1460 Edward IV made the young Henry and his brother Humphrey royal wards, and for several years they lived in the queen's household. Buckingham was directly descended from Edward III and his vast estates lay all over central England, so his adherence to the Yorkist cause was vital, and his marriage in 1466 to Catherine Woodville, the queen's sister, was designed to bind him even more closely to the reigning house. Yet, despite these precautions, it seems that, as the greatest of the old nobles, Buckingham was never fully trusted by the court. Except for acting as seneschal at the duke of Clarence's trial (1478) he took no part in public affairs while Edward IV lived.

When the king died, however, Buckingham, through his servant Persivall, quickly came to terms with the duke of Gloucester, the future Richard III, and from April to July 1483 he was in the forefront of affairs. Arriving in London as Richard's chief supporter, Buckingham busied himself in striking down the queen's relatives and in arranging the seizure of Edward V and his brother. He then publicly denied their legitimacy and pressed the Londoners to take Richard, already protector, as king. At Richard's coronation (July 6, 1483) Buckingham served as great chamberlain, while more material benefits were also showered on him He became chief justice of Wales, keeper of the royal castles there and in the border counties, steward of the honour of Tutbury, sole heir of the old Bohun family (*q.v.*) (by virtue of his descent from Eleanor Bohun and Thomas of Woodstock) and possessor of their ancient hereditary dignity as constable of England.

Yet, in Aug. 1483, Buckingham, now at Brecon, was plotting to overthrow the new king. His abrupt change of sides has never been satisfactorily explained. He may, with reason, have coveted the crown himself, or perhaps a smouldering sense of family wrong at Yorkist hands suddenly burst into flame. Some have suggested that he mistrusted Richard and shrank from the murder of the princes, which he knew was contemplated. Certainly John Morton, bishop of Ely (*q.v.*), then his prisoner at Brecon, had much to do with securing Buckingham's active support for a rising in favour of Henry Tudor. The revolt was to begin on Oct. 18, 1483, when Buckingham moved east into Herefordshire with a Welsh army. A week earlier Richard, at Lincoln, had proclaimed him traitor, and now even the elements warred against him. High floods on the Wye and Severn barred his passage, in a few days his troops dispersed and Buckingham, with a price on his head, was a fugitive at Wem, Shropshire. There he was taken, and brought by John Mitton, the sheriff, to the king at Salisbury. On Sunday, Nov. 2, having forfeited his estates, he was beheaded in the market place.

The connection of the Stafford family with the dukedom of Buckingham was finally broken by the attainder and execution of Henry's eldest son, Edward, 3rd duke, in May 1521. He had been restored in lands, blood and title by Henry VII (Nov. 1485). As constable he was one of the most powerful men in the kingdom under the first Tudor, and on at least one occasion when Henry VII was ill, Buckingham was widely considered as a possible successor, but he later quarreled with Wolsey, who effected his ruin.

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BUCKINGHAM, a market town and municipal borough in the Buckingham parliamentary division of Buckinghamshire, Eng., 17 mi. N.N.W. of Aylesbury by road. It is situated in the northwest corner of the county in the open valley of the upper Ouse, which encircles the main portion of the town on three sides. Pop. (1961) 4,379. Buckingham, once the site of a Roman settlement, was an important stronghold in pre-Conquest times, and was the only burg to receive separate mention in the Domesday survey, having been created the county town by Alfred the Great in 886. The Anglo-Saxon Chronicle records that in 918 Edward the Elder encamped there with his army for four weeks and built two forts, one on either side of the water. There are early mentions of markets and fairs and there are still two fairs in October. Edward III fixed there one of the staples (marts) for wool, but after the removal of the staples to Calais the trade decayed so much that in an act of Henry VIII Buckingham is mentioned among 36 impoverished towns. The town received no charter until 1554, when Mary I created it a free borough, and Charles II granted a second charter in 1684 in recognition of its loyalty in the English Civil War. The decline of Buckingham may be partly attributed to the development of other routes from London and the consequent growth of such towns as Aylesbury (now the county town), High Wycombe and Wendover, and to the great fire of 1725, which destroyed most of the town. From 1545 until 1867 Buckingham returned two members to parliament.

The Old Latin school, converted into a grammar school and endowed by Edward VI, in part occupies buildings of earlier date (part of a chantry) which retain a Norman doorway. Stowe house former seat of the Grenvilles, dukes of Buckingham, is now part of Stowe school for boys, opened in 1923. In the grounds are remains of the 17th-century castellated Stowe castle. The mano house, probably dating from the 14th century, has a fine twisted chimney, added about 1520. In Castle house Catherine of Aragon heard the news of the battle of Flodden in 1513.

Buckingham is a market town with agricultural trade and factories for paints, carpets, diesel equipment and light engineering products, as well as condensed milk and leather.

BUCKINGHAM AND NORMANBY, JOHN SHEFFIELD, 1ST DUKE OF (1648–1721), English statesman, patro of Dryden, and author of poetic essays in heroic couplets, wa born on April 7, 1648, in London. The son of Edmund, 2nd ear of Mulgrave, he succeeded to the title on his father's death i 1658. He served under Charles II and was a favourite until 168 when he incurred Charles's displeasure by courting Princess Ann and was banished from court. He made his peace within tw years and on the accession of James II was again in high favou receiving appointments first as a privy councilor and later as lor chamberlain.

Despite his acquiescence in the revolution of 1688 he belonge essentially to the opposition during William's reign, but on Anne accession in 1702 she made him a member of the privy council, and later lord privy seal and duke of Buckingham and Normanby. The Whig ascendancy between 1704 and 1710 compelled him to resign his appointments but during the period of Tory government between 1710 and 1714 he held several high offices, including that of lord president of the council. After the accession of George I in 1714 his active political life was at an end. He died in London on Feb. 24, 1721.

As a poet Sheffield is chiefly remembered for *An Essay Upon Poetry* (1682) and *An Essay on Satire* (circulated in manuscript in 1679 but not published until later). *An Essay Upon Poetry*, written in couplets and in a manner intended to resemble that of Horace's *Epistles*, aims to delineate the chief characteristics of the various literary kinds: the ode, the elegy, the epic, etc. Its interest is chiefly historical—as one of the attempts to naturalize Nicolas Boileau's *L'Art poétique*—but it received high praise from Dryden and Pope, and as an example of the way in which poets and critics of the later Restoration were trying to establish definite literary styles it is of permanent interest.

An Essay on Satire begins as a critical treatise but develops into a satire, attacking Charles II, the earl of Rochester and many distinguished courtiers. The work was frequently attributed to Dryden (it appears in most editions of his work and he was assaulted by hirelings of the earl of Rochester because of it) but it is generally acknowledged to be Sheffield's. It was probably touched up a little by Dryden.

Sheffield's prose *Account of the Revolution* is interesting historically although he is not entirely reliable when he is personally concerned. He also adapted Shakespeare's *Julius Caesar*, breaking it up into two plays, *Julius Caesar* and *Marcus Brutus*, introducing choruses between the acts (two of which were written by Pope), and a love scene between Brutus and Portia. (Jn. C.)

BUCKINGHAM PALACE, the London residence of the British sovereign, takes its name from Buckingham house, and was built early in the 18th century for John Sheffield, duke of Buckingham and Normanby. In 1761 it was bought for £21,000 by George III for his wife and was known for the next 60 years as "the queen's house." In George IV's reign the building was rebuilt by John Nash, and the entrance was through the Marble arch (now in Hyde park) from which the royal standard was flown. Queen Victoria was the first sovereign to live there. Facing the Mall, the east front, designed by Sir Aston Webb, was refaced in 1913 to make a dignified background for the Queen Victoria memorial. The garden (or west) front is virtually unchanged from Nash's design. The rooms inside are splendid (the throne room is 64 ft. long) and show to advantage the collections of pictures and furniture largely made by George IV. The Royal Mews or stables, which house the state carriage (designed by Sir William Chambers in 1762), are to the south of the palace. The ceremony of changing the guard takes place each morning (11:30 A.M.) in the forecourt when the sovereign is in residence. (R. T. B. F.)

BUCKINGHAMSHIRE, EARLS OF. The first earl of Buckinghamshire was John Hobart (1693–1756), a descendant of Sir Henry Hobart (d. 1625), attorney general and chief justice of the common pleas under James I, who was made a baronet in 1611, and who was the great-grandson of Sir James Hobart (d. 1507), attorney general to Henry VII. In 1740 Hobart became lord lieutenant of Norfolk and in 1746 earl of Buckinghamshire, his sister, Henrietta Howard, countess of Suffolk, being the mistress of George II. He was succeeded as 2nd earl by his eldest son John (1723–93), who was member of parliament for Norwich and comptroller of the royal household before his accession to the title. From 1762 to 1766 he was ambassador to Russia, and from 1776 to 1780 lord lieutenant of Ireland. He died without sons and his half-brother George (1731–1804) became 3rd earl.

Robert Hobart, 4th earl of Buckinghamshire (1760–1816), the eldest son of the 3rd earl, was a soldier, and then a member of both the English and Irish houses of commons; from 1789 to 1793 he was chief secretary to the lord lieutenant of Ireland, exerting his influence in that country to prevent any concessions to the Roman Catholics. In 1793, being known by the courtesy title of Lord Hobart, he was sent to Madras as governor, but in 1798, after serious differences between himself and the governor general of India, he was recalled.

Returning to British politics, Hobart was called up to the house of lords in 1798 (succeeding to the earldom of Buckinghamshire in 1804); from March 1801 to May 1804 he was secretary for war and the colonies (his family name being taken for Hobart in Tasmania), and in 1805 he became chancellor of the duchy of Lancaster under Pitt. For a short time he was joint postmaster general, and from 1812 until his death he was president of the board of control for Indian affairs.

The 4th earl left no sons, and his titles passed to his nephew, George Robert Hobart (1789–1849), a son of George Vere Hobart (1761–1802), lieutenant governor of Grenada. In 1824 the 5th earl inherited the Buckinghamshire estates of the Hampden family and took the name of Hampden, his ancestor, Sir John Hobart, 3rd baronet, having married Mary Hampden about 1656. On his death his brother, Augustus Edward Hobart (1793–1885), who took the name of Hobart-Hampden, became 6th earl.

The 6th earl's two sons predeceased him, and he was succeeded by his grandson, Sidney Carr Hobart-Hampden (1860–1930), who added to his name that of Mercer-Henderson. His son, John Hampden Mercer-Henderson (1906–63), 8th earl, was succeeded by his cousin Vere Frederick Cecil Hobart-Hampden (1901–), 9th earl.

BUCKINGHAMSHIRE, a south midland county of England, is bounded on the north by Northamptonshire, east by Bedfordshire, Hertfordshire, and Greater London, south by Surrey and Berkshire and west by Oxfordshire. Area 746.5 sq.mi. (1,933 sq.km.).

Physical Features.—The county has parts of the basins of the Great Ouse and the Thames, and reaches from the chalk Chilterns to the first outcrop of Jurassic rocks which rise in the west to form the Cotswolds, while the extreme south is drained by tributaries of the lower Thames flowing from the chalk.

Geologically it includes a succession of outcropping rocks dipping generally southeast from the Lias in the northwest to the Eocene of the London basin. The Great Oolite rises northwest of Buckingham in gentle undulations to a height of over 500 ft. The upper portions are limestones; the lower parts are more argillaceous. A large expanse of Oxford Clay, rich grassland and famous hunting country runs from Bicester to Bedford, including the low divide (Whaddon chase) between the Vale of Aylesbury (mainly Kimmeridge Clay) and the valleys of the Ouse and Ouzel. The clay is covered by numerous outliers of Portland, Purbeck and Lower Greensand beds. The Upper Greensand follows, and at the junction with the Gault are numerous springs which have determined the sites of several villages. The chalk rises abruptly from the low-lying argillaceous plain to form the Chiltern hills. The crest line of these hills crosses the centre of the county from northeast to southwest at its narrowest point (11 mi.), though another portion, Steps hill, is included in a loop made by the county boundary on the northeast. To the south of this line almost the whole land is hilly, the chalk outcropping and determining the form of the hills as far as Beaconsfield and Burnham. Eocene deposits, Reading beds and London Clay occupy the remaining southeast of the county. Between the Tertiary-capped chalk plateau and the Thames a gentle slope, covered with alluvial gravel and brick earth, reaches down to the river. Thick deposits of plateau gravel occur on most of the high ground in the south while much of the northern part is obscured by glacial clays and gravels which help to diversify the soil of this essentially agricultural county. On the Oxfordshire border, to the west of Aylesbury, a few nearly isolated hills stand out, *e.g.*, Muswell hill and Brill hill (each more than 600 ft.), marked on the geological map by outliers of Gault. The Thames forms the entire southern boundary of Buckinghamshire. The Great Ouse river forms various portions of the northern boundary and receives the Ouzel river flowing along the northeastern side of the county. In the south the dip slopes of the Chilterns are drained by the Wye, Misbourn and Chess, streams flowing to the southeast.

The soils of the county vary greatly in different localities. On the lower lands, especially in the Vale of Aylesbury, about the headwaters of the Thames, they are extremely fertile. Beech is the predominant tree in the woods. In the south a remnant of ancient forest is preserved as public grounds under the name of Burnham Beeches (*q.v.*).

History.—Traces of early man are not common in the county, though Paleolithic implements have been found in the gravels of the Thames valley. Neolithic man probably inhabited the higher parts of the Chilterns, and though the numerous camps found there seem to be of the Early Iron Age some may date further back. The Icknield way (*q.v.*) is without doubt pre-Roman in origin. There is some indication that the Vale of Aylesbury was settled in pre-Roman times. The territory which was to become Buckinghamshire was reached by the West Saxons about 570, as by a series of victories they pushed north from the chalk of Hampshire and Wiltshire over the upper Thames. A large occupation of the chalk, such as one finds in Kent, Sussex, Berkshire and Wiltshire, is not indicated. The higher open ground was inhabited during the early part of the 7th century, as is shown by the mention of the Chiltern-Saetna, or "dwellers in Chiltern," in a document called *The Tribal Hidage*, which recorded family land measures, but it was suggested that there may have been a considerable element of native population among them. The Anglo-Saxon Chronicle states that Aylesbury, Bensington and Eynsham were captured by the Saxons in 571, and there is abundant archaeological evidence for Saxon occupation of the Vale of Aylesbury. With the grouping of the settlements into kingdoms and consolidation of Mercia under Offa, Buckinghamshire was included in Mercia until, with the submission of that kingdom to the Norsemen, it became part of the Danelaw. In the 10th century Buckinghamshire suffered frequently from the ravages of the Danes, and numerous earthworks mark the scenes of struggles against the invaders. These relics are especially abundant in the Vale of Aylesbury, probably at that time one of the richest and best protected of the Saxon settlements. The Chiltern district, on the other hand, is said to have been an impassable forest infested by hordes of robbers and wild beasts. In the reign of Edward the Confessor, Leofstan, 12th abbot of St. Albans, cut down large tracts of wood in this district, and granted the manor of Flamstead, Hertfordshire, to a valiant knight and two fellow soldiers on condition that they should check the depredations of the robbers. The same reason led at an early period to the appointment of a steward of the Chiltern hundreds (*q.v.*). The district was not finally disforested until the reign of James I.

The shire of Buckingham was formed by the aggregation of pre-existing hundreds (ancient territorial divisions) as they were recaptured from the Danes. This explains the irregularities of the boundary line. As in the case of the midland counties generally, it took its name from the chief town, but it is a matter of some difficulty to understand why Buckingham should have been chosen. It was doubtless the chief town at the time; in the Domesday survey it was the only borough to receive separate mention. From the first, however, the church at Aylesbury tended to become the chief ecclesiastical centre of the county, while Buckingham never had more than one parish and one church. Of monastic foundations, the Cistercian abbey of Medmenham was founded in 1204, while the Augustinian Notley abbey dates from 1162. The 18 hundreds of the Domesday survey were reduced to 8, of which the three Chiltern hundreds, Desborough, Burnham and Stoke, are unaltered in extent as well as in name.

The proximity of Buckinghamshire to London caused it to be involved in most of the great national events of the ensuing centuries. The county was visited severely by the Black Death (*q.v.*), and Winslow was one of many districts which were almost entirely depopulated. In the English Civil War, Buckinghamshire was one of the first counties to join in an association for mutual defense on the side of parliament, one of whose protagonists, John Hampden, of Hampden house in the county, had precipitated the conflict by his refusal to pay ship money on land at Prestwood, now in the parish of Great Missenden, Buckinghamshire. Aylesbury and Brill were among the important garrisons held by the parliamentary forces, while Newport Pagnell, in the north, was held for a short time by royalists. In 1644 Charles I fixed his headquarters at Buckingham.

The Cliveden and Hampden estates are perhaps the most famous in the county. The former was presented by Viscount Astor to the National trust which owned, besides, 4.2 sq.mi. in Buckinghamshire in 1960. Of old country houses, Chequers (*q.v.*) dates from the late 16th century and in 1921 became an official residence of British prime ministers. The following have been acquired by the National trust: Ascott, with a fine collection of furniture and works of art; Hughenden manor, the home of Benjamin Disraeli, later earl of Beaconsfield; the 18th-century West Wycombe park and also West Wycombe village with 15th- to 18th-century houses; Claydon house, home of the Verney family and famed for its association with Florence Nightingale; and Waddesdon manor, with its fine collection of pictures and art treasures, bequeathed by James de Rothschild.

Many towns and villages are famous for their literary and historical associations: Chalfont St. Giles with John Milton; Stoke Poges with Thomas Gray; Hughenden with Disraeli; Olney with William Cowper; Beaconsfield with Edmund Burke, Edmund Waller and G. K. Chesterton; and Aylesbury with John Wilkes. Slough was the home of Sir William Herschel, who set up his great telescope there. A most notable institution in Buckinghamshire is Eton college, while another important educational establishment is Stowe school, once the home of the Grenvilles, dukes of Buckingham.

Population and Administration.—The population of Buckinghamshire was 488,233 in 1961, compared with 386,291 in 1951. The municipal boroughs are Aylesbury, the county town (27,923), Buckingham (4,379), High Wycombe (49,981) and Slough (80,781), the other large towns being Beaconsfield (10,013), Bletchley (17,095), Chesham (16,297), Eton (3,894), Marlow (8,724) and Wolverton (13,113). Other towns in the county are Amersham, Linslade, Newport Pagnell, Olney, Princes Risborough, Wendover and Winslow. Several of the villages on or near the banks of the Thames have become centres of residence, such as Burnham, Taplow, Wooburn and Wraysbury.

Buckinghamshire is on the midland circuit and assizes are held at Aylesbury. It has one court of quarter sessions, sitting at Aylesbury, and is divided into 14 petty sessional divisions. The county is entirely within the diocese of Oxford, but gives its name to a bishopric suffragan. There are five parliamentary constituencies, those of Aylesbury, Buckingham, Eton and Slough, South Buckinghamshire and Wycombe, each returning one member.

Industries and Communications.—There is no heavy manufacturing industry in the county, but there are important factorie at Slough, Aylesbury and Bletchley. High Wycombe is a centr of furniture manufacture, particularly chairs, originally becaus of the presence of the beech woods of the Chilterns. Cheshan has a wide variety of industries ranging from the productior of chocolate to lead pencils and electronic valves. The printin industry is well established in Aylesbury and Wolverton. Othe industries include those connected with communications. Th Wolverton works, belonging to British railways, give employmen to the largest number of workers in the county.

Although much of Buckinghamshire is pasture, the amount o land under crops remained high in the early 1960s as a result o the intensification of food production inaugurated during Worl War II. Of a total of more than 360,000 ac. under crops an grass, about 170,000 ac. were arable. The principal crops wer barley, wheat and oats. The raising of sheep, cattle, poultry an pigs was significant.

A consideration of communications is best based on the structural facts that have been outlined. Thus there are chains c villages along the water-bearing strips at the foot of the Chi terns, while it was along the Icknield way that the medieval traffi passed from the west of England to East Anglia. In Roman time Watling street was built, crossing the Chilterns near Dunstabl (Durocobrivae) in the transverse direction from southeast t northwest. Akeman street used the low route between Tring an

Berkhamsted. The medieval, turnpike and modern roads chose the same gaps, using the Thames valley in the south and the High Wycombe, Wendover and Tring routes within the county. There are altogether 1,758 mi. of roads in the county, and the opening of the London-Birmingham motorway in 1959 necessitated the creation of a special service station area at Newport Pagnell. The main line of the London Midland region of British railways uses the gap between Berkhamsted and Ivinghoe and crosses the northeast of the county. Bletchley is an important junction on this system, branches diverging northeast to Bedford and Cambridge and west to Oxford and Banbury. In the south the chief railway line is that of the Western region passing through Slough and Taplow. The Grand Union canal, which passes through 30 mi. of the county (Marsworth to Wolverton), carries a considerable amount of barge traffic between Birmingham and London.

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BUCKLE, HENRY THOMAS (1821–1862), English historian, author of the *History of Civilisation in England*, was born at Lee, Kent, on Nov. 24, 1821. Because of his delicate health he received little formal education, acquiring his knowledge through travel and wide but selective reading. He visited the continent several times between 1840 and 1844, and from Oct. 1861 to March 1862 he traveled in Egypt. From there he journeyed through Sinai to Petra, Hebron, Jerusalem and Nazareth, where he contracted typhoid. He died at Damascus on May 29, 1862.

Buckle had first won fame as a chess player, gaining an international reputation before he was 20. But already he had conceived the plan of his book. By 1853 he had decided to restrict his study to England, and the first volume (1857) achieved an immediate success. The second volume, which still did not conclude his introduction, was published in 1861 but the finishing of the work was prevented by his death.

The decline in Buckle's fame was rapid. He was unfortunate n that currents of opinion were already running counter to his views, and he wrote just too soon to assimilate Darwin's theories of evolution. Buckle believed that "the progress of every people s regulated by principles . . . as certain as those which govern he physical world," and sought to determine their nature through an inductive study of relevant historical material. He equated he progress of civilization with the advance of knowledge, arguing hat the "diminishing influence of nature" in Europe increased he aptitude for rational inquiry among its populations. His *History* was much criticized and in its capacity to stimulate thought nd controversy lay perhaps its greatest importance. Yet its inonsistencies do not altogether impair the grandeur of its design, nd it remains witness to an erudition and mastery of language dmitted even by Buckle's opponents.

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BUCKNER, SIMON BOLIVAR (1823–1914), Confederate general during the American Civil War, was born near Munordville, Ky., April 1, 1823. He graduated from West Point in 844, served in the Mexican War (1846–48) and thereafter at arious army posts until 1855, when he resigned his commission o become manager of family property in Chicago. After the utbreak of the American Civil War he worked for Kentucky's eutrality but finally espoused the Confederate cause and was ommissioned a brigadier general in the Confederate army, rejecting a similar offer from the Union. Ordered to reinforce Ft. Donelson, he found the Confederate situation hopeless and surrendered unconditionally to Gen. U. S. Grant, Feb. 16, 1862. After war prisoner exchange, he was promoted to the rank of major general and finally lieutenant general. He served the Confederacy in many areas and was in command of the District of Louisiana when the war ended. In 1868 Buckner returned to Kentucky, became editor of the *Louisville Courier* for a short time and eventually recovered his valuable real property in Chicago. After some years in private business he entered politics as a Democrat and served as governor of Kentucky from 1887 to 1891. His term ended, he retired to his birthplace estate. The Gold Democrats nominated him for vice-president of the United States in 1896. He died Jan. 8, 1914.

His only son, Simon Bolivar Buckner, Jr. (*q.v.*), became a lieutenant general in the U.S. army during World War II.

See A. M. Stickles, *Simon Bolivar Buckner* (1940). (A. M. ST.)

BUCKNER, SIMON BOLIVAR, JR. (1886–1945), U.S. soldier, was born at Munfordville, Ky., July 18, 1886. Upon graduation from the U.S. Military academy at West Point, Feb. 13, 1908, Buckner was commissioned in the infantry. His career of more than 41 years in the U.S. army was climaxed in his command of the 10th army, which invaded the Ryukyu Islands and fought the last great land battle of World War II against the Japanese on Okinawa, April–June 1945.

Rising in rank through the various grades, he became a brigadier general in the regular army and from Aug. 1940 to June 1944 was commanding general, Alaskan defense command, with headquarters at Ft. Richardson, Alaska. Following a short assignment to the central Pacific area, he was appointed in Sept. 1944 commanding general, 10th army, holding in this command the rank of lieutenant general. Buckner was killed in action on June 18, 1945, while visiting a forward observation post near the southwest tip of Okinawa. The big naval anchorage on the east side of Okinawa, formerly called Nakagusuka Wan, was renamed Buckner bay in 1945 in his honour. (R. E. A.)

BUCKTHORN, a common name for trees or shrubs of the genus *Rhamnus* (family Rhamnaceae), especially *R. catharticus*, a much-branched shrub reaching 10 ft. in height, with a blackish bark, spinous branchlets and oval, sharply serrated leaves, 1 to 2 in. long, alternately arranged and somewhat clustered at the ends of the shoots. The small green flowers are regular and have the parts in fours; male and female flowers are borne on different plants. The fruit is succulent, black and globose, and contains four stones. Buckthorn is native in Europe, north Africa and north Asia and naturalized in parts of eastern North America. In England it is found in woods and thickets, chiefly on chalk; it is rare in Ireland and not wild in Scotland. The fruit has cathartic properties; the bark yields a yellow dye.

An allied species, *Rhamnus frangula*, is also common in England. and is known as berry-bearing or black alder. It is distinguished from buckthorn by the absence of spiny branchlets, its nonserrated leaves and bisexual flowers with parts in fives. In the United States there are several native species of buckthorn, most numerous on the Pacific coast, especially in California. One of these, *R. purshiana*, yields the medicinal cascara sagrada (*q.v.*).

Seabuckthorn is *Hippophae rhamnoides* (family Eleagnaceae), a willowlike shrub, 1 to 8 ft. in height, with narrow leaves silvery on the underside, and globose, orange-yellow fruits $\frac{1}{3}$ in. in diameter. It occurs on sandy seashores of England, but is not common.

In the United States the name buckthorn is also applied to a tree, *Brumelia lycioides*, found in the south.

BUCKWHEAT, the fruit (so-called seeds) of *Fagopyrum sagittatum* (or *esculentum*) and of the allied species, *F. tataricum*, a herbaceous plant, native of central Asia but cultivated also in Europe and North America. The fruit has a dark brown or gray tough rind enclosing the kernel or seed and is three-sided in form, with sharp angles, similar in shape to beech mast, whence the name from the German, *Buchweizen*, "beechwheat." Tartary buckwheat fruits have rounded angles. The attractive white flowers depend upon bees and other insects for their pollination. Buckwheat grain is used for livestock feed. The hulled seeds, or groats, and the flour are used for human food. The chief food use in the United States and Canada is in the form of griddle cakes made from buckwheat flour. This flour is often mixed with wheat flour. Buckwheat cakes are brown, palatable and nutritious. Buckwheat often is grown for smothering weeds. It is an important honey plant. On good soils buckwheat is less productive than other grain crops but it is particularly adapted to unproductive hilly lands. Its quick maturity makes buckwheat well adapted as a late-sown "catch" crop. Two varieties (viz., Japanese and Silverhull) are commonly grown in various parts of the world. The U.S.S.R., France, Poland, Canada and the United States lead in buckwheat production. In Great Britain it is not of sufficient importance to be separately distinguished in the annual agricultural returns. It is mainly used in England for feeding pheasants, for which it is considered specially suitable, and poultry, but it is also valuable for other kinds of farm stock. The crop is sometimes sown for feeding off green by sheep, or for plowing under as green manure. (J. H. Mn.)

BUCOLICS (from Gr. *boucolos,* "a herdsman"), a term occasionally used for rural or pastoral poetry. The expression has been traced back in English to the early 14th century, being used to describe Virgil's *Eclogues,* which had been given the name early by grammarians, perhaps by the poet himself, to challenge comparison with his model Theocritus (*q.v.*), whose idylls or bucolics are the earliest collection to have been preserved. Counting certain associated apocryphal works, they number about 30.

In modern times the term bucolics has not often been specifically given by the poets to their pastorals; the main exception being that of Pierre de Ronsard, who collected his eclogues under the title of *Les Bucoliques.* *See* also Pastoral. (J. F. Ke.)

BUD: *see* Stem; Leaf.

BUDAPEST, the capital of Hungary, consists of the ancient fortress and town of Buda, on the high right bank of the Danube, and the town of Pest on the low left bank. After the two towns had been united in 1873 many suburbs were included in the city area which in 1960 covered 203 sq.mi. and had a population (1960) of 1,804,606.

The beauty of Budapest is, above all, the product of harmonious blending of the landscape and the city. The Danube, which some 25 mi. N. of Budapest turns sharply from an eastward direction to the south, is wide enough to constitute a monumental element in the setting of the massive buildings without rupturing the two parts of the city. Budapest has a moderate climate with an average July temperature of 62° F. and an average January temperature of 34° F. The yearly rainfall averages 23 in.

Buda, with Óbuda (Old Buda) to the north, lies on the hilly western bank of the Danube with Castle hill (590 ft.) and Gellért hill (1,066 ft.) to the south. Impressive caves and hot mineral springs (85° F. to 150° F.) are to be found in the Buda hills. Some of the springs have radioactive properties and others contain lime and sulfur and are of value in the treatment of rheumatic diseases. The waters were used by the Romans and later by the Turks. These springs and the swimming pools on the banks of the river add the character of a health resort to the beauty and historical interest of the city. While Buda was traditionally the seat of the rulers and of government offices, with many mansions belonging to the landed gentry, Pest, lying on a plain formed by the Danube in the Pleistocene era, was the town of trade and industry.

The City.—The royal castle of Buda was built at the southern elevation of the plateau on Castle hill. The later palace, in baroque style (1715–70), designed chiefly by Jean Nicolas Jadot and Franz Anton Hillebrandt, was partially destroyed by fire in 1849 but restored and enlarged in 1890–1904. It was heavily damaged by fighting in 1944–45 but by the early 1960s was being restored. The war damage uncovered remains of the medieval castle, some of the original designs of which have been incorporated in the work of restoration. Ramparts dating from the middle ages and the Turkish occupation circle the palace and the buildings of the castle district. St. Matthias' church, the ancient coronation church of the Hungarian kings, is in Holy Trinity square. It was built from 1255 to 1269, restored or rebuilt in the 14th and 15th centuries, and entirely rebuilt by Frigyes Schulek from 1874 to 1896. The Fishermen's bastion, built in neo-Romanesque style (1901–02) by the same architect, stands in the centre of the section of the ramparts nearest to the Pest side.

The city on the left bank of the Danube can be seen in all its splendour from the passages of the Fishermen's bastion. The lowland between Castle hill and the river bank is called Viziváros. Its most important monuments are St. Anne's church (1740–70), the former church of the Elizabethan nuns (1731–41), and the spa (16th century) built by the Turks and preserved, with three others, as relics of Turkish architecture. Hűvösvölgy, the valley jutting deep into the Buda hills, begins at the foot of the northern slope of Castle hill off Moszkva square. Villas of every description cover the hillsides.

Óbuda lies on the site of a Roman military camp. The relics of two Roman baths are exhibited there in underground museums. The ruins of the military amphitheatre dominate the panorama, and those of the Trinitarian monastery (1745–60) on the nearby hills and the fine baroque castle (1746–57), that belonged to the Zichy family, are the newer outstanding monuments.

The remains of the Roman town (the public bath, the Mithras sanctuary, etc.) lie north of Óbuda; and those of what was once a vast palace of the Roman governor are opposite Óbuda on an island in the Danube. The palace was built in A.D. 107 by Hadrian, governor of Aquincum, who later became the Roman emperor. Steep Gellért hill is crowned by a grim citadel built after the Hungarian defeat in the 1848–49 War of Independence by the Austrian military authorities to keep the town under control. The massive monument erected after World War II to commemorate the liberation of the country affords a contrast to the citadel. This monument is the work of Zsigmond Kisfaludi Stróbl.

The Danube is spanned by many bridges. Between the Árpád and Margit (Margaret) bridges, which cross the river at Óbuda, lies Margit Island, a parklike resort and amusement area; the Lánchid is a suspension bridge built by the British engineer Adam Clark; and Erzsébet bridge, one of Europe's most notable feats in bridge construction, was rebuilt in the early 1960s. The Szabadság and Petőfi bridges are at the southernmost point of the capital.

Budapest perhaps appears most beautiful from the Danube. The traveler arriving from Vienna by boat will gradually become aware of an impression of vastness and massiveness about the city astride the river. On the Pest side there stands the majestic house of parliament, built in neo-Gothic style in 1884–1904 by Imre Steindl

The row of palaces along the embankment to the south of the parliament building includes, near the Lánchid, the Renaissance-style building of the Hungarian Academy of Sciences (1862–64) In the inner city, which stands on the site of medieval Pest, the most important historical monument is the parish church, with Romanesque and Gothic details. In place of the former town walls, a semicircle of the inner boulevards encloses the inner city The streets radiate from there in every direction, like the spoke of a wheel.

Beyond the outer boulevards are the industrial districts. The former Szent István district, to the north of the inner city has preserved most of its classic monuments. Since World War I the major governmental buildings and ministries have been located there in the new 5th district. The most beautiful square in Budapest, Kossuth square, is in this area in front of the house o parliament. St. Stephen's neo-Renaissance basilica with a dom 315 ft. high (built in 1845–67 by József Hild, and 1867–89 b Miklós Ybl) is one of the most impressive monuments in the inner city.

Népköztársaság (formerly Andrássy) is the finest avenue in th capital. Laid in the last quarter of the 19th century, it runs from the inner boulevard to the spacious Heroes' square with th monument commemorating the 1,000th anniversary of the Magyar conquest. The square is bordered by the Museum of Fine Art and the Art gallery. The outstanding monument on Népköztársaság is the Opera house (1879–84) built by Miklós Ybl. Ne construction includes the People's stadium, holding 100,000 spectators, which stands near the east railway station.

BY COURTESY OF THE AMEROP TRAVEL SERVICE, INC.

ST. MATTHIAS' CHURCH, THE CORONATION CHURCH, IN HOLY TRINITY SQUARE, BUDAPEST, DATING FROM THE 13TH CENTURY. FISHERMEN'S BASTION (1901–02) IS IN THE FOREGROUND

The university, founded at Nagyszombat in 1635, was transferred to Buda (Ofen) in 1745. In addition to the Hungarian Academy of Sciences Budapest has schools and colleges of applied arts, music, drama, fine arts, economics and agronomy; and various technical institutions. There are also 9 museums all under the aegis of the Hungarian National museum which is also in the city; a library for the national archives, and many public libraries attached to the university or other institutions; and 18 theatres and concert halls besides the Opera house. Five daily newspapers were being published in Budapest in 1955.

Communications.—From the point of view of transport and communications Budapest occupies a favourable geographical position. It is linked by way of the Danube with Austria and Germany and also with the Black sea. The river is navigable by sea-going vessels as far as Budapest. At the river ports of Csepel and Ujpest imported ores, coal and timber are unloaded.

All main railway lines and highways radiate from the capital. Budapest has become, therefore, almost exclusively the foreign trade centre of Hungary, with transit traffic between the countries of southeastern and western Europe. The modern Ferihegy airport, 10 mi. from the city, provides for the greatest part of the ountry's air transport and is served by international services, direct from many parts of Europe and indirectly linking Budapest with the rest of the world. The brunt of the capital's passenger transport is borne by about 150 mi. of streetcar lines.

Occupations and Industries.—In the early 1960s just over ne-half of the working population was employed in industry, bout one-third in the civil service and various branches of learning and about 9% in trade and commerce. Budapest's share in he industrial output of the country is substantial. Most of the well-known Hungarian goods, such as precision instruments, pharmaceutical products and electric locomotives, are made there. The machine-building industry has the greatest number of employees followed by the textile industry.

History.—Budapest is one of the European cities with the oldest historical background. There is evidence of settlement in the Neolithic age. In about 70 B.C. the Eraviscans, who were of Celtic rigin but Illyrian culture, settled in these regions. In 9 B.C. the oman empire pushed forward to the line of the Danube. From hat time onward Aquincum, the Roman predecessor of Budapest, layed a significant part in the defense of the empire as one of ie cornerstones of the *limes* ("fortified frontier"). After the collapse of the empire the dark ages descended on the settlement and the surviving population gradually disappeared.

The Magyars, who occupied the Carpathian basin at the end of the 9th century, took possession of this important river crossing. Slavonic and Germanic settlers also peopled the villages that were founded on the right bank of the river (Óbuda on the site of the Roman camp, and a village that was the forerunner of Buda) and Pest on the left bank. The passing through of the crusaders and the lively transit traffic contributed to the development of a prosperous commercial and cultural life. This was interrupted by the catastrophe of the Mongolian invasion in 1241 that struck the whole country.

After the retreat of the Mongolian armies King Béla IV built his residence on Castle hill in 1247 and the royal palace and the adjoining settlement were surrounded by walls. From the 14th century onward, Buda became recognized as the country's capital, a role previously filled by Esztergom and Székesfehérvár. The leadership of Buda became more pronounced under the Angevin kings and later, in the 15th century, during the rule of Sigismund of Luxembourg and Matthias Corvinus. The palace built in the time of Sigismund was one of the biggest in Europe.

After Matthias' death the city's prosperity was followed by the decline of central power and the Turkish invasion. Buda, which fell into Turkish hands in 1541, became the centre of the territories under Turkish occupation and the seat of the governing pashas. During the 150 years of Turkish rule the Gothic and Renaissance Buda began to decay and Pest fell into ruins.

Toward the end of the 17th century the decline of the Turkish empire opened the way for the liberation of Buda in 1686 by the Christian armies and of the whole country a few years later. In the course of the war the greater part of the town was destroyed. Normal life was resumed slowly and under difficult conditions. During the 18th century Buda was rebuilt on a modest scale, in baroque style. In 1800 the combined population of Buda (including Óbuda) and Pest was about 54,000.

At the beginning of the 19th century a movement was started to throw off the Austrian yoke and to attain Hungary's independence. Pest was the centre of this movement which at first developed rapidly, and with it the growth of the population of both Buda and Pest. It was Pest that, with the revolution of March 15, 1848, gave the start to the bourgeois transformation of the social order. Neither the defeat of the War of Independence nor the oppression that followed could halt the two cities' development.

In 1873 Buda and Pest were united, with a total population of 280,349 (1870). Budapest, as the capital of the country, became the political, economic and cultural centre. The characteristic features of the city were essentially shaped at the end of the 19th century when the architectural requirements of a metropolis were successfully co-ordinated with the preservation of historical values and with the special features of the landscape. By 1941 the population of the city had risen to 1,164,963.

Budapest was severely damaged in World War II. The royal castle was burned to the ground and most of the castle district, which contained some of the major historical monuments in Hungary, became a heap of ruins. All the bridges spanning the Danube were blown up by the retreating Germans. After 1945 reconstruction was rapid. The bridges were rebuilt and the restoration of monuments was begun. Many new factories were also built. New damage, however, was inflicted on the city during the 1956 uprising, which was put down by troops of the U.S.S.R.

See Hungary; *see* also Index references under "Budapest" in the Index.

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BUDAUN, municipal town and district in the Rohilkhand division of Uttar Pradesh, India. The town is near the east bank of the Sot river, 27 mi. S.W. of Bareilly. Pop. (1961) 58,770. According to tradition Budaun was founded about A.D. 905 by a Hindu raja called Buddh. Captured by Kutb ud-Din Aibak in 1196 it became an important northern frontier post of his Muslim kingdom of Delhi. It remained a major provincial governorship under this and succeeding Indo-Islamic dynasties until Shah Jahan moved the administration to Bareilly in 1657. (*See* also Uttar Pradesh.) It became headquarters of a district in 1838.

The town contains a ruined fort and the imposing Jamma Masjid or Great mosque, with façade 288 ft. across. The mosque was built in 1223 from the materials of a Hindu temple, under the patronage of the Delhi monarch Shams ud-Din Altamash, who had been governor of Budaun. It was restored in the 14th century, in 1571–75 after a great fire in Budaun and in the 1870s.

Budaun is on the road and Northeastern railway main line (metre-gauge) between Mathura and Bareilly. There are only a few cottage or small-scale industries.

Budaun District (1,998 sq.mi.; pop. [1961] 1,411,657) is part of the great plain of the Ganges, the river forming its southwestern boundary; it is also watered by the Ganges tributaries Sot, Mahewa and Ramganga. There are many jhils, or marshy meres, and lakes. Agriculture supports 85% of the population, the main crops being millets, rice, wheat, gram and barley. (B. Si.)

BUDDHA: *see* Gautama Buddha.

BUDDH GAYA (Bodh Gaya), a village in Gaya district, Bihar, India, 6 mi. S. of Gaya town; one of the holiest places in the Buddhist world. It was there, under the sacred pipal or Bodhi (Bo) tree, that Gautama Buddha (Prince Siddhartha or Sakyamuni) attained enlightenment and became the Buddha. In the 3rd century B.C. the emperor Asoka built a simple shrine to mark the spot and erected a pillar there. Part of a later stone railing enclosing this shrine survives; it is of the Sunga period, mid-1st century B.C. The uprights have representations of the Vedic god Indra and Surya, the sun god; the railing medallions are carved with fantastic beasts. The shrine at this period is depicted on several reliefs from Sanchi and Bharhut. It appears to have been a roofed and gabled structure with supporting pillars, enclosed by a railing. The actual Bodhi tree is shown emerging from the roof or gable ends. This shrine was replaced by the present Mahabodhi temple, begun in the Kushan (Mathura) period, 2nd century A.D.; provided with a revetment and statuary in the Pala-Sena period, A.D. 750–1200; heavily restored by Sir A. Cunningham and finally restored in 1882 by Burmese Buddhists. The central tower, supported on a podium 20 ft. high and 50 ft. wide, stands 180 ft. above the ground.

See A. K. Coomaraswamy, *History of Indian and Indonesian Art* (1927); Sir A. Cunningham, *Mahabodhi* (1892). (F. R. A.)

BUDDHISM is the religion of the followers of Gautama Buddha (*q.v.*). Arising in the 6th century B.C. as an offshoot of the prevailing Hindu religion of north India, it flourished widely in that country until the 11th century A.D., spreading meanwhile to other parts of Asia. Today Buddhists in influential numbers are present in Burma (90% of the population), Thailand (89%), Ceylon (60%) and Japan (60%). In less influential numbers they are in China (about 17%), and in small numbers in India, Pakistan and the Philippines. In Indonesia there are some Buddhists in the midst of the predominantly Muslim population. Cambodia, Laos and Tibet are recognized as Buddhist countries, though statistics are not available. In Nepal the two religions are Hinduism and Buddhism. Outside Asia, Buddhists are present in North America (177,000), South America (148,000) and Europe (10,000). The total number of Buddhists in the world is approximately 168,400,000.

ORIGINS AND DEVELOPMENT

Origins in India.—Buddhism arose in an age of religious ferment. Many wandering ascetic teachers emerged, proclaiming various ways of deliverance from spiritual ignorance and suffering. An earlier polytheistic worship of the powers of nature based on the sacred literature of Aryan invaders (Vedas and Brahmanas), had developed at the hands of priests into a burdensome sacrificial and ritual system. To this had been added a social theory of caste and a conception of retribution for deeds done (*karma*), carried out in transmigration through many successive lives. Escape from evil consequences of deeds could come about only through the performance of prescribed ritualistic acts by Brahman priests. Reaction to this formalized, mechanical practice in religion was inevitable. It had already appeared in the latest development of Vedic literature, the Upanishads (*c.* 600–500 B.C.), which mark the beginning of a pantheistic philosophy, seeking a single reality behind all individua gods and aiming at deliverance from ill, not through ritualistic acts but in realization of union with this reality.

At first Buddhism was only one among numerous similar protests against the prevailing formalism. Like them it looked elsewhere for a deeper solution of problems of the inner life. In procedure it was unique. Ethically, it sought reform by rejecting the authority of the Vedas and in teaching an independent morality. Philosophically, it denied any substratum in the world of things or in any of the gods of the Vedic pantheon. Apart from all old Vedic theories it offered a way of spiritual attainment and release from endless births and deaths which it set forth as the discovery of its founder.

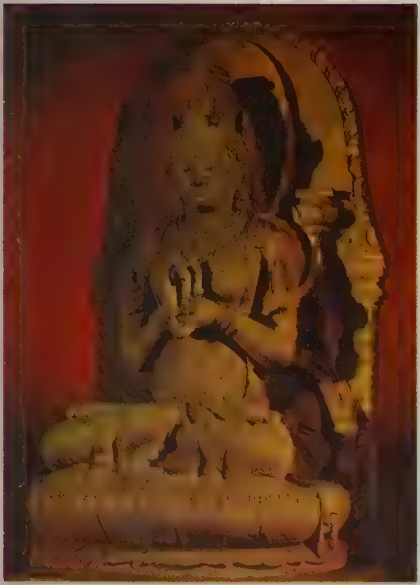
Earliest Teaching.—According to the oldest Buddhist literature (preserved in the Pali language), Gautama Buddha began his teaching career at Benares with a sermon traditionally accepted as the first exposition of his basic doctrine. It is known as Turning the Wheel of Doctrine (or "of Righteousness"; Dhammacakkappavattana) and has remained authoritative for all Buddhists

The discourse is addressed to "him who has given up the world," in the conviction that worldly life cannot give final happiness There are two extremes that ought not to be followed—the profitless life of indulgence in sensual pleasure, and the equally profitless way of self-mortification. By avoiding these two extreme Gautama Buddha "has gained the enlightenment of the middle path which produces insight, produces knowledge, and conduces to tranquillity, to higher knowledge, to enlightenment, to Nirvana." This enlightenment consists in the realization of four basic truths reverently named the Four Noble Truths:

1. The Noble Truth of Pain (or Suffering): birth is pain, old age is pain, sickness is pain, death is pain. Union with the unpleasant is pain, separation from the pleasant is pain, not obtaining what one wishes is pain. In short, the five groups of clinging to existence is pain
2. The Noble Truth of the Cause of Pain: the craving that leads to rebirth, accompanied by delight and passion, rejoicing at finding delight here and there, namely, the craving for lust, for existence, for non existence.
3. The Noble Truth of the Cessation of Pain: the complete cessation of that craving—its forsaking, relinquishment, release and detachment from it.
4. The Noble Truth of the Path that Leads to the Cessation of Pain this is the Noble Eightfold Path, namely, right view, right thought right speech, right action, right livelihood, right effort, right mindfulness, right concentration.

The motive of this first sermon is practical; viz., to awake recognition of the universality of suffering inherent in existence to indicate its cause in craving and to teach a way of deliverance through rightness in thought, conduct and inner discipline. The description of the Path covers the whole training of the disciple Its full significance is best seen in other reported discourses of the Buddha as found in Pali and later Buddhist literature.

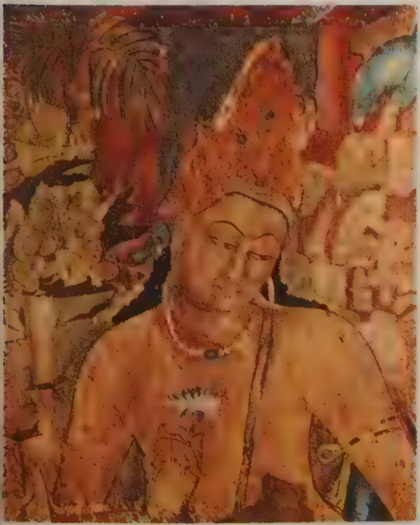
Authoritative Buddhist Scriptures.—As followers of the Buddha spread his teachings in India and beyond, a large number



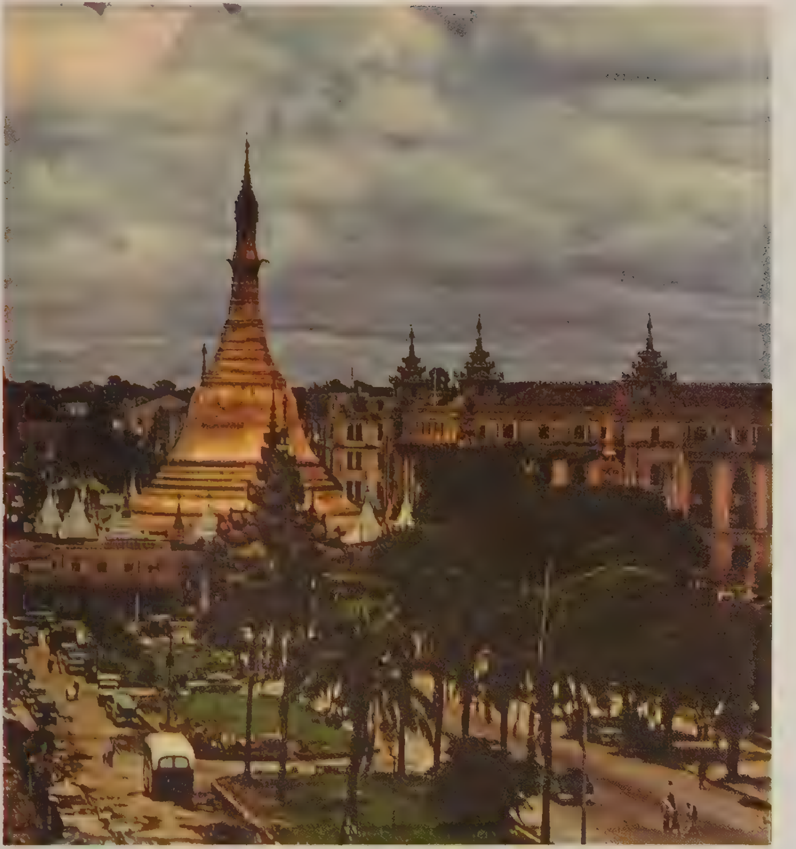
Prajnaparamita, "Perfect Wisdom," a Buddhist concept personified as a goddess in India. Her hands are shown in the teaching gesture, and she is seated in the posture of meditation. From a temple at Singosari (Singasari), the 13th-century Javanese capital

BUDDHISM IN ART

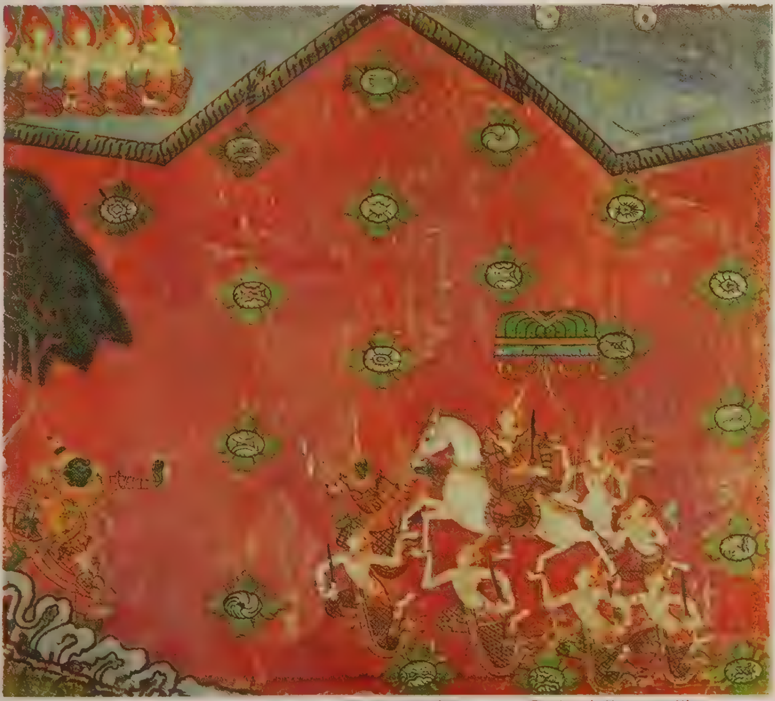
Buddhism, which originated in 6th-century B.C. India, swiftly spread through much of Asia, implanting its spiritual precepts and signifying its presence in forms of art. As Buddhism spread, its own traditional art blended with local traditions. Some of these blends are shown on this and the following Plate. While superficially dissimilar, they all show a shared concern for the spiritual qualities of the faith, held to be universal



The Bodhisattva Padmapani. In Mahayana Buddhism the Bodhisattvas are divine saviours, with limitless compassion toward suffering mortal men. Detail of a tempera wall painting from cave I at Ajanta, India (c. 7th century A.D.)



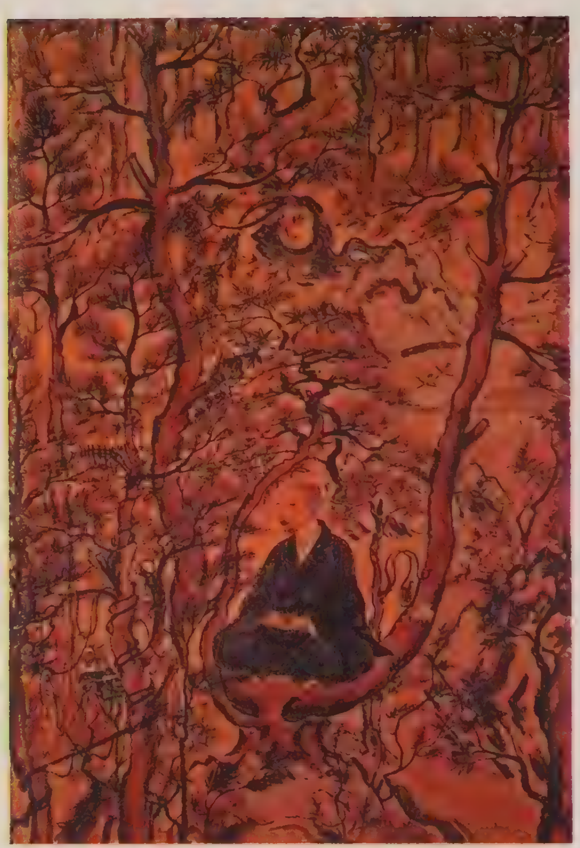
Sule pagoda, one of the principal shrines in Rangoon, Burma



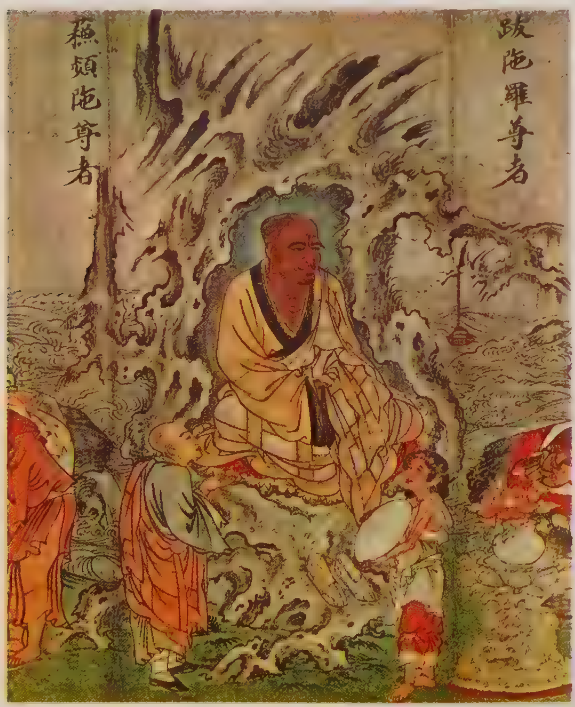
The departure of the Buddha from Thailand, 18th-century Thai painting on silk

BY COURTESY OF (BOTTOM RIGHT) MUSÉE GUIMET, PARIS; PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT) "ART OF THE WORLD: THE ART OF BUDDHISM," HOLLE VERLAG, (TOP RIGHT) © JOSEPH BREITENBACH, REPRINTED FROM "HOLIDAY," (BOTTOM RIGHT) CICCIONE—RAPHO

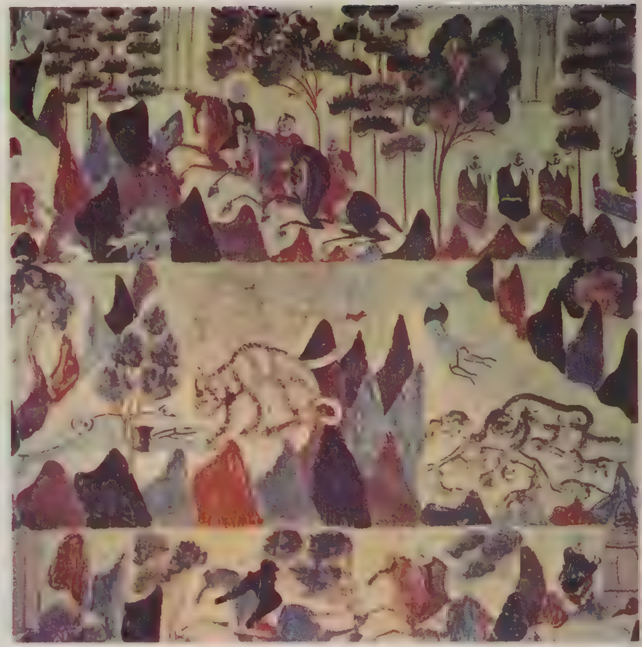
BUDDHISM



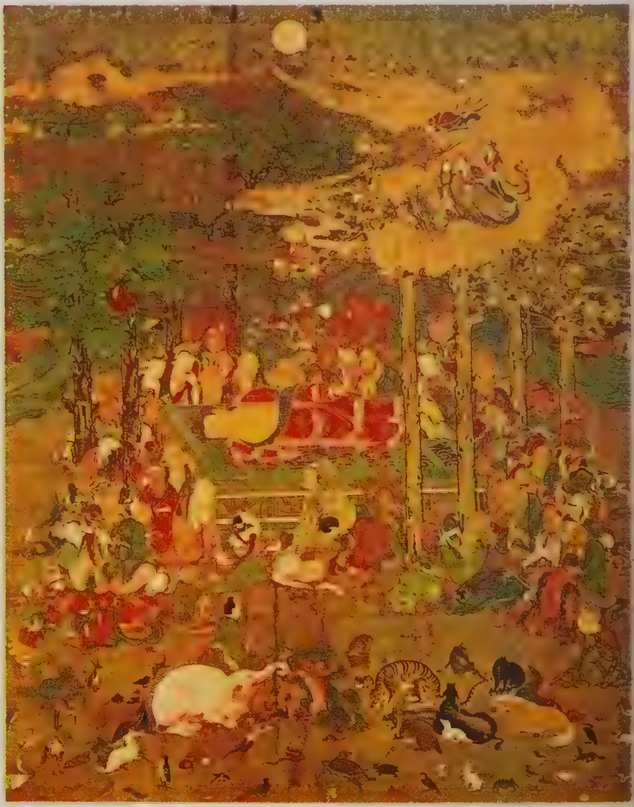
The Japanese monk Myōe-shōnin (1173–1232) in meditation. Ostensibly a portrait, the painting conveys the ideal of simplicity of Buddhist monastic life and its affinity with nature. Detail from a 13th-century scroll at the Kōzanji Temple in Kyōto


跋陀羅尊者
蘇頻陀尊者

A Chinese painting of a *lo-han*, or saint (*arahat*). The work shows a blending of cultures: the garments are Chinese, the facial features are not. Detail from an iconographic scroll; ink, colours, and gold on paper (*c.* 1173)



"Prince Mahāsattva Sacrificing Himself to a Starving Tigress," a Chinese illustration of a Jataka, one of the legendary tales of earlier incarnations of the Buddha. The Jataka describes Gautama's acts of virtue and self-sacrifice, which, by the law of *karma* (just retribution), enable him in his last incarnation to attain Buddhahood. Detail from a wall painting in cave 428 at Tun-huang



"Sakyamuni's Entrance into Perfect Nirvana," a Japanese variant of an old Chinese style based in turn on Indian models. The dying Buddha is surrounded by mourning representatives of all classes of living creatures, all of whom have been led by the doctrine of the Buddha onto the path to Nirvana. Hanging scroll; ink, colours, and gold on silk (1392)

PHOTOGRAPHS, (ALL) "ART OF THE WORLD: THE ART OF BUDDHISM," HOLLE VERLAG

of scriptures came into being, purporting to record his exact words, setting forth his rules for governing the monastic community and preserving later systematic analyses of doctrine by able scholars. All these writings, however, were put into their present form after the split-up of the original community into sects, each of which made its own collection. Only one of the collections now exists in completeness in any Indian language, the Canon of the School of Elders (Theravada). Written in Pali, this is treasured as authoritative sacred scripture in Ceylon, Burma, Thailand, Laos and Cambodia. It owes its preservation to the fact that it was introduced into Ceylon by Buddhist missionaries in the 3rd century B.C. According to the Great Chronicle (Mahavamsa) of Ceylon, it was committed to writing for the first time in the 6th century after the Buddha (*c.* 25 B.C.). Thence knowledge of it spread to other countries of southeast Asia. Other canons that once existed in Buddhist schools of northern India are known in fragmentary form through surviving Sanskrit texts and through Chinese and Tibetan translations of Sanskrit texts now lost. These show dissimilarities and divergence from the Pali canon, the result of oral transmission of teachings in widely separated communities of monks. When finally written down the changes became fixed as characteristic differences between rival schools of interpretation.

In all older schools accumulated scriptures were classified in a threefold division called the Three Baskets (Tipitaka in Pali, Tripitaka in Sanskrit). In the Pali canon this consists of (1) Vinaya Pitaka, a collection of 227 rules of discipline (*vinaya*) binding on the monks; (2) Sutta Pitaka, arranged in five collections of discourses (*sutta*), of basic importance for doctrine; and (3) Abhidhamma Pitaka, a collection of higher doctrinal treatises (*abhidhamma*), psychological and philosophical in character, on terms and ideas found in the first two collections. In all this literature, earlier and later elements are discernible, and the whole represents a slow and complex growth of tradition over several centuries, with the third collection taking shape much later than the first two. It reflects authentically, however, how the School of Elders (Theravada) understood the teaching of the Buddha (*see* TRIPITAKA).

Developed Doctrines of Early Buddhism.—In addition to the Four Noble Truths including the Noble Eightfold Path, other important conceptions appear in the Pali scriptures. Buddhism stood in opposition to rival systems and was compelled to define its attitude on certain important points. As against both Hinduism and Jainism it denied a permanent, unchanging self (*atta*) or substantial soul that transmigrates intact from one life to the next. Instead it analyzed the individual into five groups of changing constituents: corporeality, feelings, perceptions, mental formations and consciousness. Like all else in the phenomenal universe, a person is in process of continuous change, with no fixed underlying entity. All is transitory and impermanent (*anicca*), in continual unease and unrest (*dukkha*), and substanceless (*anatta*). In this ever-flowing stream of psychophysical events everything takes place according to universal causality, the law of deeds (*karma;* Pali *kamma*) by which each act brings on its own inevitable result. The idea of *karma* was not original with the Buddha, but he gave it a distinctly ethical interpretation. Good deeds bring good results, evil deeds bring evil results. This furnishes the basic condition for moral improvement. By following the Eightfold Path of right living the process of personal continuous change is directed onward and upward through successive lives toward the ultimate goal of Nirvana (Pali *Nibbana*).

Fuller explanation of the Eightfold Path is given as follows:

1. Right view is understanding the Four Truths.
2. Right thought is free from lust, ill will, cruelty and untruthfulness.
3. Right speech is abstaining from lying, talebearing, harsh language and vain talk.
4. Right action is abstaining from killing, stealing and sexual misconduct.
5. Right livelihood is earning a living in a way not harmful to any living thing.
6. Right effort is to avoid evil thoughts and overcome them, to arouse good thoughts and maintain them.
7. Right mindfulness is to pay vigilant attention to every state of the body, feeling, mind.
8. Right concentration is concentration on a single object so as to induce certain special states of consciousness in deep meditation. By following the Path a disciple aims at complete purity of thought and life, hoping to become an *arahat,* one freed from the necessity of rebirth, ready for Nirvana.

How the cycle of life goes on in the world of transmigratory existence is formulated in the "law of dependent origination" (Pali *paticcasamuppada;* Sanskrit *pratityasamutpada*). This is a list of 12 causal states of the individual, each of which is thought to determine the next: ignorance, volitional activity, the consciousness that links one birth with another, mind-and-body, the six senses (five physical, one mental), impressions (sensory and mental), feeling, craving, attachment, becoming, rebirth, old age and death. Explanations of this list have varied, but its evident aim is to emphasize the causality operating through continuing cycles of progress from birth to death to rebirth in successive lives. When ultimate enlightenment dispels ignorance the successive factors cease to operate and suffering as well as transmigration ends.

The final goal is Nirvana, a transcendent state free from craving, suffering and sorrow. Its positive character is inexpressible in any terms of finite experience, for its reality transcends the realm of birth and death. Whether the purified saint exists or not after death the Buddha left indeterminate because such language is inapplicable to what is beyond both existence and nonexistence. (*See* also METEMPSYCHOSIS: *Eastern Thought;* NIRVANA.)

Early Order of Monks.—In the India of the Buddha's day, it was common for religious teachers with numerous followers to organize their initiates into regulated communities. Gautama Buddha did likewise. His order had certain features. It removed all restrictions of caste, placed upon all members the same requirements, denounced extreme ascetic practices and emphasized moral principles. A monk's equipment was simple—alms bowl, vestments, razor, toothpick, etc. His activities consisted of daily recitations, making rounds for alms, fasting after the noonday meal, meditating and listening to religious discourses by senior monks. They also included giving instruction to junior monks, preaching to laymen during the rainy season, and joining twice a month in a general ceremony of confession in which an early code of rules (the *Patimokkha*) was recited. His preaching to laymen enjoined abstention from taking life, from drinking intoxicants, from lying, stealing and unchastity. It emphasized the social virtues in relations between parents and children, husband and wife, friend and friend, masters and servants, laity and clergy.

Ordination into the order was a simple ceremony, the central part of which was taking the Threefold Refuge: "I go to the Buddha for refuge, I go to the Doctrine for refuge, I go to the Order for refuge." This Threefold Refuge (Buddha, *dharma* [Pali *dhamma*], Sangha) later came to be called the Three Jewels, or Three Treasures, in all Buddhist lands.

Support for the order (Sangha) came from the laity who in gratitude gave gifts as they were able. Originally this was chiefly a matter of giving alms to the monks. As the number of monks and lay-followers increased, the corporate Sangha received large gifts in money, lands, parks and buildings from rulers and other wealthy patrons. This led to settled monastic establishments. Not everyone was accepted to this way of life. Persons suffering from mental or bodily defect, those who were vicious, gamblers, debtors or minors without the consent of parents were not admitted. Ordination of women was at first not contemplated by the Buddha, and it was with some reluctance that an order for nuns was sanctioned. Rules for nuns involved obedience to the order of monks in all respects. The order of nuns appears never to have been numerically large, but it has continued, as has the order of monks, into modern times.

SCHOOLS OF BUDDHISM

Emergence of Mahayana Buddhism.—About a century after Gautama's death, divisions began to appear in the Sangha. The growing community separated into two schools. One, conservative, held strictly to doctrine and practice as originally formulated; this was the School of Elders (Pali Theravada; Sanskrit Sthaviravada). The other, liberal, interpreted doctrine and practice with greater freedom; this was the School of the Great Assembly

(Mahasanghika). As groups of monks multiplied and spread to different parts of India other schisms followed. By the 1st century B.C. about 18 or 20 could be named. Under the emperor Asoka (*c.* 274–*c.* 232 B.C.) missionaries of the Theravada school carried their form of Buddhism to southern India and Ceylon. Eventually its Pali scriptures were preserved in Ceylon.

Another early group, differing little at first from the Theravada in doctrine, was the Sarvastivada school. It put its scriptures into Sanskrit, spread northward and flourished eventually in Gandhara and Kashmir. From there its ideas passed to China and Tibet. This school argued for the existence of all entities mentioned by the Buddha, whether past, present or future, whence its name Sarvastivada, which means literally the "all-is doctrine."

In the meantime, the liberal tendency, working both within and without the Sarvastivada school, was bringing about changes in interpretation of the Buddha's meaning. From inchoate beginnings the tendency developed into an increasingly self-conscious movement which around the year A.D. 1 issued in a new form of Buddhism calling itself Mahayana or Great Vehicle (*i.e.*, conveyance) to salvation. In derogation it called the earlier, strictly orthodox teaching and practice Hinayana, or Little Vehicle, which it criticized as inferior, elementary, and merely preliminary to its own deeper insights into Buddhist meanings. Primarily its target of attack was the position of conservatives in the Sarvastivada school. Today, without using the derogatory term, the differences between the earliest teaching of the School of Elders and the Mahayana may be seen by comparing Theravada ideas as found in the Pali scriptures with Mahayana ideas in the Sanskrit tradition. This will make clear the essential characteristics of the two major divisions of Buddhism.

Theravada and Mahayana.—Major contrasts appear as follows:

Theravadins revere profoundly the personality of the historic Buddha, his teachings (*dhamma*) and the order he founded (Sangha). Mahayanists remember Gautama Buddha also, but regard him as one of many Buddhas who have appeared in many universes, all being manifestations of one primordial Buddha nature, and teaching variously according to needs of beings in their different realms.

Theravadins hold that the ideal Buddhist is a follower of the Eightfold Path, the layman going as far as he is able, the monk striving further to fulfill all conditions for the perfected saint (*arahat*) whose goodness issues in universal love (*metta*). Mahayanists hold that the ideal Buddhist is a Bodhisattva; *i.e.*, one vowed to become a Buddha, inspired by great compassion to work for the good of others through perfecting himself in the six virtues (*paramita*) of generosity, morality, patience, vigour, concentration (in meditation) and wisdom.

Theravadins hold that the Buddhist works out his own salvation by faithful adherence to the way demonstrated by the Buddha. Mahayanists hold that the Buddhist may also rely on the aid of supramundane Buddhas and Bodhisattvas whose wisdom, mercy and readiness to help are unbounded.

Theravada philosophical literature (*abhidhamma*) is mainly analytical, psychological and ethical. Mahayana philosophy (*abhidharma*) is predominantly dialectical and metaphysical.

Theravadins regard faith (*saddha*) as essentially confidence in the truth, taught by the Buddha and progressively realized oneself. Mahayanists regard faith (*sraddha*) as trust in the availability of merit transferred from some superhuman Buddha or Bodhisattva (*e.g.*, Amitabha or Avalokitesvara) whom one worships with devotion and gratitude.

Literature of the Mahayana.—As compared with Pali literature, which embodies the earliest tradition, Mahayana literature exhibits a wide variety of tendencies growing out of the tradition that developed in northern India from about 100 B.C. to A.D. 500. As is known from texts in Sanskrit, Chinese and Tibetan, works were still classified roughly under monastic rules (*vinaya*), discourses (*sutras*) and philosophical treatises (*sastras*): but subject matter often differs from that found in Pali, is not the product of one single school and shows mixtures of materials compiled over considerable periods of time. While conservative traditions are sometimes cited or repeated, they are quite freely reinterpreted and new ideas are unfolded. In discourses the Buddha is still the great teacher, but in the typical Mahayana *sutra* he is a transcendent, eternal being, preaching to innumerable Buddhas, Bodhisattvas, gods and demigods along with human disciples. In treatises, arguments centre around concepts of Ultimate Reality such as Voidness (because it is inexpressible), Consciousness-only (metaphysical idealism) and Suchness (or the Truly So). In the full Mahayana narrative of the life of the Buddha (the *Lalita Vistara*), there is great expansion of miraculous, legendary and numerical elements.

Sutras.—Among notable Mahayana *sutras* in the Chinese Buddhist Tripitaka are (1) Saddharma Pundarika (Lotus of the Wonderful Law), whose chief doctrine is the Eternal Buddha; (2) Sukhavativyuha (Land of Bliss), teaching salvation into the Pure Land of the celestial Buddha Amitabha through faith; (3) Karandavyuha, which describes qualities of the Bodhisattva of Compassion, Avalokitesvara; (4) Prajnaparamita (Perfection of Wisdom), teaching the doctrine of Voidness or Emptiness of all phenomena; (5) Lankavatara, whose chief doctrine is that all discriminated entities are mind-only; (6) Avatamsaka, which teaches the interpenetration and identification of all things in universal consciousness; (7) Suvarnaprabhasa (Splendour of Gold), a miscellany of doctrine of Emptiness, praises of altruism, legends, esoteric rituals and magical spells; (8) Vimalakirtinirdesa, which extols an ideal Bodhisattva named Vimalakirti; (9) Maharatnakuta (Heap of Jewels), a collection of 49 discourses on a wide variety of Mahayanist topics.

Sastras.—Outstanding among the philosophical treatises (*sastras*) are (1) the Madhyamika-karikas (Aphorisms on the Madhyamika System) by Nagarjuna (*c.* A.D. 150), who argues dialectically for the Emptiness (*sunyata*) of all relative determinations in thought, and for the Absolute as void (*sunya*) of such determinations since it transcends thought; (2) Mahayanasamparigraha (Acceptance of the Great Vehicle) by Asanga (4th century A.D.), who teaches that all things exist in a fundamental (or receptacle) consciousness; such idealism also marks; (3) his Yogacaryabhumi Sastra, in which he sets forth the stages in a Bodhisattva's career toward Supreme Enlightenment; (4) Vijnaptimatrata (Ideation- or Representation-only), two treatises in 20 and 30 stanzas respectively, written by Asanga's brother Vasubandhu, who argues that all seemingly external objects are only mental representations, ideations-only; (5) Mahayanasraddhotpada (Awakening of Faith in the Great Vehicle), a work known only in its Chinese version, which teaches that mind in its own nature is pure, that it becomes sullied through ignorance but may be cleansed through right understanding and faith in Buddhahood and through practice of charity, unselfish kindness, patience, zeal, tranquillity and wisdom, all of which issues eventually in the attainment of Perfect Enlightenment.

REGIONAL VARIATIONS IN BUDDHISM

A. India

Decline of Buddhism in India.—As a vigorous distinctive faith Buddhism flourished in India until about A.D. 500. Then it began to decline. Its Theravada form already had passed out of northern India to the south and to Ceylon. The Mahayana form, more pliable and tolerant, could not maintain resistance to steady pressures from without. From its beginning, Buddhism was surrounded in India by other religious beliefs and practices—the old Vedic ritualism and Brahmanism, ascetic Jainism (*q.v.*) and later Hinduism with its complex variety of deities and cults. Though it had some influence on these as it spread, it never really predominated except as rulers gave it special patronage. Its rivals continued active and tenacious. With the passing of time, Mahayana Buddhism, in constant contact with Hindu cults, gradually absorbed elements and tendencies from them until its distinguishing marks grew dim. Chinese pilgrims, traveling to India between A.D. 629 and 695, report the decline of monasteries once prosperous, the presence of Hindu temples near deserted Buddhist sites, or their close connection with functioning Buddhist temples where Buddhists and "heretics" intermingled. In the 8th and 9th centuries a Hindu revival under the influence of two masterful dialecticians, Kumarila and Shankara, gave strong doctrinal competition to Buddhist teachers, while organized Saiva ascetics opposed Buddhist monastic groups. With the establishment of Muslim power in A.D. 1193, Buddhism practically disappeared from its old home in northwest India. Elsewhere it lingered on in corrupted forms, eventually becoming a subsidiary sect under Hinduism, which accepted Buddha as an avatar of Vishnu.

Tantric Buddhism.—A factor marking the decline from the 7th century onward was the assimilation of a system of esoteric beliefs and practices known as Tantrism. The name derives from its literature, *tantras* (or "manuals"). At this time Tantrism appeared in both Hinduism and Buddhism as a magical ritual, using spells (*mantras*), mystic syllables (*dharanis*), occult diagrams (*mandalas*) and symbolic gestures (*mudras*) to attain the goal of religious life. The goal here conceived is a state of mystical union with reality wherein all dualities cease, symbolically expressed as the union of a given deity with his consort. In Hinduism the deities were Hindu gods. In Buddhism they were Buddhas and Bodhisattvas, each pictured with a feminine partner. Meditation on the symbol was intended to lead to an inner unification of the devotee and his identification with the deity, which is supreme spiritual bliss. The symbolism of sexual union was used to indicate an ultimate mystical realization. In some forms of Tantrism, however, the symbol was a literal ritual union, celibacy and ascetic morals were rejected, and a general indulgence of the senses was approved. It is evident that the mystical metaphors of the *tantras*, taken literally, were easily open to abuse and could be interpreted to sanction conduct quite opposed to the precepts of early Buddhism. Historically, this brought condemnation from ascetic religious groups and upon late Buddhism itself in India.

B. TIBET

The form of Buddhism that entered Tibet in the 8th century A.D. was of the late Indian variety. It brought in not only the Hinayana and Mahayana traditions, but also the Tantric interpretations and practices which an Indian Tantric scholar, Padmasambhava, introduced. This mixed form of Buddhism combined with the Tibetan indigenous religion, Bon. The latter was essentially a worship of nature spirits, hostile or benevolent, in which human and animal sacrifices, divination, magic (black and white), exorcism and sorcery were practised. The resulting complex of beliefs and practices is the distinctive religion of Tibet and Mongolia. In general it is an advance over original Bonism, but a less pure form of Buddhism than the Theravada of southeast Asia and the Mahayana of China and Japan.

The canonical scriptures of Tibetan Buddhism are voluminous. They consist of translations of basic texts from the Sanskrit, commentaries upon them, literature of the Old Translation school, founded by Padmasambhava, and lesser collections made up of ritual texts, doctrinal summaries, guides to meditation, invocations and classical tales of the Buddha's previous births (Jataka). Most important are the first two sections, the Kagyur (or Kanjur), sacred because it contains the direct words of the Buddha, and the Tangyur (or Tenjur), containing the commentarial explanations. The Kagyur consists of the Threefold Collection (Tripitaka) of Rules, Discourses and Treatises, plus what are called the Four Great Tantras ("manuals"). These last are (1) the Tantra of Activities (Kriya), (2) the Tantra of Application (Charya), (3) the Tantra of Perfection (Yoga) and the Tantra of Supreme Perfection (Anuttara Yoga). For Tibetans the Tantra section is very important, for here are set forth the magical rites, powerful spells, complex symbolisms and mystical meditations, claimed to lead to realization of Supreme Truth by developing intuitive wisdom and compassion. One edition of the Kagyur runs to 108 volumes. Even larger is the Tangyur, 225 volumes of commentaries on *sutras* and *tantras*.

Doctrinally, Tibetan teachers have recognized three ways to the highest goal in Buddhism. These they regard as designed by the Buddha for persons on different levels or stages of development. These are: (1) Hinayana, or the way of self-emancipation through self-discipline; (2) Mahayana, the way of philosophical insight into reality for the sake of saving others; (3) Tantrayana, the way of magical rites and mystical meditations. Theoretically, these are successive steps in an all-inclusive One Way (Ekayana, or One Vehicle) which the Buddha had in mind from the beginning. Accordingly a monk is expected to spend 15 to 20 years studying literature of the first two *yanas* before going on to learn the practice of the third under qualified masters in mystical realization.

Historically, the magic ritualism of Tantrayana made the first and readiest appeal in Tibet, where Bon magic was well-known and practised. This opened the way for introduction of all forms of tantric teachings from India, including the most literal interpretations. By the 11th century the amoralism of the literalists called for reform, and more adequate knowledge of the higher teachings. Atisha (or Atisa), arriving from India in A.D. 1042, and Tsong-kha-pa (1356–1418) both disapproved of tantric extravagances, taught the more balanced doctrine of the three *yanas*, required stricter discipline among the monks and gave more spiritual interpretations of tantric teachings. This led to the establishment of the now dominant Ge-luk-pa (Virtuous Way) sect to which the supreme head of the ecclesiastical hierarchy, the Dalai Lama, belongs. The patron deity of Tibet is Chen-re-zi (*i.e.*, the Bodhisattva of Great Mercy, Avalokitesvara), of whom the successive Dalai Lamas are regarded as reincarnations. A feminine deity popularly worshiped is Tara the Saviouress. (*See* further TIBETAN BUDDHISM.)

C. BURMA AND SOUTHEAST ASIA

Among countries in which the earliest form of Buddhism is followed today, Burma is notable for preservation of original monastic practices and adherence to the tradition of councils called to maintain purity of the faith. Its yellow-robed monks guide their lives by the ancient rules of the order (Sangha). They are expected to study diligently the Pali scriptures, practise the ethical precepts, meditate regularly and aspire to the purity of character and insight leading to Nibbana. They also maintain close contact with the people. Every village has at least one monastery radiating its influence through the community. Monks minister to the people through teaching and conducting religious rites and ceremonies for them. They give training to the youth entering the order for a limited period of religious education. According to ancient custom, they go the round for alms among the laity, affording them opportunity to practice the householder's virtue of giving. Ideally, the monk stands before the people as an example of complete devotion to the higher life taught by the Buddha. The laity respect the monk (*pongyi*, or "great glory"), and expect much of him as a moral leader. If he should stray from the right path of his vows they are quick to disapprove. On the whole, the situation in modern Burma illustrates how the early order must have operated.

Historically, the Theravada form of Buddhism was not prevalent over the whole of Burma until after the 11th century A.D. Before the time of King Aniruddha of Pagan (1044–77), it flourished only around Thaton in southern Burma as a result of the work of missionaries from southern India. In northern Burma around Pagan the religious situation was confused. Hindu, Mahayanist and Tantric influences from India, China and Tibet had combined with native animism to produce an amorphous set of practices, displeasing to the common sense of Anawrahta when he came to the throne in Pagan. Learning of the pure Theravada teachings from a monk arrived from Thaton, he made it an object in his conquest of southern Burma in 1057 to bring back to his capital all the Buddhist relics, copies of the Tipitaka, and able monks of the order. This marks the beginning of the royal patronage which in later centuries co-operated with zealous religious leaders to spread Theravada teaching throughout Burma. Corrupt forms gradually died away, though the animism of the common people lingers on in the folkways as a subordinate element not regarded as incompatible with the higher ranges of their religion.

According to Theravada tradition, Buddhism has had six great councils maintaining the integrity of its original teaching and practice. At the first, held at Rajagaha shortly after the Buddha

PICTORIAL PARADE

THE "SLEEPING BUDDHA," A 50-FT. STATUE, AND (LEFT) STATUE OF ANANDA, BUDDHA'S DISCIPLE, AT POLONNARUWA, CEYLON; 12TH CENTURY

died, 500 leading disciples assembled to recite and set in order his teachings as they remembered them. At the second, held 100 years later at Vesali, the first schism occurred when the School of the Great Assembly (Mahasanghika) separated from the School of Elders (Theravada). To the third great council, convened sometime during the reign of Emperor Asoka, is credited the compilation of a canon of orthodox doctrine and plans for missionary spread of the teaching in India, Ceylon and elsewhere abroad. The fourth was held in Ceylon (*c.* 25 B.C.), where, according to the Great Chronicle of Ceylon (Mahavamsa), the collected teachings, hitherto transmitted orally, were written down in books. The fifth, supported by King Mindon of Burma, was held in Mandalay in 1871, after which the revised texts of the canon, by royal order, were carved on 729 marble slabs. The sixth great Buddhist council met in Rangoon from May 1954 to May 1956 to recite and review again the Pali texts and to celebrate the 2,500th anniversary of the death of Gautama Buddha. This tradition of councils to maintain authenticity shows the strength of a continuing devotion to the faith of the Elders, conspicuously present in Burma and to a notable degree in Ceylon, Thailand, Laos and Cambodia also.

D. JAPAN

In Japan it is the Buddhism of the Great Vehicle (Mahayana) that has survived and flourished. This represents the outcome, after more than 2,000 years, of the tendency of free interpretation of Buddhist meanings under differing circumstances of peoples from northwest India to northeast Asia. Japan inherited from China and Korea all the Hinayana and Mahayana traditions introduced into those countries during the first six centuries A.D. Since the 6th century A.D. Buddhism has been an important factor in Japanese culture. With adaptations it follows Chinese Mahayanist forms. Its authoritative scriptures are those of the Chinese Tripitaka. Its art and architecture stem from Chinese originals. Its ceremonials and sects reflect practices and organizations found in China by Japanese priests who, from the 7th century onward, went there for study. Imported elements were adapted and developed, however, to suit a new environment. Japanese Buddhists do not regard the Mahayana as a departure from the original faith but as a natural development in different situations of deepening insight into its meaning.

Establishment of Buddhism in Japan is usually dated at A.D. 594, the year in which the regent, Shōtoku Taishi, promulgated an imperial ordinance to support and urge the development of the Three Treasures; *i.e.*, the Buddha, the Truth (*dharma*) and the Brotherhood (Sangha). His aim was to bring harmony among contending clans and peace to the people by holding up the ideals of the religion with its ordered Mahayana hierarchy of greater and lesser Buddhas and Bodhisattvas. These he saw expressed in the Lotus scripture (Saddharma Pundarika) through its concepts of One Vehicle and the Eternal Buddha who speaks through countless lesser ones. On this scripture he lectured and wrote a commentary. He did the same for two other *sutras*, the Vimalakirtinirdesa and the Srimaladevisimhanāda, written for the layman and laywoman, respectively.

Six Sects of the Nara Period.—During the epoch when the capital of the country was at Nara (710–784), six philosophical sects were introduced from China:

1. The Sanron (Three Treatises) sect taught the doctrine of the Void (the inexpressible Absolute).
2. The Hossō (Dharmalaksana) sect taught that everything is "consciousness-only," a system of metaphysical idealism; and also held the theory that some beings are incapable of Enlightenment.
3. The Kegon (based on the Avatamsaka, or "Wreath," *sutra*) sect held that all things interpenetrate and are inter-related in one Total Universe, in which every living being is a potential Buddha.
4. The Ritsu (Vinaya Pitaka) sect was concerned with the ceremony of ordination and rules of discipline.
5. The Jōjitsu (Satyasiddhi, or "Completion of Truth" *sastra*) sect taught the emptiness, or ultimate unreality, of both self and all elements, material and mental, which are its supposed objects.
6. The Kusha (Abhidharmakosha) sect studied a far-famed treatise of the Sarvastivada (All-is-real) school, written by Vasubandhu in the 4th century A.D. This maintained that all elements of the universe are real and discriminable as 75 in number.

In this same Nara period an image of the Great Buddha (Daibutsu) Vairocana was erected at the capital. Still to be seen, it symbolizes the Mahayana conception of a central, cosmic Buddha, irradiating his light through all lesser Buddhas who preach his truth throughout the more than 10,000,000,000 worlds of Mahayanist cosmology.

Tendai and Shingon.—In the following Epoch of Peace and Tranquillity (Heian epoch, 794–1185), the capital was at Kyōtō, where new sects were founded by two priests who had gone to China for Buddhist study. One was the Tendai (Chinese) sect, founded by Saichō, whose honorific title is Dengyō Daishi (767–822). The other was the Shingon (or True Word) sect of esoteric Buddhism, founded by Kūkai, whose title is Kōbō Daishi (774–835).

Tendai.—Tendai doctrine was based on the Lotus *sutra* (Saddharma Pundarika) as interpreted by the Chinese philosopher Chih-k'ai (531–597), at whose monastery in the T'ien-t'ai mountains Saichō had studied. It is remarkable as a synthesis of all varieties of Buddhist doctrine on the assumption that all were present in Sakyamuni's (*i.e.*, the historical Buddha's) mind from the time of his Enlightenment, although he unfolded them gradually on different levels according to differing capacities of his hearers for insight. This wide inclusiveness, giving all Buddhist systems some share in a total scheme, attracted many monks who came to the Tendai headquarters on Mt. Hiei for their training. Saichō himself taught Lotus doctrine, esoteric mysticism, Zen meditation and *vinaya* practices.

Shingon.—Shingon doctrine is mystical, teaching that the truth which is the supreme wisdom of the Buddha (*i.e.*, Vairocana) lies somehow inherent in all living beings. It may be developed and realized through special rituals. These include chanting mystical syllables, ritualistic finger-entwining, reciting magical spells, yoga concentration and right manipulation of symbolic ritual utensils. The whole is intended to arouse an immediate sense of the pervading spiritual presence of the primordial, eternal Buddha. This is taken to be a perfect communion between Buddha and aspirant in the present life. Shingon esotericism here reflects an influence of Tantrism on Chinese and Japanese Buddhism, but much modified and systematized on a higher plane by Kōbō Daishi. This did not, however, prevent its magic rituals and symbols from being regarded by the people simply as efficacious acts to secure desired worldly benefits.

Four Sects of the Kamakura.—During the Kamakura era (1185–1333), four more sects arose which were movements in the direction of closer adjustment of Mahayana Buddhism to religious needs of the common people. Earlier sects had been established under imperial sponsorship and appealed to intellectuals and aristocratic court circles. Their philosophies and ceremonies were too complex for popular understanding. In a disordered time also—when a patrician society was declining, a beneficed clergy had become corrupt and worldly, and a military class had arisen—the distress of the people was great. Simplification of religious ministrations became imperative. Arising to meet the situation were the new sects, Jōdo, Shin, Zen and Nichiren.

Jōdo.—The Jōdo (Pure Land, or Realm, sect) was founded by Hōnen (1133–1212). A priest who had diligently studied the many doctrines of Tendai, he had failed to find the peace of an inner certainty. Becoming convinced that neither book learning nor complex rituals nor keeping precepts nor practising meditations can lead to deliverance from evil, he turned to the way of simple dependence on another power. This power he found in the Buddha Amida (Amitabha). Of him it was written in certain scriptures that by taking a great vow and performing good deeds for others through a long succession of reincarnations, he had brought into being a Blissful Realm in which to save all who would call upon his name in faith. Reciting Amida's name was known in Japan before Hōnen's time, but he was unique in stressing that it is the one thing needful, and in organizing his many followers around the chanting of the words *Namu Amida Butsu* ("Homage to Amida Buddha"). By this be felt assured of rebirth into Amida's Pure Land of perfect bliss.

Shin.—The Shin (True) sect, or True Pure Land sect, was founded by Hōnen's chief disciple Shinran (1173–1262), who carried Hōnen's teaching to its logical conclusion. Faith alone matters. Mere recitation of a name is still indicative of a certain reliance on self-effort, even as are other forms of works such as doctrinal studies, austerities, meditations and rituals. Reliance on he grace and merit of Amida alone is sufficient. Shinran, like Martin Luther, abandoned monastic practice, married and demonstrated that the religious life may be followed in the midst of lay responsibilities. Since then leaders of Pure Land temples have been householders who devote their whole time to religious maters but do not follow the *vinaya* discipline.

Zen.—The Zen (Meditation) sect first flourished in China in the 7th century A.D. under the name Ch'an. The word *ch'an* is the Chinese equivalent of the Sanskrit *dhyana* which means meditaion. In Japan the Chinese word is pronounced *zen*. The Ch'an sect in China developed several subdivisions, which were transmitted to Japan in the 12th and 13th centuries. The two most mportant branches are Rinzai (Chinese Lin-chi) and Sōtō (Ts'ao-ung). In Rinzai practice, meditation on paradoxes (*kōan*) is used o awaken intuitive insight into what transcends logical distincions. In the Sōtō branch, the practice is a silent sitting and meditating on what illumination arises. Both branches revere he historic Sakyamuni, believe in mind-to-mind instruction from master to disciple, in the possibility of awakening the Buddha-mind which everyone has originally, and in expressing religious ealization in daily work. Discipline is more austere in Rinzai Zen. n Sōtō Zen there is emphasis on teaching ethical precepts and on bodhisattva practice of charity, tenderness, benevolence and sympathy, for the sake of saving others. In Zen monasteries the most mportant place is the meditation hall, where training in the practice is given and received. In Zen study associations, lay folk lso are instructed in the elements of meditation, as well as given he ten precepts of right conduct—not to kill, steal, commit adultery, lie or sell liquor; not to speak of others' shortcomings, or o praise oneself and blame others; not to begrudge charity, not to be angry, not to speak ill of the Buddha, his law and his order. Of the two chief forms of Zen, Rinzai is more aristocratic in tradition and has a smaller number of followers; Sōtō Zen has larger ollowing among the common people. (*See* also ZEN.)

Nichiren.—The Nichiren sect is named after its founder, Nihiren (1222–82), who, after long and arduous study at the head monastery of Tendai on Mt. Hiei, became convinced that the ssential truth of Buddhism is in the Lotus scripture, but not as misunderstood and confused in the then existing sects, including Tendai. In Japanese this Lotus of the Wonderful Law is called Myōhō-Renge-Kyō, a name every syllable of which Nichiren felt o be weighted with profound meaning. It should be thoroughly understood and practised. His vehement adherence to one scripure alone, however, brought him into sharp conflict with other eachers and groups. He denounced them, and in opposition ounded a new sect. Their doctrines and practices he declared false and dangerous to the welfare of the country. For this he suffered persecution, being at times in danger of his life. His persistence won out eventually, and he gained loyal following among those who admired the defiant courage with which he upheld his faith.

Nichiren believed in the Eternal Buddha as revealed in the Lotus scripture. This he held to be the true Buddha-nature, manifested in Sakyamuni and all other great beings awake to reality and truth. He taught his followers to test the teachings of the Lotus in their lives, to centre devotion by repeating the words *Namu-Myōhō-Renge-Kyō* ("Homage to the Lotus of the Wonderful Law"), to have absolute faith in the eternal Sakyamuni Buddha and to strive for development of the Buddha-nature in themselves and others. Upon this faith, Nichiren believed, depended the salvation of Japan itself. In its cause he showed himself saint, crusader, prophet and nationalist combined. The Nichiren sect still continues to fight in the same cause, believing his teaching will spread all over the world. In this it is a uniquely Japanese form of Buddhism, having no prototype in China.

Modern Japan.—Since the 14th century no new major Buddhist sect has been founded in Japan, although subsects have appeared within the old ones, markedly after World War II. In the 19th century, contacts with western scholarship in the scientific study of religions aroused a new interest. This has led to extended research activities, by Japanese scholars using modern methods, over the entire field of Buddhist literature in all its languages, especially Sanskrit, Pali, Tibetan, Mongolian and Chinese. *See* also JAPAN: *The People: Religion.*

MODERN BUDDHIST PRACTICE

Theravada.—In Theravada countries a close relationship exists between clergy and laity, although the latter do not have membership in the order (Sangha) as laity in the west have membership in churches. Strictly speaking, the order is made up of practising monks (*bhikkhus*) who have taken vows, wear the yellow robe and live the monastic life. Yet lay folk are not without their measure of participation. Except in the case of practice in Ceylon, where a monk's ordination is for life, provision is made for a person to enter the Sangha for a few weeks, months or years and then return to lay life when he so desires. In Thailand and Cambodia especially, all young men are urged to spend at least one rainy season as a monk in order to receive moral instruction from elders of the order. On entering the Sangha the candidate repeats the Three Jewels: "I take refuge in the Buddha, I take refuge in the *dhamma* (teaching), I take refuge in the Sangha." While in the monastery his life is regulated by the Vinaya rules laid down in the Pali canon. Twice each month the monks assemble to hear recited the 227 precepts and prohibitions and confess their failures. For novices such assembling may be daily. *Bhikkhus* must abstain entirely from drugs and intoxicating liquors. Both monks and novices refrain from eating solid food between noon and the following morning. They observe silence on their house-to-house begging rounds. They must remain chaste in thought and deed. Their only personal possessions are one undergarment, two robes (yellow or yellowish brown), a belt, an alms bowl, a small knife or razor, a needle and a water strainer. All else is the common property of the Sangha. For transgressions of rules there are appropriate confessions and penances. If a major transgression is committed, the offender is required to leave the order and return to household life.

Each monastery is presided over by a senior monk. Several monasteries associated together may select a high-ranking elder (*maha thera*) to lead the entire group. In Burma the Sasana council, made up of leading Buddhists, monks and laymen, is the guiding advisory group for the order. In Thailand a *sangharaja* (Sangha ruler) is chosen by heads of major monastic groups, approved by the ministry of education and appointed by the king. He in turn makes appointments to other chief positions in the Sangha with the approval of the government. Organized activities of the *bhikkhus* thus supervised consist of observing discipline, study of Pali scriptures and commentaries, meditating, teaching novices and performing various services for the lay community.

EWING GALLOWAY

INTERIOR OF TEMPLE OF DAWN, THONBURI, THAILAND, DURING WESAK, THE FESTIVAL COMMEMORATING THE BIRTH, ENLIGHTENMENT AND DEATH OF BUDDHA. THE STATUE OF BUDDHA IS SEATED IN THE MEDITATING POSTURE

Lay followers in Theravada countries look to monks for instruction in the basic precepts for right living. These are given in popular sermon form, with examples drawn from stories of the Buddha's previous rebirths (*see* JATAKA). Injunctions include reciting the Triple Refuge formula and keeping at least five abstentions—from killing, stealing, unlawful sexual intercourse, bad speech and drinking liquor. On special days additional merit may be gained by refraining from sexual intercourse, from taking food after noon, from enjoying music, garlands, perfumes, etc., and from luxurious seats or beds. On the positive side, appropriate duties are enjoined between parents and children, teachers and students, husband and wife, friends and companions, masters and servants, monks and lay people. Devout followers maintain small shrines in their homes, go to preaching halls to hear doctrine and, where circumstances permit, go on pilgrimages to sacred sites in India, Ceylon, Burma or Thailand. With aid of monks, the people observe the tonsure ceremony when a child reaches puberty, attend his ordination ceremony when a young man of the family enters the order, and when death enters a home carry out the burial rites. At these last monks officiate in chanting scriptures with reminders of the transitoriness of life, and the ongoing of the process of mind under the force of *kamma* (retributive law of deeds) to join another body in a new form.

On the joyous side are the religious festivals, gladly observed by the people of southeast Asia. Chief of these is Wesak (usually in May), in triple commemoration of the Buddha's birth, enlightenment and death. Another is the feast of offering of robes and alms to the monks at the end of the rainy season. Especially happy is the New Year festival with its many amusements of water-throwing, processions and dances, as well as paying honour to the Buddha. Special local festivals give additional happiness in each of the Theravada countries.

Mahayana.—In Mahayana countries, practices are much more varied. Characteristic of the Pure Land sects is recitation of the formula of homage to the heavenly Buddha Amitabha. Chanted by priests in temple services and uttered by lay folk in private devotions, it is the expression of what is deepest in their aspirations. In the Nichiren sect devotion is given to the truth in the Lotus scripture, and homage expressed through repeating its name. In Zen sects reverence is given to the historic Sakyamuni, to his 500 outstanding disciples (*arahats*), to great Bodhisattvas such as Manjusri whose image adorns the halls of meditation, to patriarchs such as Bodhidharma, and to founders of Zen sects and temples. Founders of other sects, such as Hōnen, Shinran, Saichō, Kōbō Daishi and Nichiren, are honoured in the worship halls by their followers. Incense is burned before images of major Bodhisattvas such as Avalokitesvara, known as Lord of Compassion in Tibet, and as Goddess of Mercy in China (Kuan-yin) and Japan (Kwannon).

In temple ceremonies before whatever image priests chant from appropriate Mahayana scriptures and perform traditional rituals. The effect is impressive, especially on great occasions when colourful ceremonial robes are worn and several hundred monks participate. In China the laity are generally bystanders and onlookers at such services. In Japan they have more participation. Shingon rituals, for example, are complex but lay devotees hold copies of the chants, join in where indicated, and during the concluding chant come forward one by one to bow before the shrine and make offering of incense.

Social Service.—Social service is approved in modern Buddhist practice. The idea of ministry to others is not new in Buddhism, but social needs today evoke new forms of expression. In Theravada countries it is largely a personal matter between the individual monk and the layman who turns to him for help. In China and Japan there has been more emphasis on social institutions such as hospitals, orphanages, schools, young people's organizations, etc., motivated by the Bodhisattva spirit of the Mahayana. Such emphasis and instruments are relatively recent, but they are consistent with the ancient ideal of active compassion for all suffering beings.

Temples and Monasteries.—Wherever Buddhism has spread in Asia it has given rise to impressive material structures. (*See* INDIAN ARCHITECTURE; INDIAN ART; INDONESIAN ARCHAEOLOGY AND ART; CHINESE ARCHITECTURE; JAPANESE SCULPTURE; JAPANESE ARCHITECTURE.) Architectural and iconographic features naturally vary from country to country, but basic functions remain the same. The temple is the main sanctuary, housing the image of Sakyamuni (Theravada) or of various Buddhas, Bodhisattvas and saints (Mahayana). Before altars to these images services are performed, public when lay people are present, private when part of daily monastic routines. The monastery is a complex of buildings, located usually in a spot chosen for its beauty and seclusion. Its function is to house activities of the monks. Here members of the brotherhood reside, receive training and practise exclusively the religious life. There is a residence for the chief abbot, and appropriate living quarters for senior monks and novices in training. For the laity are provided guest halls that in a large monastery may accommodate as many as 500 visitors at one time. The meditation hall is important, especially in Zen monasteries. Providing for other activities are the hall for worship, lecture halls, scripture repository, dining hall, kitchens, etc. Monasteries vary in size depending on area of service—local, regional or national. In China, where only certain monasteries are equipped to perform ordination ceremonies, as at the great monastery on Pao-hua Shan (Precious Flower mountain) in Kiangsu province, novices to the number of 2,000 or 3,000 sometimes assembled from all over central China. In Tibet, which historically has been a Buddhist ecclesiastical state, the great monasteries of Sera and Drepung, outside the capital, Lhasa, have housed as many as 7,700 and 10,000 monks respectively.

Iconography.—Images, in both Theravada and Mahayana usage, have been set up in temples, monasteries and shrines. Throughout southeast Asia these generally represent the historic Buddha in postures of meditating, teaching or reclining. For the

THREE LIONS

SHWE DAGON PAGODA IN RANGOON, BURMA, THE CENTRAL SHRINE OF BURMESE BUDDHISM. THE TOWER TO THE LEFT IS COVERED WITH GOLD LEAF, WHICH PILGRIMS BRING AS A DEVOTIONAL OFFERING

devout these call to mind his enlightenment, years of teaching and passing to Nirvana. To educated Buddhists they are not idols, possessed of inherent mysterious power, but aids to fix meditation on the virtues of the Buddha.

In countries of northern Asia, the treatment of images is more complex. In Mahayana sanctuaries, the representations are of different Buddhas, Bodhisattvas, saints (*arahats*) and guardian deities derived from India. In China and Tibet these constitute a pantheon, the worship of which is practically polytheistic. Historically, as is known from old Buddhist records in China, images often have been prized for their miraculous, supernatural efficacy. Sometimes the image was thought to become efficacious on occasion of the ceremony of worship. Acts then performed in its presence became magically potent. In Japan, where modern education is widespread, the tendency is to regard images as symbols of important spiritual qualities. Thus the figure of Amida signifies both wisdom and mercy, that of Kwannon boundless compassion, that of Manjusri the supreme wisdom to be sought through meditation. In Tibet, where ancient magical rites are taken for granted, images in personal form may represent doctrinal ideas or abstractions to the learned and also serve as direct objects of worship, powerful in themselves, for the untutored laity.

Relics.—Veneration of relics and personal belongings of the Buddha has been present in Buddhism from the beginning. According to early tradition, the body of Śakyamuni was cremated after his death, and the relics divided among eight groups of claimants. Each group erected for its share a reliquary. This marks the beginning of those structures, called stupas, dagobas and pagodas, which in Buddhist countries adorn the landscape everywhere. The names are often used interchangeably. Strictly speaking, however, the stupa is the moundlike earliest form of reliquary used in India; the dagoba is like a mound stretching up into a pointed spire above; the pagoda is the towerlike, storied structure observable in China, Korea and Japan. In Tibet a variant of the stupa called *chorten* (*cho-ten*) is common. All these structures have the same basic function. They honour the Buddha in the preservation of his relics or those of his chief disciples. They also become objects of pilgrimage and places for acts of devotion such as circumambulation. Most famous for size and beauty of ornamentation are the great stupas at Sanchi, India, the Shwe Dagon pagoda (dagoba) in Rangoon, Burma, and the pagoda of Hōryūji temple at Nara, Japan.

Treasured relics vary. Sometimes a particular one is honoured in a special sanctuary such as the Temple of the Sacred Tooth at Kandy, Ceylon, where worship services are held daily. Other objects of veneration have been a collarbone, locks of hair, ashes, etc. Objects made sacred by association are the tree (or its descendant) at Buddh Gaya (*q.v.*) under which Gautama experienced his great enlightenment, shoots from this same tree planted elsewhere (*see* Bo Tree), footprints of the Buddha, his girdle, alms bowl, etc. These together with mementos of noted disciples and saints have always played a role in popular piety. As in other notable religions of history, the material traces of lives that have embodied higher verities seem to make more real for him the faith of the common man. (Ce. H. H.)

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BUDDING: *see* GRAFTING (IN PLANTS); PLANT PROPAGATION.

BUDENNY, SEMEN MIKHAILOVICH (1883–), Russian military leader, marshal of the Soviet Union, was born of a peasant family on April 25, 1883, and lived in Kozyurin, near Rostov-on-Don. He began his military service in 1903. Early in 1917 he engaged in revolutionary activity in the armed forces, and after the Revolution he was made chairman of the divisional soviet of troops in the Caucasus. He joined the Communist Party in 1919 and, as commander of the 1st cavalry army until 1924, played an important part in the victory of the revolutionary forces in the civil war. He was inspector of cavalry in the Red Army from 1924 to 1937, was made marshal of the Soviet Union in 1935 and commanded the Moscow military district from 1937 to 1940. In 1939 he was made deputy commissar for defense and in 1940 became first deputy. When German forces invaded the Soviet Union in 1941 Budenny was put in command of the southwestern front, where his troops suffered defeats. He was removed and held no further command in World War II. He was appointed a hero of the Soviet Union in 1958, in which year he published his memoirs. (D. Fd.)

BUDGELL, EUSTACE (1686–1737), English miscellaneous writer, was born at St. Thomas, near Exeter, Aug. 19, 1686. Apart from Joseph Addison and Richard Steele (*qq.v.*), he was the principal contributor to the *Spectator*. Thirty-seven papers (those marked with an X) are attributed to him. In 1710 Addison, then secretary to the lord lieutenant of Ireland, offered Budgell a clerkship; and until 1718 Budgell filled a succession of posts. Meanwhile, he wrote his *Spectator* papers and a few for the *Guardian*. Budgell also published a translation of Theophrastus' *Characters* (1714). The change in his fortunes occurred in 1718, when the duke of Bolton became lord lieutenant; Budgell quarreled with Bolton's secretary, indiscreetly lampooned him and his patron and was superseded. Too vain and indignant to be dissuaded by Addison, Budgell launched into a paper war and became increasingly irresponsible. His difficulties were aggravated by the loss of £20,000 in the South Sea Bubble; he subsequently spent about £5,000 in unsuccessful attempts to enter parliament. He wrote libels against Walpole in the anti-governmental *Craftsman* and founded his own weekly, the *Bee* (1733–35), which ran to 100 numbers, many filled with vainglorious self-justification, particularly concerning the final blow to his reputation. In 1733 Matthew Tindal died and left Budgell £2,100; Tindal's nephew contested the will and circumstantial evidence suggests that Budgell may have forged it. The will was set aside and Budgell's remaining years were spent in litigation. Finally, on May 4, 1737, he threw himself into the Thames and drowned.

See T. Cibber, *Lives of the Poets*, vol. v, pp. 1–16 (1753). (R. P. C. M.)

BUDGERIGAR: *see* PARROT.

BUDGET, BUSINESS. A business budget is a financial document representing management's best estimated plan for the performance of a company during a definite future period. Involved is an integrated group of forecasts of expenditures, receipts, profits, and asset changes. Through the use of the budget, activities of a concern may be coordinated and results of the current operations may be constantly compared with predetermined goals. By promptly applying corrective measures, management may hope to attain, if not excel, the desired rate of profit.

Budgets vary in complexity according to the nature and needs of companies. Concerns differ mainly with regard to size and variety of products, two factors that are often quite closely related. A larger company, for example, tends to manufacture a greater variety of products and therefore must keep more complicated records. To be of greatest use, the budget must be linked with the particular accounting system employed. The time period covered by the budget also varies from company to company since the period selected often is contingent upon factors such as the selling seasons, the length of the processing cycle, the methods of financing, and the availability of statistics on past performance.

Budgetary control not only involves estimates but also implies a plan whereby these are logically related one to the other and actual income and expense are definitely controlled in relation to the plans. Any plan of budgetary control must of necessity be closely coordinated with the organizational structure of the company and with the policy-making and managerial elements. Rightly conceived and administered, a budget plan is of inestimable value to the business and financial managers. By means of the budget, responsibility is definitely fixed, a better coordination of all activities is assured, and a barrier to unwise expansion is established. Budgeting is not a substitute for good management. It is, however, one of the most practical and useful tools of management, ensuring considered planning before doing.

Executive support of both the principle and plan of budgetary control is absolutely essential. Indeed, unless all the executives of the company, from the chairman of the board of directors down to the least important department supervisor, are in full accord and sympathy with the principle of planning, the success of the budget is in danger. Nothing retards the success of any plan or method more than to have it known that it has only the lukewarm sympathy and support of the principal executives. A budget should not be regarded, either by those working under it or by those administering it, as restrictive in character. Budgets must be elastic and flexible to meet changing conditions. Another important principle of budgetary control is that those who are to execute plans should have a definite and active part in making them. A salesman, for example, who is asked to assist in setting his own quota is much less likely to complain about its size or to present excuses than is one who has been assigned a quota by his sales manager or other superior without previous consultation.

Regardless of the size of the organization, the number of persons affected, and the nature of the business, it is essential that the procedure for budgetary control be kept as simple as possible. In order to give practical effect to the principle of operating the business in accordance with plans made, it is necessary that provision be made for frequent comparisons between estimated and actual performance. Such comparisons should be provided for at least once a month, with summaries every three months. One real danger, especially in a company's early experience with budgeting, is that estimates made will be merely optimistic hopes rather than realistic forecasts. Expenses are budgeted in relation to anticipated income. If actual income falls far short of the budget, net profits will be reduced unless the situation is noticed in sufficient time to reduce expenses in the same proportion. Finally, it is essential that plans once made be adhered to except in cases where sound business judgment indicates that changes are desirable.

Actual responsibility for the direction of the budget rests with different executives in different companies. The plan under which the controller or the treasurer assumes the duties of budget supervision is widely used. Under this plan of organization, it is usual to find someone with the title of financial manager, budget director, supervisor of budgets, or controller of the budget. Whatever the title of the executive in charge of budgeting may be, it should be clearly understood that he is representing the head of the company in the discharge of his duties. Heads of the separate departments of a business usually prepare individual departmenta budgets that are molded into a preliminary budget by the budget director, who arbitrates budgetary conflicts. Top managemen officers then review and revise this preliminary budget after discussions with department heads.

In general, there are two classifications of business budgets—operating budgets and financial budgets. In the first category the basic budget and undoubtedly the one most difficult to prepare is the sales budget, which shows both anticipated income from sales and the quantities it is expected will be sold. Best practice favours the separation of sales income from sales expense. In preparing the sales budget, the three fundamental factors of probable market conditions, past sales, and plans and policies of the company for the coming year are used. Of these three, the first is the most difficult to deal with, particularly when the economy is passing through a transitional stage.

A great deal of attention has been given to market analysis, both by companies themselves and by research organizations. While space does not permit a detailed discussion of this important phase of budgeting, it should be clearly understood that a thorough market analysis must necessarily precede the preparation of a sales budget. (*See* Market Index.)

After the sales budget has been prepared, the next step is the coordination of the estimated sales volume and income with other operating budgets dealing with direct costs and overhead costs, including the expenses of distribution, administration, and research and development. In the case of a manufacturing business it is obvious that the sales estimate must be coordinated with the production capacity of the plant and that inventories also must be considered. It will be necessary to make the original sales estimate conform to factors such as the ability of the company to finance the contemplated sales program, the percentage of selling expense, anticipated net profits, advertising plans, personnel available to carry out the sales estimate, etc.

While the modification of the sales budget is being carried on, but after the original sales estimate has been prepared, other executives are preparing various other operating budgets. These operating budgets are supplemented by financial budgets of three types: (1) capital expenditure budget covering the company's plans for replacing, improving, and adding to capital equipment; (2) cash budget which projects cash excesses and deficiencies and indicates the necessity for borrowing and investing; and (3) budgets forecasting the income statement and the balance sheet, the so-called proforma statements. This third type of financial budget is commonly considered to be the master budget.

Since the balance sheet and the profit-and-loss statement are the two accepted financial statements that summarize the past activities of the business from a financial point, it is only logical that the plans be finally put into estimated statements of the same kind. Banks throughout the United States often ask companies to which they extend accommodations to submit estimated financial statements of this kind.

See also Economic Forecast.

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(J. H. MacD.; F. W. Q.)

BUDGET, GOVERNMENTAL. As commonly understood, a budget is the forecast by a government of its expenditures and revenues for a specific period of time. In national finance, the period covered by a budget is usually a year, known as a financial year or fiscal year. In the United States the fiscal year for the federal government starts on July 1 and in the United Kingdom it begins on April 1, a date that has been consistently used since 1854. In general, the date on which the fiscal year begins is determined largely by administrative convenience.

The word "budget" is derived from Old French *bougette*, "little bag." The British chancellor of the exchequer, when he makes his annual financial statement, is said to "open" his budget or receptacle of documents and accounts.

A budget is not solely a matter of finance in the narrow sense. Budget policy is an important part of a government's general economic policy. In many countries a great increase in government expenditure began before World War II. Moreover, the importance of the effect of governments' transactions upon the rest of the economy is now more widely recognized. For these reasons the budget is generally regarded as the occasion for a review of and debate upon the country's economic situation. (E. E. Bs.)

UNITED STATES

The Role of the Budget Process.—In the United States, the chief executive prepares an executive budget, which is essentially a proposal, not merely a forecast. The legislative branch enacts revenue, appropriation, and borrowing measures, not necessarily those proposed by the executive. The executive branch executes the budget within the restraints established by statute. The legislative branch reviews and postaudits the execution of the budget.

The discipline of political parties is neither demanded nor offered with regard to the budget. Hence, even when the president's party holds a clear majority in both houses of Congress, his budget may be changed in many respects in the course of enactment.

While the budget system originated in a public concern for economy and efficiency, the system also serves other objectives, which ideally include: (1) informed and well-considered decisions on the scope and level of government programs for an ensuing period, usually one year; (2) maximum efficiency in the conduct of government programs; (3) an optimum allocation of financial resources among functions and agencies of government; (4) orderly financing of expenditures through revenue measures and, on occasion, borrowing; (5) making government finances responsive to the desires of responsible officials and legislators with regard to impact on the economy (neutral or activist); (6) presenting data on programs and finances in a manner that encourages understanding and responsible citizenship; (7) providing information on the stewardship with which executives have carried on their functions in immediately prior periods; and (8) providing the mechanism for limiting the financial transactions day by day to the extent deemed necessary by the legislative body or the chief executive.

Consideration of budget proposals for spending may start with a definition of the need for governmental action on a particular subject and a measure of the "universe" of that need. A budget proposal may then set forth the extent to which the government should seek to meet the need over a period of years and for the year covered by the budget (that is, it should define a long-range program). For the budget year, the proposal should state specifically the work output proposed and the input required, at least in dollars, and, in many cases, classified in terms of such cost elements as salaries, supplies, travel, and contractual services.

The budget provides a regular process for reconciling conflicting views: between program policy, with its usual upward pressures on the budget, and fiscal policy, which may often be resistant to an accumulation of such pressures; and among advocates of priority for differing measures to meet a variety of needs. Although the budget process needs the support of accounting and statistical data and quantitative economic analysis, budget amounts cannot be scientifically proved "right"; the budget is what those chosen by the people (the president and the Congress) consider desirable.

The national budget is unitary. It embraces both an expenditure account and a loan account. Separate financing is not calculated for capital as distinguished from current costs. The government's business enterprises are included, along with more traditional government activities.

History of the National Budget System.—The budget system of the national government was initiated by the Budget and Accounting Act of 1921. A budget system had been recommended earlier, by the Commission on Economy and Efficiency, appointed by Pres. William Taft. Following its report in June 1912, the president volunteered a trial budget for the fiscal year 1914, but the "lame duck" Congress virtually ignored the recommendations of a "lame duck" president. In 1919 the effort for reform picked up momentum in Congress. The act that was to become law in June 1921 had been passed by Congress in identical form in May 1920 but met with a veto from Pres. Woodrow Wilson, not because of opposition to a budget system but because of his concern over the 15-year tenure of office, independent of presidential removal, provided in the act for the comptroller general and assistant comptroller general of the United States.

The Budget and Accounting Act provided for the preparation and transmittal to Congress of an annual budget representing the president's judgment on a fiscal plan for the government. Other officials and employees of government departments and agencies were forbidden to ask Congress for appropriations in excess of the president's recommendations. A Bureau of the Budget was created in the Treasury Department to assist the president.

While, from the first, the Bureau of the Budget gave attention to budget execution as well as budget preparation, the formal concentration of power over the execution processes, through an apportionment system in the Bureau of the Budget, became a reality only in 1933, an action in the administration of Pres. Franklin D. Roosevelt.

Following a report of the President's Committee on Administrative Management, the Bureau of the Budget was transferred into the newly organized Executive Office of the President in 1939. The director of the bureau had always been the president's "own man"; the transfer gave formal sanction to the concept. In the years following, the bureau greatly expanded its activities of assisting the president in the field of government management.

In 1945 the Government Corporation Control Act brought the government-owned corporations under the annual budget review of both the president (through the Bureau of the Budget) and the Congress. The Employment Act of 1946 gave congressional approval to the concept that the government has a continuing responsibility for the nation's economic well-being and that the budget may be an instrument to that end; some staff of the Bureau of the Budget, already working on national economic analysis, transferred to the staff of the newly formed Council of Economic Advisers, where their functions were continued.

A Legislative Reorganization Act in 1946 started a short-lived attempt of Congress to make its approach to the budget more comprehensive. Under its procedures, Congress was expected to adopt a "legislative budget" target early in each regular session for its guidance in acting later on appropriations and other measures. This system was quietly abandoned in 1949.

Following recommendations of the first Hoover Commission on Organization of the Executive Branch of the Government, the executive budget transmitted in January 1950 gave special emphasis to program classification and performance measurement. The Budget and Accounting Procedures Act of 1950 ratified this approach. The second Hoover Commission sought changes in the accounting basis of examining budget requests; administration action in 1956 was followed by legislation calling for requests to be constructed on the basis of data on accrued costs, along with the older concept of "obligations" (known in municipal finance as "encumbrances").

In 1962 a major change in budget format separated the program and financial summaries for the public generally from the technical details used by the appropriations committees of Congress, putting the former in "the budget" volume and the latter in an appendix.

Emphasis upon the formal use of quantitative methods in the analysis of programs was introduced in August 1965, under the term "a planning-programming-budgeting system." Such procedures had previously been applied in the Department of Defense.

Although the budget document had since the 1945 law included all funds administered by the government, there was controversy over how to measure the budget totals and surplus or deficit. A presidential commission on budget concepts recommended in October 1967 that all government-administered funds, including those nominally held in trust (such as the social-insurance funds), be included in the reckoning. Starting with the budget transmitted in January 1968, that has been done.

The Bureau of the Budget was transformed into the Office of Management and Budget, still within the Executive Office of the President, by a presidential reorganization plan effective in July 1970. The scope of its management concern was enlarged. A Domestic Council, to which specified White House employees gave professional assistance, was also created within the Executive Office of the President (*see* GOVERNMENT DEPARTMENTS).

The Office of Management and Budget (OMB).—The director and deputy director of the office are appointed by the president without Senate confirmation and serve at his pleasure. The total OMB staff, professional and clerical, runs from about 550 to about 600. Of these, not more than ten are considered "noncareer" (political) appointees; the remainder are career (classified civil service) personnel.

The OMB's six "program" divisions are the means by which the office gives its first review to agency programs and budget requests. Each such division concerns itself with the programs and operations of particular agencies of the executive branch, grouped in broad sectors of the government's total range of activities. The divisions are: national security; international; natural resources; human resources; economics, science, and technology; and general government.

Other units of OMB provide functional expertise and coordination of matters extending beyond an individual agency or program: (1) budget review, centred upon the formulation of the president's budget, the drafting of his budget message, and the coordination of budgetary control; (2) evaluation, which assists the program divisions in evaluating program effectiveness and efficiency and makes special program analyses; (3) legislative reference, which involves the analysis of agency views upon proposed legislation and congressional enactments coming up for the president's approval or veto; (4) organization and management systems, which develops solutions to problems of executive branch organization and seeks to improve management tools and operating methods; (5) program coordination, responsible for improving interagency coordination and cooperation between "levels" of government, especially in the "delivery" of government services; (6) statistical policy and management information systems, focused on improving the federal statistical-services data systems, for both public and management use; (7) executive development and labour relations, which is concerned with developing effective personnel management systems for the government, especially for the utilization of career executive talent.

The director of OMB works closely with the assistant to the president who heads the staff of the Domestic Council, and there are frequent exchanges of views between the staff of OMB and the staff of the council. There is also close liaison with the National Security Council and other units of the Executive Office of the President.

Budget Preparation.—The making of the annual budget involves two virtually simultaneous approaches:

1. The head of each department and independent agency transmits to OMB a budget request for his organization. In preparing it, he has the assistance of a "budget officer" who is an employee of his organization. In most cases, chiefs of bureaus and other subordinate units initiate preliminary requests that are used, though not necessarily in the amounts first submitted, in arriving at the department's request. The request identifies program objectives, measures, and issues, as well as financial requirements. Budget submissions are studied in OMB. Issues requiring the president's attention are isolated and defined, with alternative answers and often a specific recommendation suggested for his consideration.

2. The budget review staff of OMB, in consultation with the staff of the Council of Economic Advisers and the Treasury Department, prepares a statement of the overall economic and fiscal outlook. For government expenditures, this takes account of the most recent moving five-year projections, prepared annually from agency submissions, reflecting the extension of policy decisions as of the time of its preparation. Possible targets for budget totals for the coming year and an approximate allocation of expenditures among the various agencies are studied at successive levels, finally by the director, who consults with the chairman of the Council of Economic Advisers and the secretary of the treasury on the totals.

The director takes up the results of both these approaches with the president, who reaches a conclusion on the program issues and on the sums to be allowed in his budget for each agency. Such conclusions are tentative at first and then become more fixed as the "budget season" progresses toward the deadline for transmittal to Congress. Throughout the process, there is a necessity for fitting the two approaches together so that the budget will have integrity as to the individual programs, relative priorities among programs, and totals.

Departments and agencies are requested to revise the details of their respective budgets to conform to the president's conclusions. The revised budgets are assembled by OMB for printing in the president's budget volumes, along with estimates for the legislative branch and the judiciary, which are not subjected to presidential change. A presidential message to the Congress is prepared. The completed budget, the appendix, and a volume of special analyses are placed on the desks of members of Congress, and the message is read aloud by a clerk in each house, by the 15th day of each regular session (usually the latter part of January).

There is coordination between the budget preparation task and the preparation of two other major presidential messages for submission to Congress in January—the message on the state of the union and the economic report of the president. All three usually deal with program policy, but the budget much more explicitly than the others.

Budget Adoption.—The appropriation proposals in the budget are referred to the standing committees on appropriations in the respective houses of Congress. Subcommittees hold hearings, at which members, previously briefed by permanent professional staffs of the committees, question officials of the agencies as to the need for the amounts recommended by the president and often as to their stewardship over the use of prior appropriations.

Each subcommittee's recommendations, after approval or occasional modification by the whole appropriations committee, go to the house concerned in the form of an appropriation bill and a report. There are about 11 to 13 regular appropriation bills each year, embracing about 475 to 550 appropriation items for the executive branch, plus appropriations for the legislative branch and the judiciary. Differences between the two chambers are reconciled through a conference of members of both houses, subject to final approval again by each house. Supplemental appropriation bills, usually two each year, follow the same procedure. In addition, a temporary appropriation act, in indefinite amounts, is usually enacted to provide for the agencies and programs for which the regular appropriation acts are still in progress at the start of the fiscal year, July 1. The temporary appropriations are an "advance" on the regular appropriations but can be used only for continuation of activities in progress at the close of the preceding fiscal year and at the previous levels.

Some appropriations, such as for interest on the public debt, are "permanent"; that is, additional amounts are recorded as appropriations each fiscal year, without fresh action by Congress, as a result of permanent statutes. There are also some statutes that grant authority to obligate and spend which bypass the appropriations committtees but are contained in other bills reported by other committees in the two houses.

Most revenue laws are "permanent"; that is, without expiration dates. The renewal, however, of those few that expire, the amendment of tax rates, and the enactment of new types of taxes are embraced in one or more revenue bills in each session of Congress. The president's recommendations on revenues are presented in detail by Treasury officials to the Ways and Means Committee of the House of Representatives in hearings. Recommendations of the committee go to the House for a vote, and then the measure passes through the Senate Finance Committee, the Senate, a conference committee, and finally the two houses again. The Senate can amend, as in the case of other bills.

The Treasury is authorized by law to borrow and repay borrowing from day to day, subject to a statutory limit on the amount of debt outstanding at one time. The debt limit has been so constraining that amendments have been necessitated by most recent budgets. Bills to change the debt limit are handled through the same channels as revenue measures.

Budget bills, like other bills passed by Congress, are subject to approval or veto by the president.

Budget Execution.—Upon enactment of the regular appropriations, each agency devises an operating budget, based upon the amounts appropriated (as distinguished from the amounts that had been in the president's budget) and usually dividing the planned use of the money by interim periods within the year. The OMB, after a review of the agency's operating budget, apportions the available appropriations, usually by quarters of the year, but rarely in equal quarterly amounts. Departments and agencies must keep their obligations for the payment of money within the sums appropriated and apportioned. A system of administrative control is required under which sums are allotted (distributed) to subordinate officials, who must also keep their transactions within the amounts prescribed.

There is no authority for the executive branch, even the president, to spend or obligate in excess of, or in advance of, appropriations. If it appears that an appropriation will be insufficient, the president may recommend to Congress a supplemental appropriation. Such requests are processed through OMB in a way similar to the annual budget. Congress may act on supplemental appropriations at any time.

Most appropriations are not a mandate to spend, but are only permissive. The OMB may reserve parts of the appropriations when it apportions. Reserves may not be used unless OMB reapportions them for the purpose for which appropriated. OMB cannot divert a reserve to any other purpose.

Independent Audit of Budget Execution.—The Budget and Accounting Act of 1921 not only laid the foundation for the national budget system but also created the General Accounting Office, independent of the executive branch, headed by a comptroller general. Originally, he had the power to prescribe accounting systems for the government; after 1950, his authority in accounting was one of prescribing "principles, standards, and related requirements" and of approving or disapproving systems. Accounting-systems work and accounting operations are the responsibilities of the several departments and agencies and of the Treasury Department. A statutory declaration of policy provides that the accounting system in each case must meet the needs of both the executive branch (for management) and the legislative branch (for audit); specifically, with regard to the budget, the accounting systems are to provide "reliable accounting results to serve as the basis for preparation and support of the agency's budget requests, for controlling the execution of the budget, and for providing financial information required by the office of management and budget."

A representative of the comptroller general countersigns the Treasury's appropriation warrants, the documents that establish in the accounts the amounts that have been appropriated by law and that also constitute authorization to the agencies to certify amounts for which Treasury checks may be drawn to those to whom the agency's liabilities are payable.

The General Accounting Office makes a postaudit of the government's financial transactions. In the case of expenditures that the comptroller general considers contrary to his interpretation of law, he has the power to demand that restitution be obtained from the responsible officer or employee (for example, the person who certified the voucher for payment) or from the insurance carrier that issued the fidelity bond covering that person. Department heads and financial management personnel may seek advance decisions in which the comptroller general states the interpretation of the law he will follow in the subsequent audit and settlement of a particular transaction. Expenditures that the comptroller general considers unwise but not unlawful may be reported to Congress, but the comptroller general cannot require recovery. Committees of Congress occasionally conduct hearings on the audit reports; sometimes a report may lead to legislation designed to prevent a recurrence of a transaction, the soundness of which has come under criticism.

State and Local Budgeting.—Influenced by the same reform pressures that brought about the Budget and Accounting Act, state and municipal governments also adopted budget systems.

County governments and townships have been less concerned, with some exceptions.

All 50 states had budget systems in the early 1970s, 46 of them with an executive budget prepared by the governor and 4 with budget preparation committed to a board. In most states the legislative body had unlimited power to change the budget, except for possible constitutional restraints on the taxing power or borrowing power; in 4 states the legislature's flexibility was more limited. Since many state legislatures met only once in each two-year period, 24 states had biennial budgets (a few of them consisting of separate sums for each fiscal year, the rest embracing the whole 24-month period without distinction as to year). In the 26 states where there were annual sessions of the legislature, the budgets were annual. In 40 states the governor's veto power extended to items in appropriation bills, a power that permitted portions of the bill to become law while the remainder was recommended to the legislature for reconsideration and possible action to override the governor.

Local budgeting, however, in some jurisdictions was under a form of state control, more often as to procedural standards than as to substance. Where executive and legislative functions were vested in separate officials or bodies, local government budgeting usually emerged with the same general pattern of procedures as in the federal and state governments. Where a single executive was lacking, as in some counties and most townships, the budget process was more difficult to define.

BIBLIOGRAPHY.—Government budgeting is an interdisciplinary subject, usually the subject of a chapter or chapters in the standard texts on economics, political science, and public administration.

The recognized "classic" books on this subject are W. F. Willoughby, *The National Budget System* (1927); A. E. Buck, *Public Budgeting* (1929); J. Burkhead, *Government Budgeting* (1956). Other significant volumes are H. D. Smith, *The Management of Your Government* (1945); F. C. Mosher, *Program Budgeting: Theory and Practice* (1954); A. Smithies, *The Budgetary Process in the United States* (1955); C. J. Hitch and R. N. McKean, *The Economics of Defense in the Nuclear Age* (1960); J. P. Harris, *Congressional Control of Administration* (1964); A. Wildavsky, *The Politics of the Budgetary Process* (1964); R. F. Fenno, Jr., *The Power of the Purse* (1966); D. Novick (ed.), *Program Budgeting* (1965); R. T. Golembiewski (ed.), *Public Budgeting and Finance* (1968); C. L. Schultze, *The Politics and Economics of Public Spending* (1968); D. J. and A. F. Ott, *Federal Budget Policy*, rev. ed. (1969).

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UNITED KINGDOM

In the United Kingdom, as noted above, the financial year begins on April 1. The established practice is for the chancellor of the exchequer, as soon as possible after that day, to make a budget speech to the House of Commons giving a report of the previous financial year as shown by the Exchequer (*q.v.*) accounts, the estimated expenditure for the new year, the estimated revenue on the basis of existing taxation, and the changes, if any, which he proposes by way of reduction or increase of taxation. By the middle of the 20th century it had become usual to associate with that statement an economic report reviewing the general economic position of the country and White Papers on government lending and on the balance of payments, giving the latest statistics for the national economy as a whole. These three publications, together with the financial statement (which is issued immediately after the chancellor's budget speech elaborating the details of expected revenue and expenditure and proposed changes in taxation), provide the background for the debate that follows the speech. The budget speech is one of the central events of the parliamentary year and often provides the opportunity for announcing important changes in financial and economic policy.

The basic financial principle of the British budget has long been that all government expenditure is met from a central fund and must be provided out of revenue, except where Parliament has authorized the Treasury to borrow money to meet it. Until 1968 these requirements were met by passing all revenue and expenditure through the Consolidated Fund; specific authority to mee certain categories of expenditure from borrowed monies was provided in each of the statutes dealing with the expenditure itself Any surplus of revenue over ordinary expenditure was applied to redemption of the national debt; any deficiency had to be made good out of revenue the next year unless Parliament determined otherwise (during World Wars I and II and in 1946 and 194 Parliament authorized the Treasury to borrow to meet the deficit caused by the heavy expenditure in those years).

From April 1, 1968, a separate National Loans Fund took over from the Consolidated Fund most of the domestic lending by the central government and all the government's borrowing transactions, including the service of the national debt. (The latter i partly offset by receipts of interest on loans and profits of the issue department of the Bank of England, the balance being me by a payment from the Consolidated Fund.) Revenue from taxation and miscellaneous receipts continued to be paid into the Consolidated Fund, and any surplus after meeting the ordinary expenditure on "supply" services and the Consolidated Fund standing services (*see* below) was transferred to the Nationa Loans Fund. The Treasury's powers to borrow for various purposes, previously spread over a large number of statutes, were replaced by a single authority under the National Loans Act o 1968 to borrow only sufficient funds to cover any net deficit on th National Loans Fund from day to day. In this way the basic principle of a central financial control over revenue, expenditure and borrowing was maintained.

In practice this principle is modified to the extent that specified amounts of receipts accruing to departments (*e.g.*, fees for service to the public) are allowed to be "appropriated in aid" (*i.e.*, used by them toward meeting their expenditure), thus reducing the demand on the Consolidated Fund. Similarly, in the case of continuing trading services where there is no complicating question of a subsidy, receipts from sales are set off against expenditure any net deficit being provided by a vote and any surplus being paid into the Consolidated Fund.

Again, there are certain special funds set up by statute to finance such services as national insurance, industrial-injuries insurance, and redundancy payments. Some of these funds receive payments from votes, but the bulk of their income is in the form of statutory contributions by the public.

Before World War I the British budget was comparatively simple. Expenditure varied little from year to year. Expenditure on certain capital projects was provided for by advances outside the budget, largely from the growing deposits in the Post Office Savings Bank, such advances being repaid by annuities chargeable over a period of years, as expenditure inside the budget. The main budget decisions were: how much surplus should go by way of sinking fund to reduce the national debt, and what tax remissions should be made or, alternatively, what new taxes should be imposed? The Treasury had no permanent borrowing power in normal times, and any budget deficit was regarded as a temporary shortage to be put right by subsequent increased taxation.

After 1914 there were great changes in the scale and pattern of state revenue and expenditure (for example, ordinary expenditure in 1967–68 was more than 50 times as great as in 1913-14). There was also developed, particularly during and after World War II, a wider conception of budget policy, taking account of economic forces and trends to a much greater exten than formerly.

The wider functions falling to the state meant that much more of its expenditure was of a capital or extraordinary nature, which it would be generally impossible to attempt to cover fully by current revenue. Examples are loans to finance nationalized industries and other public corporations and loans to local authorities for housing and other purposes. In such cases Parliament gave the Treasury power to borrow to meet the expenditure, and the national debt was correspondingly increased. In due course repayment of advances made for these purposes was used to reduce the national debt. These transactions were called "below the line"—the line being an imaginary one across the Consolidated Fund accounts dividing the transactions for which Parliament had authorized the Treasury to borrow from those "above the line," which were to be met from revenue. From 1968 to 1969 this division by "line" was replaced by the National Loans Fund accounting arrangements described above.

The great increase in the scale and extent of government activity made the budget play a different and more important part in the general economy of the country. For example, by the middle of the 20th century expenditure by the government on goods and services for current purposes was absorbing more than 12% of the gross national product at factor cost. Other current expenditures, such as debt interest, subsidies, and social-service benefits, did not represent a direct claim by the government itself upon national resources, since they represented transfers of income from one set of people to another within the economy. Nevertheless, they had to be provided for in the budget and had an important influence on expenditure in other sectors of the economy. The total of current government expenditure, including such payments, was an amount equal to about one-third of the national product.

It was then no longer possible to regard the government's accounts as a self-contained entity, or for the government to aim at balancing its budget without regard to its effect upon the level of economic activity and the balance of payments. In 1944 the wartime coalition government published a White Paper on employment policy, in which it accepted responsibility for ensuring, as far as possible, that employment remained at a high and stable level; and it recognized that in this the budget had a part to play. The current economic situation is described, and the immediate prospects for production, employment, and the external balance of payments are reviewed, to show how fully the country's productive resources are likely to be employed in the year ahead. The appropriate levels of taxation are decided against this background. Thus, for example, when demand is in danger of outrunning the productive resources available to meet it, rates of taxation may be maintained at a high level in order to restrain private expenditure (*i.e.*, expenditure other than that of the government) and to keep supply and demand in balance; or, when it appears that demand is likely to be deficient in relation to the productive capacity of the economy, tax reductions may be made in order to maintain employment and to promote continued economic expansion.

Preparation of the Budget.—It is a fundamental principle of British finance that all proposals involving expenditure require approval by the Treasury. The seeking of this approval is a continuous process, the various government departments approaching the Treasury with reasoned requests to sanction additional expenditure. When doubtful points have been cleared up, the Treasury either authorizes or refuses to accept the proposals in whole or in part. If any difference of opinion persists between the Treasury and the department concerned, it must be resolved between the ministers concerned or, in the last resort, by the Cabinet.

In conformity with that general principle, the Treasury plays a special part in the preparation of the annual estimates of expenditure, for which parliamentary approval is sought. On Oct. of each year the Treasury sends a circular to the civil departments calling for their estimates of expenditure for the following financial year. These estimates are examined by the Treasury, and important policy decisions are referred to ministers. After approval by the Treasury, the estimates are presented to Parliament in February (*i.e.*, well before the budget speech) by the financial secretary to the Treasury, and, although they are not formally approved by Parliament for several months, the expenditures represented by them figure in the coming budget.

A rather different procedure applies to the estimates of the defense departments, where much of the proposed expenditure is directly determined by Cabinet decisions on the future size and shape of the armed forces. Treasury approval is required for the defense estimates, but they are presented to Parliament by the service and defense departments and not by a Treasury minister.

The above procedures cover "supply" expenditure (*i.e.*, expenditure voted annually by Parliament). The remaining component of ordinary expenditure is the Treasury's assessment of the sums needed for Consolidated Fund charges. These charges, known as "Consolidated Fund standing services," are not voted annually but rest upon specific statutory authorities which remain in force until Parliament determines otherwise. They include the payment to the National Loans Fund in respect to interest, etc., on the national debt (*see* above); payments to the Northern Ireland Exchequer; the civil list (*q.v.*); and salaries and pensions of the speaker of the House of Commons, the judges, the comptroller and auditor general, and others whose special position is emphasized by the fact that their salaries do not have to be voted and discussed annually.

Total expenditure by the public sector includes the outgoings of the National Insurance Funds, the expenditure of local authorities, and the capital outgoings of the nationalized industries and other public corporations. As this is all spending directly or indirectly within the control of the government, machinery has been evolved for planning and controlling total public expenditure for several years ahead, with the particular aim of ensuring that its prospective growth is compatible with the growth of the nation's resources and with the medium-term economic outlook. This machinery was set up in 1961 as a result of the recommendations of the Plowden Group on public expenditure. (*See* the White Paper *Public Expenditure: Planning and Control* (Cmnd. 2915; February 1966). In brief, departments submit to the Treasury every spring estimates of their spending for the next five financial years; these are compiled by the Treasury into a report which gives a functional (rather than a departmental or administrative) classification of the figures; and this report is presented to ministers in June or July, together with the current economic assessment of the same five-year period. On this basis, ministers can take decisions on the long-term growth of public-sector programs and on the priorities between these programs that they wish to establish. Parallel but slightly different arrangements exist for reviewing the investment programs of the nationalized industries.

On the revenue side the boards of customs and excise and inland revenue, which collect the bulk of the taxes, furnish the Treasury with the estimates of receipts, first on the existing basis of taxation and later on the basis of any changes which the chancellor of the exchequer may be considering. To these must be added the estimated receipts from selective employment tax (which are partly offset by repayments forming part of "supply" expenditure), motor-vehicle duties, broadcast receiving licenses, interest and dividends, and miscellaneous items.

With this material, the chancellor can begin to consider how far he can afford to reduce taxation or whether he should increase it. He must also take account of the outgoings from the National Loans Fund and the balance which will have to be met by borrowing. He must consider the likely trends of the economy generally for the coming year and whether stimulus or increased restraint is needed. He has to make an assessment of the economic position—the trends of the overseas balance of payments, of home production, and of the demand for goods and services (both public and private)—in fact, a balance sheet of the nation's (not only the government's) income and expenditure.

Parliament and the Budget.—The British budget is explained to Parliament by the budget speech. Parliament is called upon subsequently by votes and an Appropriation Act to authorize part of the estimated expenditure—the supply charges—and by resolutions and a Finance Act to assent to such changes in the law as may be needed to give effect to the revenue proposals.

The House of Commons, when considering the estimates of expenditure, can vote the grant proposed or reduce it or reject it, but cannot increase it or annex a condition to it or alter its destination. The House will vote money only on a recommendation from the crown, signified through a minister. If it desires to increase a vote, this can be done only if the government is willing to introduce a supplementary estimate or to replace the original estimate by a new one. It is, however, very exceptional for discussions in the House to result in any changes in the original estimates. A select committee exists to examine what economies can be effected consistent with the policy employed in the estimates; but its approval is not necessary before the House is asked to pass them.

Parliament has little time before the end of the financial year on March 31 to consider the estimates of expenditure for the coming year. The House is therefore first asked only to vote funds sufficient to cover expenditure until the full program of grant and appropriation can be completed. Statutory authority is given by a Consolidated Fund Act, which must be passed by the end of March. The act also covers supplementary estimates presented late in the year which is ending, as well as excess votes (*i.e.*, excesses of expenditure authorized after scrutiny by the Public Accounts Committee). These preliminary votes "on account" may not be used for new services; that is, services which have not been previously sanctioned by Parliament.

The taxation proposals are made by the chancellor of the exchequer on "budget day." Immediately after the budget speech, the budget resolutions are introduced to give effect to the scheme of revenue proposed. In general, taxes rest upon continuing statutes, but two taxes (the corporation tax and the income tax with its surtax) are voted for one year only, in order to ensure that taxation proposals are brought within the purview of the House every year, even though there might be no budget changes in respect to them. Under an act originally introduced in 1913 but consolidated, with its subsequent amendments, in 1968, budget resolutions varying or renewing taxes can be given statutory effect for a period of four months or, if the budget is proposed in March or April, until Aug. 5 of each year. Thus the budget proposals have immediate effect, provided that they are confirmed by a statute (the Finance Act) within that period.

The budget speech is followed by a debate of several days' duration, ranging over the whole field of financial and economic policy. Then the finance bill is introduced, reimposing the annual taxes and giving effect to any changes in taxation proposed. This is considered in detail and must reach the statute book within the period allowed for the validity of the budget resolutions.

Concurrently, the House considers the supply estimates. A limited number of days before Aug. 5 are allotted for the purpose of discussing all supply business, the choice of subjects resting with the opposition. The balance of the amounts requested in the estimates must be confirmed by a further Consolidated Fund bill, which also appropriates the total amounts granted by this and the earlier Consolidated Fund Act to the separate services concerned. When enacted, this becomes known as the Appropriation Act. With the passage of the Finance Act and the Appropriation Act, the budget receives the full sanction of law.

Under the provisions of the Parliament Act, 1911, a "money bill" (broadly, one concerned solely with taxation or charges on the Exchequer) cannot be amended by the House of Lords and may become law without the lords' consent if they have not passed it within one month of its leaving the House of Commons. The certificate of the speaker of the House of Commons is required to a money bill, and all Consolidated Fund bills and some finance bills are so certified. Thus the House of Lords, while it debates each budget, has no effective say in its authorization.

There may be years when circumstances change so rapidly that a second budget is needed in the autumn, revising taxation for the remainder of the financial year. For example, there were autumn budgets in 1945—after the end of World War II—and in 1947, 1955, and 1964—to deal primarily with inflation. In 1952 and 1968 the budget was opened early in March in order to make an early contribution to the balance-of-payments crisis.

The House of Commons requires to see whether the budget proposals work out according to plan. The collection of revenue and (subject to the authority of the ministers concerned) the expenditure on public services are in the hands of officials whose operations are subject to control and audit on behalf of the House. This audit is carried out by the comptroller and auditor general, a high officer of Parliament, appointed by the crown and independent of any minister. He is required to make a test audit of the revenue receipts, to audit the accounts of expenditure of each department, and to report to Parliament any irregularities or other matters of interest arising out of the account. It is also his duty, as comptroller, to authorize all issues of monies out of the Consolidated Fund and the National Loans Fund in order to ensure that no such issues are made without parliamentary authority. His annual reports are laid before the House and referred to the Public Accounts Committee, which summons before it the accounting officer of each department and officials of the Treasury and other departments. Any recommendations made by the Public Accounts Committee are communicated to the Treasury for consideration. The House may debate their reports and those of the Estimates Committee on any of the allotted supply days.

The central accounts of the Consolidated Fund and the National Loans Fund are kept on a cash basis. They are made up for the financial year at the close of business on March 31, and a summary is published that day. The accounts are called appropriation accounts, and they are published several months after the end of the financial year. As a general rule, they include all orders for payment drawn on or before March 31, whether or not they were cashed within the year. Periods between three and six months in the case of different departments are allowed for including all belated encashments of orders and agency transactions between departments. When the appropriation account is closed, any further receipts or payments, even if related to the past year, are included in the accounts of the year in which they actually occur.

(E. E. Bs.; F. G. L.; D. Al.)

Bibliography.—The United Kingdom budgets are published annually in the form of a White Paper entitled *Financial Statement* (HMSO). *See* also Sir Herbert Brittain, *The British Budgetary System* (1959); U. K. Hicks, *British Public Finances: Their Structure and Development 1880–1952* (1954); Central Office of Information, *Public Finance in Britain*, C.O.I. Reference Paper R.5622 (Sept. 1963); The Treasury, *A Select Bibliography of the Control of Public Finance and the Budget*, 3rd ed. (1965). (D. Al.)

CANADA

In Canadian parliamentary practice, the budget is the annual statement of accounts and financial requirements presented to parliament by the minister of finance when he makes his proposals regarding changes in taxation and other measures to provide for financing during the fiscal year (which in Canada begins on April 1). Generally, similar practices are followed in the various provincial legislatures.

The expenditure side of the Canadian budget is presented separately to parliament in the form of estimates. The main estimates are normally introduced about the beginning of February and are the culmination of the analyses of departmental spending plans. These estimates take the form of some 200 "votes," each of which must be separately approved by the house of commons sitting as the committee of supply—a committee of the whole house. The estimates are usually referred initially to an appropriate standing committee of the house. Discussion in standing committees and in the committee of supply may concern either matters of policy relating to the estimates or particular grievances related to the service concerned as well as matters of administration.

The level of annual estimates to be presented to parliament, in total and for each department, is determined in the context of the immediate outlook for the economy and the departmental proposals for the estimates year and the four following years. This is done in the summer of each year during a review of long-range departmental plans by the treasury board, which is a committee of the cabinet established by law and chaired by a minister known as the president of the treasury board.

The departments are advised of the estimates levels so determined and begin the preparation of the estimates proper in the detail required for presentation to parliament. Each minister forwards his estimates to the treasury board whose staff members examine and criticize the proposals in the light of the pre-determined desirable totals, of general government policy and of standards of economy and efficiency. The treasury board considers the departmental proposals and the comments of its staff and directs the preparation of a recommendation to cabinet for final approval of the estimates and the presentation of these estimates to parliament. Additional or "supplementary" estimates normally are also submitted to parliament during the fiscal year.

The budget proper is normally presented to parliament after the main estimates, often in late March or April, close to the beginning of the fiscal year to which it will apply. Supplementary budgets may be presented during the year if economic circumstances dictate. The principal elements of the main budget are an analysis of the economic situation and outlook, and proposals for tax changes. The budget is very largely the personal responsibility of the minister of finance, but it must be approved by the cabinet before presentation to parliament. In the months immediately preceding the budget the minister of finance and his senior officials intensify their regular review of trends in economic activity to determine what fiscal action is called for. They also review, with the minister of national revenue and a few of his top officials, the many proposals and representations received from the public and officials as to desirable changes in tax legislation. On the basis of these studies and discussions the minister of finance prepares his budget, which is reviewed first with the prime minister and then with the cabinet before its presentation in the house of commons.

The budget speech presents the revenues and expenditures of the past financial year and the forecasts and proposals for the new year against a review and analysis of economic conditions, relating policy in the field of public finance to economic policy in general. To make this possible without too long a speech, it is usual to present the details in the form of a printed "white paper" containing in one part data on government revenues, expenditures, assets, and liabilities, and in another a review and analysis of the performance of the Canadian economy and its outlook. In the analysis of the financial results of the past year and the requirements for the future, account is taken not only of budgetary revenue and expenditure proper but also of public debt transactions and other receipts and disbursements, including payments giving rise to certain types of liquid or interest-bearing assets.

In concluding the budget speech, the minister moves that the house of commons constitute itself a committee of ways and means to consider resolutions, which he thereupon tables, summarizing the substance of his tax proposals. These resolutions must be approved by the house before the bills embodying the actual changes in the tax laws are introduced. A general debate on the budget as a whole, which normally covers a wide ground, follows the motion to go into committee of ways and means; subsequently there is a debate on the individual resolutions concerning particular tax changes, and finally a more technical discussion on the bills themselves. When they have been approved by the house of commons, the bills then go to the senate, where they are usually handled with expedition and with due respect for their character as money bills, for which the lower chamber accepts special responsibility.

The over-all size of the Canadian budget was greatly influenced by World Wars I and II and by the economic and social changes that followed them. In 1913–14 the total of expenditures provided for in the budget was about $180,000,000; in 1922–23 it was about $440,000,000; by 1938–39 it had grown to $550,000,000; at the peak of the war in 1943–44 it was $5,500,000,000; by 1947–48 it reached a postwar low of $2,100,000,000; and for 1967–68 it was up to $9,869,000,000 plus an additional $1,388,100,000 paid from a special fund for old-age security pensions into which certain earmarked taxes were placed.

Prior to World War I, budget deficits were frequent, but surpluses were the general rule during the prosperity of the 1920s. In the 1930s, deficits were reluctantly accepted as a consequence of depression and, during the war, as a necessity to be minimized by a "pay as you go" policy. From 1947 through 1954 budgetary surpluses were usual, because of the rapid growth of the economy and varying degrees of anti-inflationary fiscal policy. After 1954, however, expenditures generally exceeded revenues, with the size of the deficits ranging from $33,000,000 in 1955–56 to $791,000,000 in 1961–62.

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BRITISH COMMONWEALTH AND EUROPE

Features of the United Kingdom's fiscal system, described above, are also found in other countries. The similarities are, understandably, greatest in those independent countries of the British Commonwealth whose administrative apparatus was to a large extent modeled on that of the U.K. The differences are most marked in countries which have a federal as against a unitary system of government or have been greatly influenced in their administrative arrangements by the doctrine of the separation of powers. Even in Commonwealth countries, however, there are important variations in practice. Budget making—in the sense used here, the raising of revenue and the authorization and control of public expenditure—lies at the heart of all government, and the methods of each country are bound to be profoundly influenced by its constitutional, parliamentary, and economic development.

In what follows, some characteristics of fiscal and budgetary practice outside the United Kingdom are analyzed on the basis of the experience of selected countries. (For Canadian practice, see *Canada* above.) The main questions considered are the timing of the budget in relation to the financial year; the administrative and parliamentary processes necessary for its passage into law; the form and structure of budgets; the purposes they are designed to serve; the methods of control over expenditure and revenue; and the system of accounting and scrutiny of accounts.

Financial Year and Date of Budget.—The financial year is usually chosen from one of three periods: from April 1 to March 31 (*e.g.*, in India); from Jan. 1 to Dec. 31 (*e.g.*, in France, the Federal Republic of Germany, and Switzerland); and from July 1 to June 30 (*e.g.*, in Australia and Sweden). The financial year largely determines the date of introduction of the budget, though in some countries it comes before, in some after, the beginning of the new year. In Australia the normal date is sometime in August; that is, more than a month after the financial year has begun. In India, on the other hand, the central budget is normally introduced on the last working day of February. On the continent of Europe the budget, whatever legislative form it may take, is often presented well in advance, so that it may be passed into law before the new year begins. This interval may be long; in Sweden, for example, where the financial year begins on July 1, the budget is normally introduced in the second week of January. In Italy it has to be introduced by July 31.

Legislative Framework and Parliamentary Procedure.—Countries that separate the procedures for examining and authorizing government expenditure from the procedures involved in raising revenue may here conveniently be distinguished from countries where the two sides of the budget account are considered by the same bodies and at more or less the same time.

The method of separation, which is that of the United Kingdom, is followed with variations by many independent countries of the British Commonwealth. In Australia the estimates appear at the same time as the budget. The estimates are first referred to a committee of supply and after being voted are embodied in appropriation bills, which subsequently receive legislative sanction. In India the practice is somewhat different, since the estimates are set out in the budget itself. Even there, however, the first stage, following a general discussion, is the voting of demands by the lower house of the legislature, after which the votes are incorporated in an appropriation bill, which is debated in the ordinary way. The voting of revenue in many independent Commonwealth countries is on lines analogous with those of the United Kingdom. The principal changes in taxation will normally be outlined in the budget speech of the minister of finance or treasurer and voted as a series of resolutions. Together with more detailed amendments of the taxation laws, they will then be included in either one or more bills and subsequently debated. In Australia taxation proposals are given effect in a series of bills; in India, on the other hand, changes in the existing taxation law are enacted through a single finance bill, but proposals for new types of taxation are enacted through separate bills in each case.

In Europe budget proposals normally take the form of a bill in which details both of expenditure and of the revenue proposals to meet it are set out at the same time. The general practice is for the bill to be considered by a budget or finance committee, which then reports to a chamber of the legislature. This is the course followed in France (where the bill is first considered by a parliamentary committee, which then reports to the National Assembly), in Sweden (where the bill may ultimately be passed on a combined vote of both chambers), and in Italy (where the budget, which used to take the form of a number of bills for each department, has consisted of one consolidated budget since 1965).

In Switzerland the budget proposals of the Federal Council (or Cabinet) are considered by the finance committee of each chamber, which reports through its chairman to the whole chamber. Each chamber votes separately, and the budget is continually referred back and forth until agreement is reached. This procedure is similar to that applied to other bills; both chambers are equally competent in financial matters.

In several countries, as in the United Kingdom, provision is made for the voting of funds on account to permit the business of government to be carried on if the passage of the budget is delayed. Thus, in India a vote on account is passed to provide the executive with funds when it is not possible to complete all stages through which the budget must pass before the financial year begins. In France, under a procedure introduced at the beginning of 1959, if the finance bill has not been approved within the time limit established in the constitution (70 days after the submission of the bill), the budget may be brought into force by decree. In Italy a provisional budget for four months may be approved as from the end of the previous financial year, based on the new finance bill. Most countries also have arrangements for granting supplementary estimates during the financial year.

Form of the Budget.—Subject to the minor qualification already noted (under which orders for payment drawn by departments before March 31 are included in the appropriation accounts, whether or not they were cashed before that date), the budget accounts of the United Kingdom are cash accounts in the strictest sense. This system in its unqualified form is to be found also in India and Australia. Some countries, however (*e.g.*, Canada; *see* above), work on a modified cash basis.

On the continent of Europe and in some other countries the budget accounts are drawn up on an income-and-expenditure rather than on a cash basis; in other words, they include all income receivable in a particular year, as well as all expenditure appropriated for that year. Mention should be made here of a distinctive feature of the Swiss budget. Though the accounts presented to the Parliament are formally on the basis of estimates of income and expenditure, in fact the scope for variation on both sides of the account is strictly limited, since the sources of the federal government's revenue are laid down in the constitution and can be varied only by means of short-term emergency decrees or of special tax laws which are subject to referendum. On the expenditure side of the budget most items are fixed by special laws difficult to change, for political reasons. The budget, therefore, is based on an estimate of income from predetermined sources against which are set details of expenditure restricted to conform as far as possible with the available income. There are two other important variations in the form of the public accounts of different countries. In some, all government receipts and expenditures are concentrated in a single account or fund; in others, more than one fund will be kept—in some cases many more. Further, some countries make no distinction between capital and current items in their accounts; others draw a fairly sharp distinction.

In Australia, in addition to a Consolidated Revenue Fund, there are two other accounts—the Loan Fund and the Trust Fund. The distinction between these and the Consolidated Revenue Fund does not correspond strictly to the distinction between current and capital already mentioned. Much capital investment is in fact financed from the Revenue Fund; the Loan Fund itself is confined to those expenditures which are financed by borrowing by the Commonwealth government and the states. Contributions from the Revenue have been made to the Loan Fund to assist the borrowing programs of the Loan Council. India draws a sharp distinction between its revenue budget and capital budget.

Practice on the continent of Europe varies widely. The French long made no distinction between current and capital in their budget, but did so for the first time in the 1960 budget. In the Italian budget a distinction has been made since 1965 between current and capital expenditure, the capital expenses including all items which are not strictly running costs. In Sweden the capital budget constitutes a plan for state investment during the fiscal year, and an annual program is drawn up for each of the ten funds of the trading enterprises and spending agencies controlled by the government. Capital investment by the state, either directly or through state-owned industries, came to play a large part in the national investment of most countries—not only the relatively new and developing ones (*e.g.*, Australia and India, but also those more developed, such as France.

The Budget as an Instrument of Economic Control.—Traditionally the budget is a fiscal machine for raising revenue to meet authorized government expenditure. By the 1960s some countries continued to regard it only in this light. Others had come to look upon it also as a balancing factor in the national economy, designed to serve broader economic ends such as eliminating inflation or preventing trade depression, securing a large volume of investment, or correcting balance-of-payments difficulties. In France, as already noted, the budget is used as a major instrument in the national investment plan and also in an attemp to secure a greater balance in the economy. In Germany, on the other hand, the budget continued to be used primarily for fisca purposes. In Italy in recent years the budget has been increasingly used for anticyclical purposes and to serve broad economic aims. In 1968, for example, the bill containing the budget incorporated a number of important measures to stimulate productive investment. In theory, Switzerland lies midway between the extreme positions. The Financial Law of Jan. 1, 1958, specifically recognizes the need to take account of the general economic situation when provision is made for the repayment of national debt In practice, the lack of scope for variation on the revenue side and public pressure to have taxes reduced in times of surplus are likely to tie the hands of the federal government. This lack of scope can be changed only by revision of the laws and constitution from time to time. In Sweden by the 1950s the budge was employed as an instrument of planning, annual balancing having been discarded. Moreover, in order to emphasize its importance in the field of economic control, two emergency budgets as well as the ordinary budget are provided and voted each yea to meet the situation which might arise in case of war or depression and unemployment. No revenue is voted for either of these budgets, which are confined to authorizing expenditure (in the latter case grants for public-works schemes to relieve unemployment), but authority is given for the raising of loans to cove expenditure should the emergencies in question arise.

Control over Revenue and Expenditure.—In many independent countries of the British Commonwealth the system o parliamentary and administrative control over revenue and expenditure follows the United Kingdom's practice, on which it i largely based, though not without differences. In all these the control is generally on a statutory basis and is exercised first through Parliament and then through executive action. In Australia control is mainly directed by the Treasury through the medium of the Audit Act and Treasury regulations. Under the act only Treasury officers may transfer money to departments. The issue of money so transferred to meet expenditure is supervised by officers in departmental accounts branches, who are designated by the Treasury to see that it is in accordance with parliamentary and other authority. In India the system is less rigid; sums authorized by Parliament are placed at the disposal of the controlling authorities in the various departments, who are themselves responsible for seeing that expenditure does not exceed the amount authorized without prior authority. Powers of reappropriating expenditure to purposes other than those originally authorized are also within limits delegated to departments. Collection of revenue is in the hands of a number of special departments, but overall control over both revenue and expenditure is exercised by the Finance Ministry.

In France, control over a department's expenditure is exercised by the minister, who in turn is assisted by controllers of current expenditure, officials of the Ministry of Finance. In Italy, on the other hand, day-to-day control over revenue and expenditure is exercised by the director-general of the Treasury, who has to certify the legality of proposed disbursements. In Sweden, spending is largely in the hands of the spending agencies, and no special parliamentary or administrative control is exercised, apart from the duties performed by the General Accounting Office (*see* below).

Scrutiny of Accounts.—Independent audit of accounts by an officer responsible to the legislature and not to the executive or to any department thereof is a practically universal feature of financial control. In independent countries of the British Commonwealth the system is again, in part, modeled on that of the United Kingdom. In Australia departmental accounts are under continuous examination by audit inspectors throughout the year, and the Audit Act requires the treasurer to furnish the auditor-general at the close of each year with a statement showing the financial results for the year under various heads. This is then transmitted by the auditor-general to Parliament with a report thereon. In India a similar system prevails. In France and Italy, though the Ministry of Finance and Treasury respectively are concerned with scrutinizing day-to-day expenditure of departments, accounting results come under examination or are reported on by an independent Court of Accounts. In Italy this court is also concerned with the account of institutions in which the state has a financial interest. In Sweden a General Accounting Office is responsible for accounting procedures applied by the spending agencies, and it also has authority to supervise the arrangements for disbursements on current account. At the same time the National Debt Office is responsible for arranging disbursements in respect to the capital budget. The General Accounting Office also has the function of collecting monthly details of expenditure from spending agencies and consolidating them into a central account, which is submitted as a monthly report to the Cabinet, together with a statement of estimated budget revenues and expenditure to date.

In a number of countries parliamentary scrutiny of expenditure is carried on by committees comparable to the Public Accounts Committee of the United Kingdom. Committees of this name operate in Australia and India. In Switzerland a *délégation des finances,* consisting of six members drawn from the Finance Committee of the two chambers, has the task of examining departmental finances. The finances are subject to continuous control by a small department of officials who are responsible to the *délégation des finances.* In Sweden a post-audit by a specially appointed committee of both chambers of the *Riksdag* is made, as well as by the General Accounting Office. The object of the first is to review administrative practice and recommend improvements in the interests of efficiency and economy; the second is concerned with post-audit in the narrower sense.

(E. E. Bs.; F. G. L.; D. Al.)

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BUENAVENTURA, the main Pacific port of Colombia, South America, in Valle del Cauca department. Founded in 1540 on the island of Cascajal where the Dagua River reaches the Bay of Buenaventura, it was later burned by Indians and virtually ceased to exist for many years. It was relatively unimportant until the 1930s, handicapped by a hot and humid climate and by poor transportation connections with the interior. There was an unpaved highway, impassable in rainy seasons, and a single-track railroad which reached the Cauca Valley but not Bogotá. But by the 1930s the often unnavigable state of the Magdalena River hurt the commerce of Barranquilla, then Colombia's major port. In the same years Buenaventura's inland connections were improved, resulting in the growth of road-borne traffic. Modern port facilities and an airport were constructed. By the mid-1950s Buenaventura exported products valued at about eight times those shipped from Barranquilla and imported half again as much. In the mid-1960s, however, Barranquilla's import values were close to those of Buenaventura. The port for the sugar and coffee of the fertile upper basin of the Cauca Valley, Buenaventura also handles most of the gold and platinum of the Chocó region to the north.

The city grew from a population of 14,515 in 1938 to 35,087 in 1951 and 70,079 in 1964. (T. E. N.)

BUENA VISTA, a village 8 mi. S of Saltillo, Mex., at the northern edge of the battlefield where one of the major battles of the war between the United States and Mexico was fought in 1847. A U.S. force of about 5,000 under command of Maj. Gen. Zachary Taylor occupied a defensive position on the rugged terrain south of Buena Vista. A Mexican army of about 20,000 came from the south under the command of Gen. Antonio L. de Santa Anna on Feb. 22, 1847, and attacked early the next morning. The tide of battle wavered throughout the day. At one time an American order to advance was relayed as an order to retreat, thus causing confusion which nearly turned into a rout. The situation was saved by the calmness of Taylor, who had returned from Saltillo, and the effective support of the artillery. Later, when Taylor's army held a decided advantage, Santa Anna requested a truce, which proved to be a ruse to permit him to extricate some of his units When darkness brought the fighting to a halt, it was not clear that either army had gained a victory. Both had suffered heavy casualties. The Mexican army remained numerically stronger, but its morale was at a low ebb, and during the night Santa Anna ordered a general retreat. After a desultory pursuit of Santa Anna, Taylor withdrew to Monterrey and the campaign in northern Mexico was over. *See* also Mexican War.

See D. Lavender, *Climax at Buena Vista: the American Campaigns in Northeastern Mexico, 1846–47* (1966). (H. W. By.)

BUENOS AIRES, largest and most populous province of Argentina. Area 118,844 sq.mi. Pop. (1960) 6,766,108, excluding the federal district of Buenos Aires, located on the estuary of the Río de la Plata in the northeastern corner of the province. Roughly square in shape, Buenos Aires is bounded on the north by the Paraná river and the provinces of Santa Fe and Córdoba, on the east by the Río de la Plata (which separates it from the republic of Uruguay), on the east and south by the Atlantic ocean and on the west by the provinces of Río Negro and La Pampa.

The island of Martín García, located on the estuary of the Río de la Plata near the mouth of the Uruguay and Paraná rivers (area 0.7 sq.mi., pop. [1960] 1,712) and site of a military prison, is usually considered part of the province of Buenos Aires.

Physical Geography.—The province forms the major part of the humid pampa of Argentina, a vast grass-covered plain which, through the production of cattle, sheep and wheat, brought wealth to the area in the late 19th century. Rainfall is usually adequate for agriculture, although drought is not unknown; the annual average in the northeast is 39 in., dropping off to approximately 20 in. in the south and west. The region enjoys mild winters and hot summers with the growing season ranging from 300 days in the north to 140 days around Bahía Blanca in the south. Absence of any continuous snow cover makes grazing possible throughout the year. Variable weather and windstorms are characteristic of the area. The pampa is monotonously flat with a soil of alluvium and wind-blown dust or loess, entirely free of stones or pebbles. There are only two low mountain ranges: the Sierra del Tandil (1,772-ft. elevation), which starts on the coast at Mar del Plata and extends inland approximately 150 mi. in a northwesterly direction; and the Sierra de la Ventana (highest point [Tres Picos] 4,078 ft.), about 60 mi. in length and extending in the same direction from the coast near Bahía Blanca. The province is well watered with a ground-water table which lies close to the surface, but most of the drainage is underground and there is little running water. As a result there are numerous sloughs, occasional swamps and temporary lakes in the rainy months, particularly in the central region.

One principal river, the Río Salado, traverses the entire province from northwest to southeast for a distance of 360 mi. None of the provincial streams can be navigated, and they are used only slightly for irrigation.

Population.—The bulk of the population is concentrated in the northeastern section of the province around the federal district of Buenos Aires. An enormous and continuous urban cluster, which comprises more than one third of the total population of the republic or over 7,000,000, is formed by the cities of Vicente López, San Isidro, General San Martín, San Justo, Morón, Lanús, Lomas de Zamora, Avellaneda, Quilmes and the Capital Federal. This commercial, industrial and cultural conglomeration known as Greater Buenos Aires dominates not only the province but also the nation. Several other industrial and commercial centres have developed within the province, such as the port of Bahía Blanca in the south, the provincial capital and port of La Plata approximately 33 mi. S. of the federal district, the seaside resort of Mar del Plata, and the agricultural centres of Pergamino in the north and Azul and Tandil in the south. There are important foreign elements within the province, exceeding 1,000,000 persons by the 1960s. The most numerous nationalities represented are Spanish, Italian, French, German, Russian and Polish.

History.—Throughout the period of the Spanish empire the area of the province was virtually unexploited save for the hides from the vast herds of cattle and horses which ran wild on the pampa. Actually the interest to sell such hides and salted meat on the world market free of Spanish commercial restrictions, in addition to the natural restlessness and independence of the gaucho, led the inhabitants of the province to support a separation movement from Spain in 1810. Subsequently the province under the leadership of the city of Buenos Aires became involved in efforts to impose a type of government on the autonomous provinces which would someday form Argentina. A degree of national unity was imposed by the governor of Buenos Aires province, Juan Manuel de Rosas, from 1829 to 1852. His despotic rule eventually led to revolution, and in the ensuing strife Buenos Aires separated itself from the Argentine confederation. When in 1862 another Buenos Aires governor, Bartolomé Mitre, was elected president, national organization was achieved with Buenos Aires as the first province of the nation. Continued strife within the province was resolved in 1880 with the federalization of the city of Buenos Aires as the residence of the national government and the subsequent move of the provincial authorities to La Plata. At the same time a major campaign against the pampa Indians removed the danger of their raids from the southern boundaries of the province. Peace was thus assured in time for economic prosperity to benefit the province in the final decades of the 19th century. Refinement of refrigeration techniques, making the transport of beef to Europe feasible, led to improvement and expansion of cattle raising. Simultaneously it was discovered that wheat, corn and alfalfa would grow extremely well on the pampa. The provinces of Santa Fe and Córdoba also benefited from these economic developments, but it was the province of Buenos Aires, heartland of the pampa, which prospered most Hundreds of thousands of immigrants, primarily Italian and Spanish, arrived in the province to provide labour for this economic boom, and British, French and Germans responded with managerial experience and capital. The trend toward industrialization, especially marked during and after World War II, again greatly benefited the province since its area contained the major urban concentrations and the centre of transport and commercial facilities of the nation.

Government.—The provincial government enjoys considerable autonomy in local matters although the national government retains authority to intervene in provincial matters if judged necessary. Because of its important relationship and proximity to the federal district, this autonomy is probably less in the case of Buenos Aires than in some other Argentine provinces. There are three branches of government: an executive or governor elected by popular vote; a bicameral legislature; and a judiciary (with civil, commercial and criminal courts in several cities, a court o appeals and a supreme court in the provincial capital at La Plata). The province is divided into 110 districts and 8 electoral sections. Each of the municipalities which heads a district has an elected mayor and council. Public primary education with free compulsory schooling from age 6 to 14 is provided, but a considerable portion of this group does not attend school. Relatively few continue to secondary school, although national *colegios* exist in al the principal cities. In addition to the National University o Buenos Aires located in the federal district, there are national universities at La Plata and Bahía Blanca.

Economy.—Modern economic expansion of the province o Buenos Aires started near the end of the 19th century with the production of beef, wool and wheat for the European market The cattle, which had multiplied and roamed the pampa and had previously been utilized only for their hides and for salted meat, were fenced, bred and fed alfalfa. Even a dairy industry began to develop. Sheep raising, from a modest start at mid 19th century, became concerned with improvement of stock and wool. Gradually, however, the cereal products assumed more importance, and in 1903, for the first time, the value of agricultural exports (corn, wheat and linseed) exceeded the value o animal products. Although Buenos Aires ranks first in the republic for the number and quality of its livestock and utilize more than 50% of its land for grazing, an increasing area ha been given over to agriculture. Livestock raising is concentrated in the eastern coast below the federal district, extending inland 150 mi. and southward to Mar del Plata. A broad band runnin north and south through the province and growing wider in the southern coastal region is devoted to wheat. The maize area i situated in the northern part of the province, while around the federal district for a radius of 50 mi. are the intensive truck gardens which supply the urban population with its fresh fruit and vegetables. In the 1960s approximately 40% of the nation's area sown to cereals and linseed was located in the province o Buenos Aires.

Although the province has 1,000 mi. of coastal frontage on the Atlantic and the Río de la Plata and 300 mi. of river frontage on the Paraná in the north and the Río Negro in the south, there are few natural ports. San Nicolás and Zárate (on the Paraná) Bahía Blanca (chief Argentine naval port) and La Plata (provincial seaport) are the major exceptions. Both at the federa district of Buenos Aires and at Mar del Plata, extensive artificia ports have been constructed. The former handles the bulk o Argentine foreign trade and shares the important river trade with Zárate, Campana and La Plata. Eighteen miles southwest of the federal district is the large and modern Ezeiza airport, completed in 1950, which serves as the hub of domestic and foreign flights in Argentina.

Indeed the centre of Greater Buenos Aires is the veritable commercial hub of the nation. All the main railroad lines pass through the province and converge on this centre. Although meat packing is the major industry, the industrial expansion led to the building of flour mills, foundries, breweries, tanneries, refineries, distilleries and innumerable consumer goods factories in this urban zone. (Js. R. S.)

BUENOS AIRES, capital city of Argentina situated in the federal district on the west bank of the Río de la Plata estuary at an elevation of 65 ft. Pop. (1960) 2,966,816. The temperature is moderate; July is the coldest month with a mean of 49° F., while January is the warmest at 73.6° F. The mean annual temperature is 61° F. Average rainfall is 38 in., April being the wettest month. Humidity is high throughout the year and most objectionable in January and February.

The city is laid out in a rectangular pattern extending back from the river front. Deliberate widening of streets and occasional elimination of entire city blocks have created the beautiful thoroughfares of Avenida de Mayo, the central avenue running back from the river and extending under the name Avenida Rivadavia a distance of 1,180 blocks (each roughly 136½ yd. long) to the western limit of the federal district; the diagonal avenue Roque Sáenz Peña (Diagonal Norte) which fans out from the principal Plaza de Mayo; and the 425-ft. wide Avenida 9 de Julio which cuts across the previous two. The Avenida General Paz skirts the federal district on three sides for a distance of 18 mi. Well known though shorter are the ten blocks of narrow Calle Florida, lined with shops and turned over to pedestrians during daytime and evening hours when motor traffic is barred. The heart of old Buenos Aires and of the modern downtown city is small, limited to an area 18 city blocks square. Self-contained suburbs have developed within the federal district, and additional suburbs within Greater Buenos Aires (some at 15–20 mi. from the city centre) have built the urban population to a total of nearly 4,000,000 in the early 1960s.

Reminiscent of the Spanish heritage are the public buildings surrounding the Plaza de Mayo: the Casa Rosada (government palace), the Intendencia Municipal (executive branch of municipal government), the historic Cabildo (meeting place of the colonial town council), the Roman Catholic cathedral and the Banco de la Nación. Approximately 20 blocks west along the Avenida de Mayo is the seat of the Argentine congress. Few buildings reach skyscraper dimensions in the city, and the Kavanagh office building with 29 stories is one of the tallest. The architecturally magnificent Colón theatre attracts famous artists during the winter opera season of June, July and August.

A relatively large area of the federal district, three square miles, is devoted to parks which dot the city. The largest, 3 de Febrero, covers nearly 1,000 ac. on the riverbank north of the city centre. Other notable parks include Parque del Retiro, two botanical gardens, the zoological garden and the innumerable squares and plazas which offer trees and quiet walks even in the heart of the downtown area.

Approximately 350 public libraries, of which the National library is the largest, represent a selection of over 2,000,000 volumes, although few permit circulation of books for home reading. Outstanding among the museums are the Nacional de Bellas Artes and the Histórico Nacional. The numerous theatres, cinemas, stores, hotels and restaurants uphold the city's position as the "Paris of South America."

The citizens of Buenos Aires proudly identify themselves as *porteños* (people of the port). Although the basic racial stock, s in the rest of Argentina, is Spanish and Italian, a striking variaion is caused by large foreign elements located in the city, umbering more than 750,000 in the 1960s. Demonstrating the omogeneity of these groups is the fact that seven foreignanguage newspapers and seven hospitals are supported by their members. To the traditional groups of English, French, Italians, Spanish and Germans, significant numbers of Poles, Russians, Portuguese, Syrians and Turks were added in the period 1920 to 955.

History.—The city of Buenos Aires did not enjoy an auspiious beginning, and its national and world importance are phenomena which began in the late 19th century. Juan de Solís, chief avigator of Spain, entered the estuary of the Río de la Plata in 516 in hopes that he had found a route to the Indies and was killed on the shores by hostile Indians. A Spanish royal expedition under Pedro de Mendoza set up Nuestra Señora Santa María del Buen Aire settlement on the same shores in 1536. After enduring great hardship and Indian attack for five years, the settlers moved upriver and established themselves at Asunción on the Paraguay river. Not until 1580 did Juan de Garay, arriving from Asunción, plant a permanent Spanish settlement at Buenos Aires. By this date, wealth and glory had been found by the Spaniards in Mexico and Peru, and for two centuries Buenos Aires remained the neglected stepchild of the Spanish empire in America. The population at mid-17th century numbered approximately 1,000 inhabitants largely sheltered in mud huts. In 1776, in response to dangers of English and Portuguese expansion in the area and increased smuggling through the port, Buenos Aires was made the seat of a Spanish viceroyalty. The relaxation of trade restrictions at the end of the 18th century, however, only served to make more evident to the *porteños* the advantages of separation from the Spanish empire. Further self-reliance was developed when English invasions in 1806 and 1807 were repulsed without Spanish help. When the separation movement from Spain developed within the empire in 1810, the city and port of Buenos Aires stood to gain the most from independence and free trade.

PAUL ALMASY

PLAZA DE MAYO, BUENOS AIRES, SHOWING (RIGHT) THE CATHEDRAL, COMPLETED 19TH CENTURY

After an initial declaration of autonomy in 1810, the city led the attack on Spanish strongholds; at one point in 1816 it was the only centre of importance in the western hemisphere not reconquered by Spanish arms. Independent of Spain, the area found that its immediate problem was organization of some form of national government, and the 19th century was marked by the repeated efforts of the city of Buenos Aires to originate and control such a government. Moderate success was attained when a *porteño*, Bartolomé Mitre, became president of the republic in 1862. To complete his program, the city was federalized and made permanent capital of the republic in 1880. Stability and order brought economic growth and foreign immigration in increasing amount to the city and to Argentina in the closing decades of the 19th century. Internal military cliques caused the collapse of political democracy during World War II and instituted the rule of Juan D. Perón, which lasted from 1946 until 1955. Extreme industrialization which took place most noticeably during and after World War II contributed to the unprecedented growth of Buenos Aires and reinforced the financial, economic and political dominance which that city enjoyed over the rest of the country.

Government.—The presence of a local municipal government and a national federal government within the same city occasioned much difficulty in the 19th-century history of Buenos Aires and has necessitated a delicate division of responsibilities and duties. The municipal government is composed of two branches: the executive known as the *intendente municipal* (mayor), who is appointed by the national president subject to senate confirmation; and the *consejo deliberante* (city council), which is elected by popular vote. Since there is intimate contact between the city as a municipality and as a residence of the national authorities, the *intendente* is empowered to present to the national congress matters which affect the municipality and to the *consejo deliberante* matters which have originated with the federal government. The national government, meanwhile, is charged with the expenses and control of the police and fire departments, public health and overall supervision of public education. An example of divided duties is public sanitation; the national government controls port sanitation and the city water and sewer system, while the municipality supervises laboratories, bacteriological and disinfecting activities and relief services.

Education.—The public-school system in the city is under the supervision of the national council of education, although the municipality administers certain schools. Primary education is free and compulsory for children from 6 to 14 years of age. A number of public and private *colegios* provide intermediate schooling. The National University of Buenos Aires has ten faculties scattered throughout the city: law and social science, medicine, engineering, philosophy and letters, agriculture and veterinary, economics, dentistry, architecture and town planning, exact and natural sciences, and pharmacy and biochemistry. Except for a nominal registration fee, tuition is free, and many classes are held in the evening.

Transportation.—The urban and interurban transport system is well developed and adequate for even rush hour flow. Five independent subway systems provide rapid communication to outlying areas of the city, and buses and trolleys complete the excellent transport service. The city is a highway hub and the terminus of every major railroad in the country.

Port Facilities.—Just as the city serves as a communication centre with the rest of Argentina, so it is the country's primary link with the outside world. As one of the world's largest ports, it is significantly entirely man-made, vessels reaching it through a tortuous channel up the broad Río de la Plata estuary. Five distinct port units comprised of interlocking basins and docks stretch along the river front for a distance of five miles. Puerto Nuevo, completed in 1935 and including Dársena Norte, is reached from the main La Plata channel by a branch channel approximately six miles long (depth in both channels 31 ft.). This is the main passenger port as well as an important freight centre due to its adjacent location to the Retiro train yards where railroads for northern and central Argentina originate. Southward along the river front are located Puerto Madero, Dársena Sud, the outer-port or port for inflammables, and the Riachuelo. A separate channel (depth 27 ft.) connects these port units with the main La Plata channel. An enormous bulk of foreign trade enters Argentina via the port of Buenos Aires, averaging more than twice the tonnage of all other ports combined. By the 1960s, however, such ports as Rosario, La Plata and Bahía Blanca were rapidly increasing their share of export trade.

See ARGENTINA. (Js. R. S.)

BUERGER'S DISEASE (THROMBOANGIITIS OBLITERANS) is a chronic and uncommon malady characterized by inflammation of the arteries and veins of the arms and legs. It is rarely fatal since it seldom affects vital organs. The cause is unknown, but tobacco has been implicated because most patients with this disease are heavy smokers, and abstinence from tobacco usually leads to improvement. Of the persons affected, 99% are men.

The symptoms first appear between the ages of 20 and 45 years. The acute lesions of the veins are painful and subside spontaneously in a week or two but may recur. More serious is involvement of the arteries, because obstruction may occur which will interfere with the blood supply to the hands and feet. Symptoms include aching in the calves or arches when the patient walks, and coldness, blueness, and painful ulceration or gangrene of one or more fingers or toes. Amputations of toes or fingers are sometimes necessary. Major amputations of arms and legs are seldom necessary, especially if the victim stops smoking.

(R. W. GD.)

BUFFALO, a city and port of entry in New York, U.S., and the seat of Erie County, is at the eastern end of Lake Erie and the upper end of the Niagara River, about 400 mi. NW of New York City. High land (its altitude varies between 572 and 699 ft. above sea level), temperate climate, and the excellent drainage and water supply make Buffalo one of the most healthful cities. Pop. city (1960) 532,759, (1970) 462,768; standard metropolitan statistical area (Erie and Niagara counties) (1960) 1,306,957, (1970) 1,349,211. Metropolitan area communities include in Niagara County the cities of Niagara Falls (*q.v.*), North Tonawanda, and Lockport (*q.v.*), and in Erie County the cities of Lackawanna and Tonawanda (*qq.v.*), the towns of Amherst, Hamburg, Cheektowaga, Lancaster, Tonawanda, and West Seneca. (For comparative population figures *see* table in NEW YORK: *Population.*)

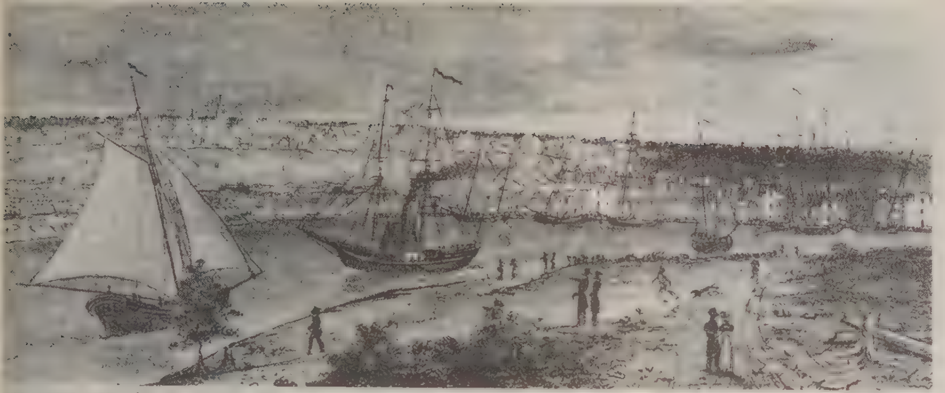
The population in the second half of the 20th century included large elements of Polish, German, Irish, Canadian, and Italian birth or descent.

History.—The first Europeans to visit the Buffalo area were French trappers and Jesuit missionaries. In 1679 René Robert Cavelier, sieur de la Salle, built his ship, the "Griffon," on the banks of the Niagara River. At the river's mouth he constructed Ft. Conti, which burned the same year. In 1687 the marquis de Denonville built Ft. Denonville, the predecessor of the fortifications later known as Ft. Niagara. The area was the scene of military operations up to the close of the Revolutionary War. The earliest known map with the name Buffalo on the present city site was made in 1764.

The origin of the name is still widely disputed. The site of Buffalo, originally part of the Phelps-Gorham purchase, became the property of the Holland Land Company in 1797. Joseph Ellicott, company agent and surveyor, known as the "father of Buffalo," laid out a town named New Amsterdam, by which name it was known on the company's books until 1810 but the name Buffalo proved more popular. In 1808 it became the seat of newly created Niagara County.

In the War of 1812 with Great Britain, Buffalo was the headquarters for most of the military operations on the Niagara frontier. Several vessels used in later naval operations were built at a Scajaquada Creek navy yard by Lt. Jesse D. Elliott of the U.S. navy. On Oct. 9, 1812, he captured two merchant vessels moored under the guns of Ft. Erie in Canada. On Nov. 30 Gen. Alexander Smyth made an unsuccessful attempt to cross the river and attack Ft. Erie. On July 13, 1813, the British crossed the river and fought a sharp skirmish within the present limits of Buffalo. On Dec. 30–31, 1813, and Jan. 1, 1814, British, Canadians, and Indians under Gen. Sir Phineas Riall burned the greater part of Buffalo, Black Rock and other frontier communities in retaliation for similar devastation by U.S. forces in Canada. The surrender of Ft. Erie to U.S. forces under Gen. Jacob Brown on July 3, 1814, was followed by the battles of Chippewa (July 5) and Lundy's Lane (July 25), with the U.S. forces retiring to Ft. Erie. The ensuing British siege of Ft. Erie was temporarily abandoned on Sept. 17. Another American advance to Chippewa was turned back in October. On Nov. 5, 1814, Maj. Gen. George Izard abandoned Ft. Erie and withdrew across the river to Buffalo.

Buffalo, rapidly rebuilt after the war, was incorporated as a village in 1816. The first steamboat on the upper Great Lakes and Lake Erie, "Walk-in-the-Water," was built in Buffalo in 1818. The village remained a seat when the state legislature created Erie County in 1821. With the completion of the Erie Canal in 1825 and the westward movement of population, Buffalo's importance greatly increased because of its strategic location at the transportation break of the east-west route. Expanding commerce led to manufacturing, beginning in the 1820s. Buffalo's first federal census (1820) showed a population of 2,095, which increased to 8,653 in 1830. In 1832 Buffalo was incorporated as



THE GRANGER COLLECTION

BUFFALO, NEW YORK: LITHOGRAPH AFTER GEORGE CATLIN, 1825

a city and Ebenezer Johnson was chosen the first mayor; population by that time had reached about 10,000. The rapid development of railroads in the 1850s appeared at first to threaten the economic life of the city, dependent upon water and turnpike transportation, but the American Civil War, by deranging lines of communication in the middle states, threw much commerce to the northern routes. Trade with the expanding west grew rapidly during and after the war and the railroads, attracted by existing markets and established trade routes, converged upon Buffalo. This in turn stimulated manufacture and Buffalo industry grew rapidly. At the end of the century the development of hydroelectric power from Niagara Falls furnished another impetus to expansion of industry.

In the 19th century Buffalo was the home of two U.S. presidents. Millard Fillmore, a Buffalo attorney, was elected vice-president in 1848 and became president upon the death of Pres. Zachary Taylor on July 9, 1850. Grover Cleveland, elected mayor of Buffalo in 1881, went on to become governor of the state the following year and president in 1884 and again in 1892.

In 1901 the city held its Pan-American Exposition, marred by the assassination of Pres. William McKinley. Other notable events included the opening on Aug. 7, 1927, of the Peace Bridge, an international vehicular bridge to Fort Erie, Ont., Can. and a memorial to a century of the U.S.-Canadian peace. In July 1932 the city celebrated its centennial with an exposition. The long-discussed St. Lawrence Seaway (*q.v.*) stimulated commercial activity in the city and in September 1957 Buffalo held a world port celebration to signal its position as the first major U.S. port of call on the seaway.

The first Buffalo newspaper, the *Gazette* (a weekly), was established in 1811 and became the *Commercial* in 1835. The first daily was the *Western Star* (1834), which later became the *Courier*. In the second half of the 20th century there were two dailies, the *News* and the *Courier-Express*.

Government.—From 1916 to 1928 Buffalo had a commission form of government, with the legislative and executive powers united in five commissioners, chosen at nonpartisan primaries and elections.

The 1928 charter restored a mayor-council plan of government. Elective offices are those of the mayor, comptroller, president of the council, five councilmen-at-large, and nine district councilmen. The mayor prepares the budget and executive powers are strongly concentrated in his hands, with the unicameral council holding a check through powers of taxation, appropriation, and confirmation. The mayor, council president, and councilmen-at-large may not succeed themselves after their four-year terms. District councilmen may be re-elected to a second two-year term.

Commerce, Industry, and Transportation.—Situated almost equidistant from New York City, Boston, Mass., Philadelphia, Pa., Baltimore, Md., and Chicago, Ill., at a natural junction point for lake, rail, and highway transportation, Buffalo is one of the leading commercial and industrial centres of the United States. Within a 500-mi. radius, firms could reach over 75,000,000 U.S. consumers and over 70% of Canada's population. Handling more than 20,000,000 tons of cargo annually, Buffalo ranked first in value of commerce handled by all inland ports of the United States. The outer harbour is protected by a breakwater 4½ mi. long enclosing an area of about 680 ac. Municipal piers supplement private dockage; the Niagara Frontier Port Authority handles the expansion of port facilities to meet the traffic increase from the St. Lawrence Seaway. The New York State Barge Canal provides transport to the seaboard for barges up to 2,000 tons capacity. Buffalo is also an important rail centre. A large municipal airport and the development of the state throughway and expressway systems made it an international trucking and airline hub as well.

The Buffalo area is a leading flour-milling centre and a major steel producer. Other important products include chemicals, electrical motors and apparatus, radios, television sets, clothing, automotive, airplane and helicopter parts, and meat products. The activities of research laboratories were nationally significant. A notable feature of the area is the high diversification of industry. Important agricultural interests include dairy products, poultry, vegetables and fruits, especially apples, peaches, and cherries.

Education and Cultural Activities.—The State University of New York at Buffalo, founded in 1846, comprises faculties of arts and sciences, business administration, dentistry, education, engineering, law, medicine, nursing, pharmacy, and social work. Canisius College (Jesuit), established in 1870 and chartered in 1883, offers curriculums in arts and sciences and business administration. D'Youville, Rosary Hill, and Mount St. Josephs Teachers College (Catholic colleges for women) offer liberal arts and teacher education programs. State University of New York College at Buffalo, founded in 1867, prepares teachers in divisions of art education, home economics, industrial arts, elementary and secondary education, and the education of exceptional children. The Erie County Technical Institute, affiliated with the state university, offers two-year associate degree programs in ten technical fields. Important libraries include the Grosvenor, a major reference library, and the Buffalo Public, both parts of the county library system, and the specialized libraries of the Historical Society, the 8th judicial district (law), and the Catholic institute.

Outstanding cultural assets are the Albright Art Gallery, the Historical Museum, the Museum of Science, the Buffalo Philharmonic Society, and the city's zoological gardens.

Parks and Recreation.—Major municipal facilities include Kleinhans Music Hall, Civic Stadium, Memorial Auditorium, a Lake Erie beach, and more than 75 parks and playground areas. More than 400,000 city-owned trees grace the parks and local streets. With excellent county and state parks nearby, the area offers unusual opportunities for recreational activities in any season.

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BUFFALO, a name applied to several different cud-chewing (ruminant) mammals of the ox family (Bovidae). The true or Indian buffalo (*Bubalus bubalis*), also known as the water buffalo, or arna, exists both as a wild and a domestic animal. It has been domesticated in Asia from very early times and was introduced into Italy about A.D. 600. There the name "bubalus" is said to have been transferred to it from a north African antelope, and then corrupted to "buffalo." As a truly wild animal the buffalo is found in Nepal, Assam, the old Central Provinces and perhaps some other parts of India, and in Burma. As a feral animal, wild but descended from domestic stock, it is more widespread and occurs in Ceylon, Indochina, Borneo and Malaya. It is also found as a domestic animal throughout the warmer parts of the old world from China to Egypt, and in Hungary, France and Italy. It is so widespread in domestication that the status of apparently wild animals is often difficult to assess.

W. SUSCHITZKY

AFRICAN OR CAPE BUFFALO (SYNCERUS CAFFER)

Buffaloes are large oxlike animals of massive and rather clumsy build with large horns which are triangular in cross section. The Indian buffalo, standing 5 ft. or more at the shoulder (over 6 ft. has been recorded), has a dull black body, often very sparsely covered with hair. The horns, which may be over 6 ft. long, spread outward and upward, approaching each other toward the tips; they meet more or less in one plane above the rounded forehead and elongated face. The horns of the cow are more slender than those of the bull. There are many domestic races in which the size, body build and shape and size of the horns differ.

Wild buffaloes live in herds in swampland and grass jungle, less often on open plains and rarely in forest; they graze morning and evening and spend most of the day lying down or wallowing in marshes. They are bold and even savage animals and will frequently charge an intruder. A herd of domestic buffaloes is sometimes used to stampede a wounded tiger out of cover. Domestic buffaloes are mainly kept as draft animals and for milk and butter. Cows give birth to one or two calves in the summer, ten months after mating.

The Cape or African buffalo (*Syncerus caffer*) is a black animal of similar massive build, standing up to 5 ft. at the shoulder and sparsely covered with hair. The heavy horns are distinctive, although those of some races of the Asiatic buffalo are somewhat similar in shape; typically they curve downward, then upward and inward and at their bases form large bosses that almost meet. African buffaloes, formerly found all over the continent from the Cape to the Sahara, have been greatly reduced in numbers by disease and hunting. They are animals of the open or scrub-covered plains and open forest. In the forests of western Africa the buffaloes are much smaller, reddish in colour and have shorter horns which are less wide-spreading and without bosses at their bases. The African buffalo is as bold as its Asiatic cousin and when wounded is regarded as one of the most dangerous animals to man. It has never been domesticated and is a gregarious grazing animal, as fond of wallowing in swamps as is the Asiatic species.

ROSS MADDEN FROM BLACK STAR

A TEAM OF INDIAN OR WATER BUFFALO (BUBALUS BUBALIS), BURMA

A dwarf relative of the Indian buffalo, the anoa (*q.v.*; *Anoa depressicornis*), is found in the Celebes; it stands a little over 3 ft. high and has short, almost straight, backwardly directed horns. A slightly larger race, the timarau, is found in the Philippine island of Mindoro. Although exceedingly wild it has been so depleted in numbers that it is now completely protected.

The American bison (*q.v.*) is generally, though zoologically inaccurately, known as the "buffalo" in its native land. *See* Bovidae; *see* also references under "Buffalo" in the Index.

(L. H. M.)

BUFFALO BERRY, called also rabbit berry and Nebraska currant (*Shepherdia argentea*), a hardy North American shrub of the oleaster (*q.v.*) family (Elaeagnaceae), allied to the seabuckthorn (*Hippophae rhamnoides*) of English coasts. The buffalo berry is native to stream banks in the Great Plains region from Manitoba, Saskatchewan and Alberta southward to Kansas, New Mexico and Nevada. It grows from 6 ft. to 20 ft. high, with whitish, somewhat thorny branches and small, oblong, silvery leaves, and in August or September bears a profusion of oval, scarlet-red or golden-yellow berries about the size of currants.

The fruit has a tart flavour and makes a good meat relish. The plant is not only an attractive shrub but, because of its spiny branches, is suitable also for hedges. Attempts have been made to cultivate it for its fruit, and some nurserymen catalogue it, but the sale of plants is limited. The bushes are productive, and great quantities of the berries could be gathered from the wild.

Propagation is effected by seeds and cuttings. Seeds should be stratified over winter and planted in nursery rows in spring. Two or three years are required to grow plants large enough for sale. Cuttings are made and handled like currant cuttings. Plants may be dug from native thickets, but they do not readily bear transplanting. Since the buffalo berry is dioecious, it is necessary to set out one male plant with each four to six female plants. Male plants may be distinguished by their dense clusters of plump buds, while the female plants have looser clusters of pointed buds.

The smaller thornless Canadian buffalo berry (*S. canadensis*), 4 ft. to 8 ft. high, with ovate leaves, silvery only on the undersurface, grows on wooded banks from Newfoundland to Alaska, and southward to New York and Oregon, extending in the Rocky mountains to New Mexico. Its rounded red or yellowish currantlike fruit is insipid.

BUFFALO BUR (*Solanum rostratum*), called also beaked nightshade and prickly potato, a North American annual of the nightshade family (Solanaceae), native to high plains east of the Rocky mountains from North Dakota to Mexico. The plant grows from 1 to 2½ ft. high and in aspect strongly resembles the potato, to which it is closely related, but is more slender, has bright yellow flowers and is armed throughout with needlelike prickles, especially on the burrlike covering inclosing the berry. The buffalo bur is the original host or food plant of the destructive Colorado potato beetle and has now become an aggressive weed through most of the eastern and northern states, and also in southern California. *See* Potato Bug.

BUFFET: *see* Cabinet Furniture.

BUFFIER, CLAUDE (1661–1737), French philosopher historian and educationalist, was described by Voltaire as "the only Jesuit who has given a reasonable system of philosophy." He was born in Poland of French parents, who returned to France and settled at Rouen. He taught in the college of the Jesuits in Paris, where he spent the rest of his life. He seems to have been an admirable teacher, with a great power of lucid exposition.

His object in the *Traité des vérités premières et de la source de nos jugements* (1717), his best-known work, is to discover the ultimate principle of knowledge. This he finds in the sense we have of our own existence and of what we feel within ourselves He thus takes substantially the same ground as Descartes, but he rejected the a priori (*q.v.*) method. In order to know what exists distinct from the self, "common sense" is necessary. Common sense he defined as "that disposition which nature has placed in all or most men, in order to enable them, when they have arrived at the age and use of reason, to form a common and uniform judgment with respect to objects different from the internal sentiment of their own perception, which judgment is not the consequence of any anterior judgment."

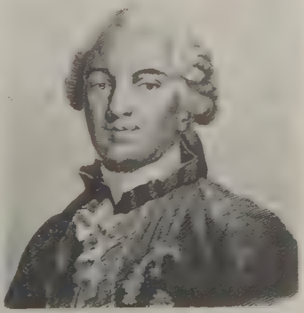
Buffier's aversion to scholastic refinements gave his writings an appearance of shallowness and want of metaphysical insight, and unquestionably he failed entirely even to indicate the nature of that universality and necessity which he ascribed to his "eternal verities"; he was, however, one of the earliest to recognize the psychological as distinguished from the metaphysical side of Descartes' principle, and to use it, with no inconsiderable skill, as the basis of an analysis of the human mind, similar to that enjoined by Locke. He anticipated the spirit and method as well as many of the results of Thomas Reid and the Scottish school.

He wrote also *Éléments de Métaphysique* (1724), a French grammar on a new plan, and a number of historical essays. Most of his works appeared in a collected form in 1732, and an English translation of the *Traité* was published in 1780.

BUFFLEHEAD, the common name for a North American duck (*Glaucionetta* or *Bucephala albeola*), or butterball, allied to the goldeneyes (*q.v.*). In colour the male bufflehead is blackish above, white below, with a white band extending around the back of the large head from eye to eye, and with the remainder of the head and the neck of a purplish-green sheen; the female is dark-gray above, whitish below, and has a white spot on either cheek. This small duck, about 15 in. long, is noted for its powers of quick diving. It feeds in part on small fish, which it pursues and captures beneath the surface. It breeds from central Alaska and western Ontario south to British Columbia, northern Montana and Manitoba, wintering southward. The bufflehead has been seen rarely as a visitor in England. (G. F. Ss.)

BUFFON, GEORGES LOUIS LECLERC, Comte de (1707–1788), French naturalist famous for his comprehensive work on natural history, the first modern attempt to embrace all scientific knowledge. He was born on Sept. 7, 1707, at Montbard (Côte-d'Or), where a large estate (including the "terre de Buffon") was acquired by his parents in 1717. Georges added the name Buffon to his original name of Leclerc at about the age of 25.

In 1726 he obtained a degree in law at the Jesuit college at Dijon, where his father was a councillor in the Burgundian parliament. Two years later he left for Angers. In 1730 Georges Buffon made the acquaintance of a young Englishman, Lord Kingston, and of his tutor, a botanist and entomologist. With Kingston, Buffon visited England, and while there was elected a fellow of the Royal society. He published a French translation of Stephen Hales's *Vegetable Statics* in 1735, and of Sir Isaac Newton's *Fluxions* in 1740. Having made researches on the properties of timbers and their improvement in his forests in Burgundy, he was appointed keeper of the Jardin du Roi, and of the museum which formed part of it, at the age of 35. He acquired this post, on the death of C. F. Du Fay, through the patronage of the minister of marines, J. F. P. de Maurepas, who realized the importance of science and was anxious to use Buffon's knowledge of timber for the shipbuilding projects of the French government. Maurepas also charged Buffon to undertake a catalogue of the king's museum which Buffon's ambition transformed into an account of the whole of nature. This became his famous *Histoire naturelle, générale et particulière.* He was elected to the Académie française (his inaugural address being the celebrated *Discours sur le style,* 1753) and was treasurer to the Académie des Sciences.



THE GRANGER COLLECTION

COMTE GEORGES BUFFON, ENGRAVING BY AMBROISE TARDIEU (1788–1841)

Buffon's *Histoire naturelle* was the first work to present the previously isolated and apparently disconnected facts of natural history in a generally intelligible form. It passed through several editions, and was translated into various languages. The first edition is highly prized by collectors because of the beauty of its plates; it was published in Paris (1749–1804) in 44 quarto volumes, the publication extending over more than 50 years. In the preparation of the first 15 volumes of this edition (1749–67) Buffon was assisted by Louis J. M. Daubenton, to whom he had entrusted the descriptive and anatomical portions of the treatise, and subsequently by P. Gueneau de Montbeillard, the abbé G. L. C. A. Bexon and C. N. S. Sonnini de Manoncourt. The following seven volumes, which form a supplement to the preceding, appeared in 1774–89, the famous *Époques de la nature* (1779) being contained in the fifth of them. They were succeeded by nine volumes on birds (1770–83), and these again by five volumes on minerals (1783–88). The remaining eight volumes, which complete this edition, appeared after Buffon's death, and comprise reptiles, fishes and cetaceans. They were executed by B. G. E. Lacépède, and were published in successive volumes between 1788 and 1804. A second edition, begun in 1774 and completed in 1804, in 36 volumes quarto, is in most respects similar to the first edition, except that the anatomical descriptions are suppressed and the supplement recast.

Buffon died in Paris on April 16, 1788. He left one son, Georges Louis Marie Leclerc Buffon, whom he envisaged as his successor and whom he sent with J. B. Lamarck on his botanical travels in Europe. But the youth proved a spendthrift and his imprudences finally led him to the guillotine at the age of 30, on July 10, 1793.

Bibliography.—The *Histoire naturelle* was translated into English by W. Smellie, *Natural History* (1781–1812), with *Life* of Buffon by W. Wood. *See* also R. Heim (ed.), *Les grands naturalistes français,* vol. 1 (1952).

BUG, the name of two rivers of Europe.

The Southern Bug (Yuzhny Bug) of the Ukrainian Soviet Socialist Republic, U.S.S.R., 532 mi. in length, rises near Khmelnitski (Proskurov) and flows generally southeast through Vinnitsa and Pervomaysk before entering the long winding Black sea estuary confluent with that of the Dnieper below Nikolayev. Its upper part is beset with rapids, utilized for hydroelectric power, and the lower has numerous sandbanks and rocky stretches which prevent navigation above 55 mi. upstream.

The Western Bug (Zapadny Bug) is a tributary of the Vistula (*q.v.*), 481 mi. long, and rises in the western Ukraine east of Lvov (Lemberg). It flows north through Hrubieszow whence, for about 125 mi. downstream, it forms the boundary between Poland and the Soviet Union. Near Brest it swings west to meet the Vistula 23 mi. below Warsaw, and in this navigable section is linked to the Polish capital by a short canal which avoids the difficult currents at the confluence of the Bug and Vistula. Its main tributaries are the Narew (Narev) and the Muchawiec (Mukhavets), which provide navigable routes via the Augustow and Muchawiec canals respectively to the rivers Neman and Dnieper. (Ed. Br.)

BUG, the common name for insects belonging to the suborder Heteroptera of the order Hemiptera, frequently referred to as "true bugs," but also used in North America for almost any kind of insect, often in a combined form: ladybug (ladybird beetle), June bug (June beetle), lightning bug (a beetle), mealy bug (a homopteran), doodlebug (a neuropteran larva). In fact, even a crustacean—not an insect at all—is termed sow bug or pill bug. In a restricted sense, especially in England, the term bug is applied to the bedbug, *Cimex lectularius* (*see* Bedbug).

Bedbugs and most other true bugs produce characteristic buggy odours that seem to offer them some protection from birds and other predators. They have a wide range of habits: some are aquatic, others terrestrial; the majority are plant feeders, but many are predators.

Within the suborder Heteroptera many families are known by common names that incorporate the word bug, examples being stinkbugs (Pentatomidae), lace bugs (Tingidae), giant water bugs (Belostomatidae) and many others. Common names for species likewise include bug, as in chinch bug (*Blissus leucopterus*), squash bug (*Anasa tristis*) and kissing bug (*Reduvius personatus*). *See* also HEMIPTERA: *Heteroptera;* INSECT. (R. I. SR.)

BUGA, KAZYS (1879–1924), Lithuanian linguist, whose studies of Slavonic loanwords in the Baltic languages and of Baltic river names in present Belorussia and central Russia were of great importance. He was born on Oct. 25, 1879, in Paziege near Dusetos, eastern Lithuania. From 1905 to 1913 he studied linguistics at the University of St. Petersburg and was a lecturer there in 1916. In 1917 Buga became associate professor in the University of Perm, Russia. He returned to Lithuania in 1920 and from 1922 was professor in the University of Kaunas. After Buga's premature death on Jan. 1, 1924, at Kaunas, his greatest work, the dictionary of the Lithuanian language, was continued by J. Balcikonis and others. Between 1908 and 1924 he published a number of articles in Lithuanian, Russian and German periodicals; his collected works, in two volumes, *Bugos Rastai*, I–II were published at Vilnius in 1958. Buga's deep and wide linguistic interests had a lasting influence on the next generations of Lithuanian, Baltic and Slavic linguists. (MA. G.)

BUGANDA: *see* UGANDA.

BUGEAUD DE LA PICONNERIE, THOMAS ROBERT, DUC D'ISLY (1784–1849), marshal of France who played an important part in the French conquest of Algeria, was born at Limoges on Oct. 15, 1784. In 1793, during the French Revolutionary period, his father, who belonged to the nobility of Périgord, was imprisoned; his mother, who was of Irish origin, died in 1796, so that the young Bugeaud was brought up by his sisters among the peasants of the Dordogne. Enlisting in the light-armed troops of the foot grenadiers of Napoleon's imperial guard, he was appointed sublieutenant in 1806. Under Marshal Suchet, he distinguished himself in the closing campaigns of the Peninsular War, rising to the rank of colonel. Having declared himself for the Bourbons at the first Restoration (1814), he was forced by his men to revolt during the Hundred Days (1815) and so was put on half pay at the second Restoration. A rich marriage having enabled him to repurchase his family lands, he took up farming and interested himself in the improvement of agricultural methods until the July revolution of 1830 allowed him to resume his military career. Elected deputy for Excideuil, he served Louis Philippe's regime as jailer of the duchesse de Berry at Blaye (1833) and helped to suppress the Paris riots of 1834.

Sent to Algeria for a short period in 1836, Bugeaud defeated Abd-el-Kader at Sikkah (July 6). At the same time he began to criticize the way in which the Algerian war had hitherto been conducted. At first in favour of a restricted French occupation, he made remarkable concessions to Abd-el-Kader in the treaty of Tafna when he was sent to negotiate with him in 1837. In 1841, however, he returned to Algeria with the rank of governor general and the task of conquering the whole country. Abandoning the strategy of fixed positions, he formed mobile columns of light troops with which he systematically devastated the lands of the natives.

This ruthless method won early success, and in 1843 he was made marshal of France. On Aug. 14, 1844, he crushed Abd-el-Kader's Moroccan allies at the battle of Isly, for which he received his ducal title. By inciting the prince de Joinville to bombard Mogador regardless of British objections, he showed himself ready to pursue his own policy without consulting the French government. After a short stay in France, however, he went back to Algeria to avenge the disaster of Sidi Brahim (Sept. 1845). Having returned to France in July 1846, he again went to Algeria in April 1847. Finally, however, embittered by the government's neglect of his plans for military colonization, he resigned his post in Sept. 1847.

On the outbreak of revolution in Paris in Feb. 1848, Bugeaud took command of the army for Louis Philippe but could not save the monarchy. Under the second republic he published numerous pamphlets against socialism and also accepted the command of the army of the Alps. He died of cholera on June 10, 1849.

Bugeaud remained true to his origins—proud of his noble birth, conservative, deeply attached to the land and concerned for the welfare of his soldiers as long as they observed the discipline to which he had once been subject. A self-taught man who hated intellectuals and was quick to solve particular problems arbitrarily, he wrote copiously in defense of his own views. He was ready to teach his soldiers how to handle the flail and the plow, and his efforts to protect the Algerian peasantry against the French civil administration, which he despised, give him some claim to be regarded as a colonial precursor of Galliéni and Lyautey. His collected military writings were published in 1883.

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BUGGE, (ELSEUS) SOPHUS (1833–1907), Norwegian philologist, the author of the first critical edition of the *Edda* (*q.v.*), was born at Laurvik, on Jan. 5, 1833. He was educated at Christiania, Copenhagen and Berlin and in 1866 became professor of comparative philology and Old Norse at Christiania university. He was a pioneer in the collection and study of Norwegian folk songs, traditions and runic inscriptions. Bugge's critical edition of the elder *Edda* (*Norroen fornkvaedi*) was published at Christiania in 1867. He maintained that the songs of the *Edda* and the earlier sagas were largely founded on Christian and Latin tradition imported into Scandinavian literature by way of England. His next most important work was the monumental edition (1891 *et seq.*) of ancient Norwegian inscriptions. His writings also include *Gamle norske folkeviser* (1858), a collection of Old Norse folk songs; and *Helgedigtene i den aeldre Edda* (1896; Eng. trans., *The Home of the Eddic Poems*, 1899). He died on July 8, 1907, at Oslo.

BUGIS, a Malayan people, who number about 2,500,000 are the largest and most advanced ethnic group of the Celebes Islands, Indonesia, and are often linked with the closely related Macassarese. The Bugis stronghold is in the southern portion of the Celebes but they are steadily expanding into adjacent territory as well as into Borneo. They were among the early Malayan converts to Buddhism who accepted many Indian customs. These include a graded society, ranging from the raja at the top down through district officers and princes to village heads. Along with such borrowings came an Indian form of writing in which a rich literature was recorded. Early in the 17th century the Bugis were converted to Islam. Today a priestly organization deals with matters pertaining to religion, marriage, and inheritance.

In former times even the houses indicated the rank of their owners by the number of gable ends and by carvings on the ridge poles. Today these structures serve as matrilocal family houses, often with as many as 20 inhabitants. There are no fixed rules concerning marriage although unions are usually between people of the same area and status. Child marriage occurs, bridewealth is paid, and polygyny is allowed.

Agriculture is important, as is the raising of cattle, horses, and water buffalo. Each village is practically self-supporting, but increasing demands for foreign goods and conveniences are leading part of the men to seek work for wages or to produce export crops. Village schools are well attended and at least one-fourth of the population is able to read and write. *See* also CELEBES.

See R. Kennedy, *Field Notes on Indonesia* (1953); W. Kaudern, *Ethnographical Studies in Celebes*, 5 vol. (1925–38); P. and F. Sarasin, *Reisen in Celebes*, 2 vol. (1905). (F.-C. CE.)

BUGLE, a wind instrument sounded by the vibration of the lips against a cup mouthpiece. As a modern military signaling instrument it dates from *c.* 1750, when Hanoverian jäger battalions adopted a large semicircular copper horn, with widely expanding bore, used by the *Flügelmeister*, an official of the hunt. English light infantry then did the same, the German *Flügelhorn* or *Horn* taking the name bugle horn, a term of medieval origin derived from Old French *bugle* ("bullock"). This early bugle was pitched in C or D, often lowered to B flat by a coiled crook; its semi-

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SINGLE-VALVED BUGLE

circular form may still be seen in many light infantry and rifle regiment badges, for which it was adopted in 1814, though from *c.* 1800 the bugle itself was once-looped in trumpet shape and was officially so made from 1812. The compact British design, twice-coiled with narrow bell, became official in 1858.

Bugle calls and marches employ the natural harmonics from the second to the sixth, written middle C, G, C, E, G, but sounding a note lower, the modern bugle being built in B flat. The calls are grouped as regimental calls, field calls and routine calls. Some of the most familiar, including the Reveille and the "Last Post," remain virtually unchanged since 1815 if not earlier. Others, especially among field calls, were originally played at a lower pitch, making greater use of the low C, though essentially the same in pattern and rhythm as the calls laid down from 1860 onward. The first official list of calls was issued in 1798.

The popularity of the bugle horn at the end of the 18th century is reflected both in the publication of many bugle marches with military band and also in the featuring of the instrument in light operas. Inevitably this led to an invention whereby its purely musical scope was enlarged. In 1810 in Dublin, Joseph Halliday, bandmaster of the Cavan militia, patented the key bugle, or Royal Kent bugle, with brass keys fitted to the once-coiled bugle of the period to give it a complete scale. Usually with six keys (five closed, one open-standing), this was most successful and became a leading solo instrument in military bands until replaced by the cornet (*q.v.*).

BY COURTESY OF THE CINCINNATI ART MUSEUM

SPANISH CAVALRY BUGLE, 19TH CENTURY

The key bugle also had some success in Germany (*Klappenhorn*) and in France, where it inspired the ophicleide (*q.v.*), its bass version. Valves, invented in Berlin *c.* 1815, were fitted to the ame once-coiled bugle on the continent during the 1820s, the new instrument in Germany keeping the old name *Flügelhorn*, and n France being called *bugle* (the French word for the field bugle being *clairon*). It became and still remains the principal treble brass instrument of continental military and brass bands, pitched n B flat, though sopranos and altos in E flat are sometimes used with it. In England, this valved bugle, with its German name Flugel Horn, has always been overshadowed by the cornet; a regularly constituted brass band includes one, but a military band none. It possesses the full tone of the bugle, softened by use of a deeper mouthpiece, and in the orchestra it has a part in Vaughan Williams' Eighth Symphony and Stravinsky's *Threni*.

Bugles have also been fitted with a single valve that lowers the pitch by a fourth as a simple method of providing a partly diatonic compass and dominant harmony.

See WIND INSTRUMENTS; TRUMPET.

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BUHAYRAH, AL (BEHEIRA), a governorate of lower Egypt in the northwestern corner of the Nile delta, is triangular in shape, bounded by the Mediterranean, the Western desert and the Rosetta branch of the Nile. Pop. (1966) 1,978,889; area 1,773 sq.mi. The governorate capital is Damanhur (*q.v.*) on the main railway from Cairo to Alexandria (38 mi. W.N.W.). Other chief towns are Idku and Rosetta. The northern part of the governorate contains the lakes Maryut and Idku, with their contiguous saline marshes, which reduce the over-all population density to 947 per square mile in spite of dense population in the south.

Al Buhayrah is one of Egypt's principal cotton-growing governorates, about 25%–30% of the cultivated land being under cotton each year. Production increases toward the south and includes some of the longest stapled varieties, but there is some yield from the reclaimed portion of the lagoon area. Agriculture is the principal occupation; besides cotton the main crops are maize (corn), rice, barley, wheat and clover, and some grapes are grown near Alexandria. Mineral resources are few: limestone from Al Maks, near Alexandria, supplies a cement works and provides building stone, while natron (a mixture of sodium carbonate and bicarbonate) is obtained from the lake-dotted depression of Al Barruqi, 12 mi. S.W. of Damanhur. There is rice milling, cotton ginning and textile manufacture, including modern rayon and cotton textile mills at Kafr ad Dawwar. The Nile control works at Idfina, 12 mi. above Rosetta, constructed in 1951, supply irrigation canals and, in the low-water season, prevent sea water from penetrating up the river.

A separate small administrative unit, At Tahrir (Liberation), was formed out of Al Buhayrah on the desert side in the late 1950s. (A. B. M.)

BUHTURI, AL- (WALID IBN 'UBAYD AL-BUHTURI) (820–897), Arabic poet and anthologist, spent many years as court poet to the Abbasid caliphs. Of the tribe of the Tayyi', he was born at Manbij (modern Membij, the ancient Hierapolis) in Syria northeast of Aleppo. Much of his poetry is devoted to praise of Aleppo, and much of his love poetry is addressed to an Aleppo girl, 'Alwa. After long residence at Baghdad under the patronage of successive caliphs, he returned to his birthplace to die. The *Hamasah* (an anthology of early poems) compiled by him was less popular than that of his predecessor Abu Tammam (*q.v.*); but two collections of his own poems were made in the 10th century.

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BUILDING INDUSTRY. Building gratifies an age-old instinct in man. It is one of the oldest forms of work, going back to prehistoric times when men left their caves and started building crude dwellings. Construction fulfills the second of the three basic needs: food, shelter, and clothing.

The building industry in the United States is the nation's largest industry and its operations, instead of being concentrated in a few centres like other big industries, extend everywhere in the country. The industry provides more employment for more workers, directly and indirectly, than any other single industry. It requires many different kinds of highly developed skills. Its wage rates are among the highest in the nation.

Construction became the largest U.S. industry in total dollar volume of work in 1951, when for the first time it surpassed agriculture in total value of production. It is estimated that, in the U.S., construction accounts, directly or indirectly, for about 15% of total nonfarm employment.

Relationship of Architect and Builder.—Variations in the structure of the industry in different parts of the world appear principally in the definition of the roles of architect and builder. In the past, the skilled craftsman who had sufficient ability became a master builder, and in this capacity he not only constructed buildings but designed them. In Europe the first distinction between builder and architect began to appear in the 15th century, but it was not until the 19th century that real division of the two functions occurred. The status of the architect as one of an organized professional group dates in the United States only from 1857. In Latin America and parts of Europe the architect is still, in effect, his own building contractor employing his own building labour. Other countries follow the practice of Great Britain and the United States, where the architect and contractor generally are entirely separate.

The Modern Building Industry.—The building industry in the United States is made up of the following professional and business interests:

1. The contractor, who is the manager of the building project, coordinating the work of assembling materials into a structure, and contributing his knowledge of costs and building methods through consultation with the architect and the owner.

2. The specialty subcontractor, who performs mechanical and other specialized parts of the work.

3. The labour force, which by the early 1970s numbered approximately 5,000,000 men directly involved in construction. New techniques were being developed to keep up with the ever increasing demand for building-trades craftsmen. Accelerated recruiting and training programs were constantly under way, and the search for new methods and equipment to increase productivity was always going on.

4. The manufacturer, who has helped revolutionize the industry by developing better products and better distribution methods.

5. The engineer, who has made possible modern structural developments by his ability to use existing materials in new and startling forms.

6. The architect, who with his artistic and technical knowledge has introduced new visual ideas, changing the future of building and providing an environment for modern living conditions.

The Building Owner.—Construction of buildings is the result of cooperation between the building owner or client, the architect and his professional consultants, and the contractor. Other parties also may assist in a project; for example, a financing agency may be called upon to provide the necessary funds, and governmental agencies may be consulted about building safety and health regulations, zoning restrictions, and other questions.

The second half of the 20th century saw the growing emergence of a new type of owner, the corporate client, the large business organization that erects buildings for its own use. Building owners of this type have brought about changes in building procedures because in some cases their own staffs of architects and construction personnel can design and build without resorting to outside labour. In other instances, where buildings such as apartments, offices, or shopping centres are constructed as a financial speculation, the so-called package plan may be used, the "builder" in this case being the financing agency, contractor, architect, and owner, each contributing to the project and sharing in its success or failure.

Planning.—In general, all projects are constructed following certain specific lines. The owner engages the services of an architect who, in consultation with the owner and other interested parties, prepares the program and basic specifications for the proposed project. During this stage the architect may consult a competent building consultant for aid in preparing budget estimates, schedules, and analyses of materials and systems. This is a normal and logical procedure because the consultant's knowledge of site problems, organization of the labour force, and practical limitations imposed by materials and working methods can help enable the architect's ideas to be executed to the satisfaction of the owner.

In most modern projects the architect employs professional consultants to prepare detailed plans and specifications for the structural and mechanical portions of the project. The complexities of modern structures and of air-conditioning and electrical systems, for example, require the advice of specialists. The architect has the overall responsibility for the design and coordination of the complete project to fulfill the owner's requirements.

Bidding and Contracts.—There are various procedures under which the contract for a building may be awarded. For example, bids may be taken from a selected group of building contractors whose qualifications are known to the architect. These may be lump-sum bids when complete plans and specifications are available. If it is not possible to wait for complete plans and specifications to be prepared, "cost-plus" bids can be submitted; in this case, the contractor is paid a set fee or sometimes a percentage in addition to the cost of the work. Many of the larger and specialized types of structures are built under the cost-plus-fee plan. Alternatively, a comprehensive schedule of rates for all items envisaged may be agreed upon in advance for less complicated forms of construction.

In Great Britain quantity surveyors are employed to prepare detailed bills of quantities of materials required in the project, and the building contractors bid or tender on these quantities. This practice is not followed in the United States.

When bids are received by the architect, the contractor submitting the lowest bid is generally awarded the contract, unless there are special reasons to the contrary. After the decision of the owner, in consultation with the architect, to accept the proposal of a certain contractor, the acceptance is followed by the execution of a formal contract between the owner and the contractor. The contract outlines the work to be done as shown by the architect's drawings and specifications; it shows the amount the contractor is to be paid and in what manner; and it indicates the date agreed upon for completion of the work. Standard contract forms in general use in the United States are those prepared by the American Institute of Architects and approved by the Associated General Contractors of America and organizations representing other segments of the industry. In Great Britain the relevant form of contract is that approved by the Royal Institute of British Architects.

Construction Management.—The modern building contractor is better organized for efficient production of the work than he was in the past. A new concept known as the "systems approach" is being used more and more, particularly in the planning of housing and schools where the demand for these types of projects brought about by the population increase cannot be met by conventional methods of the past. The "systems approach" uses the prefabrication of building components off-site in order to attempt to reduce the on-site employment by as much as two-thirds, the off-site employment in factories being less affected by weather and other site conditions. The enormous market that must be served in providing low-cost housing, particularly, can only be served by th concept of an industrialized systems approach.

Some building contractors have become what is known as brokers, that is, they take complete responsibility for a project but turn over all of the work to subcontractors. This method of operation has certain drawbacks, including the widening of the ga between management and labour in the construction industry, an the division of responsibility among the subcontractors.

See the *Britannica Book of the Year* for current development in the building industry. *See* also references under "Building Industry" in the Index. (C. B. S.; E. C. D.)

BUILTH WELLS, a market town and urban district o Breconshire, Wales, in the Brecon and Radnor parliamentary division, 64 mi. N. of Cardiff by road. Pop. (1961) 1,604. Th town is at the focus of the Irfon, Ithon and Wye valleys in a smal plain beneath high hills. Under the Normans the district know as Buellt became a lordship marcher (a border area under milita jurisdiction of an earl) annexed to Brecon, but it fell away o the marriage of the daughter of William de Braose (Breos). A the eastern end of the town is a fine motte and bailey castle whic may have been erected either by Philip de Braose (William grandfather) or Bernard de Newmarch; there are traces of a 13th century stone castle. In 1278 Edward I granted the town a char ter which later fell into disuse. As an advanced outpost of th invaders in the upper Wye valley, the castle suffered severely notably at the hands of Llewelyn ap Gruffydd, prince of Wales in 1260. In this neighbourhood Llewelyn fell in ambush in 128 and with him collapsed much of the Welsh resistance. The lord ship remained in the Marches until the Act of Union, 1536, whe it was grouped with others to form the shire of Brecknock o Brecon (*q.v.*).

With the development of better roads in post-medieval time Builth became an important gathering centre for shipment o cattle to England. Its fairs and marts for livestock are sti well attended. The old town was destroyed in 1691 by a fire and was rebuilt in the 18th century. It is an agricultural town and a summer resort with mineral springs, known as Park wells, and salmon and trout fishing. Builth has been an urban district since 1894.

In 1898 the urban district was made conterminous with the civil parish and renamed Builth Wells.

BUISSON, FERDINAND EDOUARD (1841–1932), French educator, reorganizer of the French primary school system, whose work for international understanding led to his receiving, jointly with Ludwig Quidde, the Nobel peace prize in 1927, was born in Paris on Dec. 20, 1841. From 1866 to 1870 he held the chair of philosophy at the Academy of Neuchâtel, Switz., and in 1867 took part in the first Geneva peace conference, where he advocated a united states of Europe. He was also an early advocate of the League of Nations.

After the fall of Paris in the war of 1870 he organized an asylum for war orphans. He became secretary of the statistical commission on primary education in 1870 and inspector general in 1890, during this period publishing his *Dictionnaire de pédagogie* (1882–93). In 1896 he became professor of education at the Sorbonne, Paris. From 1902 to 1914 he was a member of the chamber of deputies and from 1913 to 1926 was president of the Ligue des Droits de l'Homme.

Buisson died at Thieuloy Saint-Antoine (Oise) on Feb. 16, 1932. (S. J. C.)

BUKHARA (BOKHARA). (1) A khanate of central Asia which ceased to exist as such in 1920; (2) an *oblast* of the Uzbek Soviet Socialist Republic, U.S.S.R.; (3) a city, capital of the former khanate and now of the *oblast* of the same name.

1. The khanate of Bukhara was founded in the 16th century. The most important part of it originally belonged to Sogdiana (*q.v.*), which, after the conquest of Alexander the Great, formed part of the Seleucid Empire. For many centuries the country was inhabited by the Sakas, who, toward the end of the 2nd century A.D., were driven out of the Oxus (Amu Darya) country by the Yue-Chi, who, in their turn, were ejected by the Hephthalites, or White Huns, in A.D. 450. One hundred years later the Turks of central Asia defeated the king of the Hephthalites near Bukhara and became possessed of the rich lands between the Oxus and the Jaxartes (Syrdarya) rivers. The Hephthalites were engaged in a continual warfare with the Sassanian rulers of Persia, and when the Turkish khan drove them out of Bukhara he wrote to the Persian king that "the blood of their common enemy had reddened the waters of the Oxus." Down to the time of the invasion of Transoxiana by the Muslims at the end of the 7th century Bukhara had remained under the overlordship of the western Turks. The town of Bukhara fell in the year A.D. 676. It was not, however, until 30 years later that Transoxiana was finally subdued. The Arab historians gave to the country the name of Mavera-un-nahr or "what lies beyond the river" (*i.e.*, the Oxus). Down to the beginning of the 9th century Transoxiana was under the jurisdiction of the governor of the eastern provinces of the caliphate. Hitherto Arabs had been appointed to this governorship, but in 820 it was given to a Persian named Tahir in whose family the post became hereditary. These governors in their turn appointed subgovernors to various provinces, and several members of a Persian family known as the Samanids were employed in this capacity in Transoxiana. One of the Samanids, named Ismail, managed in 904 to make himself a semi-independent ruler with Bukhara as his capital and founded a dynasty which lasted down to the end of the 10th century. It was under the Samanids (*q.v.*), the first Persian dynasty to rule in Islam, that Bukhara became a centre of learning. On the fall of the Samanids the Turks again controlled Transoxiana, and it continued to be governed by various Turkic peoples until the Russian occupation. In 1220 Bukhara was sacked by Genghis (Jenghiz) Khan. It attained its greatest importance during the rule of the Shaybanids (1500–99). Persia conquered Bukhara in 1740. In 1753 the amir Mohammed Rahim freed himself from Persian vassalage but lost control of the provinces of Khorezm, Tashkent, and Fergana.

A. PETERSON—PUBLIX

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Toward the middle of the 19th century Bukhara became an object of rivalry to Russia and Great Britain and envoys were sent by both nations to cultivate the favour of its amir. Two of the British emissaries, Col. C. Stoddart and Capt. A. Conolly, were thrown into prison by the amir Nasrullah and there put to death in 1842. In 1866 the Russians invaded the territory of Bukhara proper and crushingly defeated the amir's forces. In 1868 the Russians entered Samarkand and a treaty was concluded whereby the amir of Bukhara became, to all intents and purposes, a vassal to the conquerors and undertook to protect Russian trade. In 1885 a Russian political agent was appointed to reside in Bukhara and later a Russian bank was established; thus, gradually, Bukhara became a part of Russian Turkistan. In 1892 the amir made a journey to the Russian court and left his two sons to be educated in Russia. In 1920 the amir was overthrown with Red Army help and fled to Afghanistan and the Bukharan People's Republic was set up. An anti-Soviet rising largely directed by Enver Pasha (*q.v.;* formerly minister of war in Turkey) and known as the Basmachi revolt began in 1921, but collapsed after Enver's death the following year. In 1924 Bukhara was declared a Socialist republic but in the same year its territory was divided up among the newly formed Uzbek, Tadzhik, and Turkmen Soviet Socialist Republics.

2. The *oblast* of Bukhara (area 55,290 sq.mi. [143,200 sq.km.]) includes the lower Zeravshan Valley and a large section of the Kyzylkum (*q.v.*) Desert. The chiefly agricultural economy—cotton cultivation, sericulture, fruit farming, and Karakul sheep farming in the desert—was transformed by the discovery of huge natural gas deposits in the late 1950s and of one of the biggest gold deposits in the Soviet Union at Muruntau in the desert in the mid-1960s. Gas is piped to the Urals and to central European Russia as well as to the other Central Asian republics, and Navoi, a new chemical centre, has been built at the site of the old town of Kermine. Apart from the capital the main towns are Kagan and Navoi. The population, 934,000 in 1970 (prelim.), consists mainly of Uzbeks.

3. The city of Bukhara is situated in the Zeravshan Valley on the Shahrud Canal. Pop. (1970 prelim.) 112,000. The railway

station (8 mi. [13 km.] away at Kagan) is on the Ashkhabad line. Bukhara is a town of great antiquity, the date of whose foundation is unknown. It was already an important commercial and cultural centre when it was conquered by the Arabs in the 8th century. After A.D. 999, when it was captured by the Karakhanid Turks, it lost some of its status to Samarkand. In the mid-12th century it was occupied by the Kara-Kitais. Laid waste by Genghis Khan, it was reestablished by Jagatai and at the end of the 14th century was part of Timur's realm. In the 17th century it became the seat of the Bukhara amirs and remained so until 1920.

The city, formerly called Staraya (Old) Bukhara, was to some extent modernized under the Soviet regime but it retains much of its medieval appearance and character: mosques, mausoleums, flat-roofed houses of sun-dried brick, and bazaars. Many of the mosques and all the Muslim schools have been closed and only one theological seminary is still active. Bukhara contains many outstanding examples of Muslim architecture. The oldest is the mausoleum of Ismail Samani (9th or 10th century). Other monuments are the Minaret Kalyan (12th century), a 152-ft. (46.3 m.) tower from which state criminals used to be thrown, the Mir-i-Arab madrasah (16th century), and the Abdul-Aziz madrasah (17th century). The main square of the city is called Registan. The population is mixed. Uzbeks predominate but most of them speak Tadzhik (Tajik), a form of Persian. There are also Arabs, Afghans, and a Jewish colony. Educational establishments include a pedagogic institute. Instruction in the schools is in Uzbek, Tadzhik, and Russian. Bukhara has a considerable amount of light industry, including Karakul processing, silk reeling, cotton ginning, and cloth manufacture. Its importance has grown with the discovery of natural gas nearby.

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BUKHARI, AL- (MUHAMMAD IBN ISMA'IL 'ABDALLAH AL-JU'FI, called AL-BUKHARI) (810–870), Arab author, is almost universally regarded by Sunni Muslims as the greatest of the Traditionists; *i.e.,* recorders of the sayings and acts of the prophet Mohammed. His compilation, entitled *Kitab al-Jami' al-Sahih* (French trans., *Les Traditions islamiques,* 1903), ranks second only to the Koran as the source of Muslim doctrine and law. Of Persian origin, al-Bukhari was born on July 21, 810, at Bukhara in central Asia. At 16 he began his travels throughout the Middle East recording the Prophetic Tradition. He died on Aug. 31, 870, at Khartank (a village in the Samarkand region), in exile there as a result of a fundamental theological controversy in which he held that the words of the Koran were the creation of an inspired prophet and not a transcript of eternal divine law.

Al-Bukhari's scrupulousness as a compiler is illustrated by his reported statement that he never entered a tradition except after taking a bath and offering special prayers and that his final selection was made by sifting 600,000 traditions, choosing only what was absolutely sound (*sahih*). His mastery of his subject is attested by the chroniclers, who record that, in order to try him, the Traditionists of Baghdad offered him a series of traditions in which the texts had been dislocated from the transmissional chain of authorities (*isnad*), and that he always detected the fault. His definite theological views are illustrated by his refusal to record traditions from those who did not believe that faith included good works and by his break with his teacher, Muhammad ibn Yahya, in the theological controversy which led to his exile.

Al-Bukhari's great work is divided into chapters according to legal topics. This involves much repetition as one tradition is sometimes quoted to prove several points of law. Each chapter heading is followed by a discourse or comment by al-Bukhari himself. Variations in the text, as he received it, are carefully recorded, but this did not prevent the arising of further variants from new and different recensions.

Al-Bukhari also wrote a *Ta'rikh* (modern ed. 1941), containing critical biographies of the authorities who formed the links in the chains of transmission of the Tradition.

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BUKHARIN, NIKOLAI IVANOVICH (1888–1938), Russian Communist leader and active Marxist propagandist, called by Lenin "the most valuable and greatest theoretician of the party," was born in Moscow on Oct. 9 (new style; Sept. 27, old style), 1888. At the age of 18 he joined the All-Russian Social Democratic Labour party (R.S.D.R.P.). In 1908 he was co-opted to the Moscow Bolshevik committee. He was imprisoned in 1911 and deported to Onega, but fled to Germany. He was in Cracow in Austrian Poland in 1912, where he met Lenin, in Vienna 1913–14, in Switzerland 1914–15 and later in Sweden, Norway and Denmark. In Oct. 1916 he arrived under the false identity of Dolgolevski in New York city, where he edited a Russian Communist newspaper, *Novy mir.*

After the outbreak of the Russian Revolution in 1917, Bukharin returned to Russia through Japan. The sixth congress of the R.S.D.R.P. elected him member of the central committee in Aug. 1917, and he was editor of *Pravda* from the end of that year. He opposed Lenin at the time of the Brest-Litovsk peace treaty, but later regretted this attitude. He was elected to the executive committee of the Communist International (Comintern) at its first congress in March 1919, and often visited western Europe. In 192 he published *The Economy of the Transitional Period,* a book in which he maintained that once the dictatorship of the proletariat had been firmly established the revolution would be completed, the class struggle exhausted and the propaganda of communism would proceed by natural evolution. Lenin himself criticized these views as being too "scholastic."

In 1924 Bukharin became a member of the Politburo, having been a candidate member since 1919. Although he disliked an distrusted Stalin, he supported him in his campaign against L. D Trotski, G. E. Zinoviev and L. B. Kamenev, believing it hi duty to uphold Lenin's policy of 1921; *i.e.,* that of maintainin a firm alliance between the peasants and the proletariat, an laying the foundations for industrial growth in a prosperou agriculture. When Stalin suddenly reversed this policy in 1928 Bukharin, with A. I. Rykov and M. P. Tomski, opposed hin Bukharin's argument that industrialization was possible on the basis of capital accumulated from the savings of the peasantr without forcible means is contained in an article entitled "Notes o an Economist," published in *Pravda* on Sept. 30, 1928, the onl reasoned case against Stalin's forcible policy ever to be publishe in the Soviet Union. Bukharin was stripped of his Comintern an party appointments and expelled from the Politburo in Nov. 192 Although he recanted his views, under pressure, he never occupie any influential post thereafter, though he played a leading part i drafting the constitution of 1936. Early in 1937 he was suddenl arrested, and in March 1938 he was put on trial with others as a alleged member of a counterrevolutionary organization, condemne to death and shot (March 14). The charge has since been admitted to have been false; the evidence adduced can be assumed t have been faked, and the partial confession made by Bukharin t have been extracted by force.

Bukharin's published works include: *World Economy and Imperialism* (1918); *Vom Sturze des Zarismus bis zum Sturze de Bourgeoisie* (1918); *Programme of the World Revolution* (1920) *The A.B.C. of Communism* (1921); *Historical Materialis* (1925); *The Way to Socialism and the Peasant-Worker Allianc* (1925); *Die ökonomische Theorie des Rentners* (1926); *Poetry Poetics and the Problem of Poets in the U.S.S.R.* (1935).

(L. B. Sc.)

BUKIDNON, a pagan people of north central Mindanao, i the Philippine Islands, are of special interest since they appear t approximate the pre-Spanish condition of the now Christianize

Bisayans (*q.v.*). Today their settlements, possessions and means of gaining a livelihood differ little from those of the poorer people of the coast. However, in two aspects—dress and religion—the Bukidnon remain unique. Women's jackets and voluminous skirts are made of strips of coloured cloth decorated with embroidery and appliqué designs. To such outfits are added earrings, ear plugs, necklaces, finger and toe rings and huge combs. The men's dress is equally colourful; their jackets, long trousers and carrying bags are covered with designs. Most adults blacken the teeth and, in addition, have the incisors cut off or inlaid with brass wire.

Religious beliefs are of great complexity. Each person has seven indwelling spirits, or *gimokod*. If all are present in the body all is well, but if one or more wanders trouble or death ensues. This has led to the art of soul snatching and soul catching. In addition to the *gimokod* there is a bewildering number of spirits for whom many elaborate ceremonies are held at critical periods in the life of the individual or of the group. To cope with them there has developed a trained group of men and women, known as *baylan*, who conduct ceremonies, make offerings and act as soul catchers. However, they are not mediums in the sense that is usual among Malayan peoples. Postwar conditions have led to rapid change in the conservative Bukidnon people.

See F.-C. Cole, *The Bukidnon of Mindanao* (1956); R. Lynch, "Changes in Bukidnon Between 1910–1950," *Anthropological Quarterly*, vol. 28, no. 3 (1955). (F.-C. Ce.)

BUKIDNON, a province of the Northern Mindanao region, Republic of the Philippines, is roughly coextensive with the Bukidnon Plateau, a volcanic tableland that is cut by deep canyons and ravines. The soils are moderately fertile, but erosion is a problem in some areas. Agricultural products include corn, upland rice, and pineapples; livestock grazing is probably better developed than in any other province. A 15,000-ac. pineapple plantation supplies a modern cannery at Bugo (Misamis Oriental Province) with enough fruit for year-round operation. Pop. (1970 est.) 283,000; area 3,202 sq.mi. (8,293 sq.km.). Malaybalay (pop. [1970 est.] 45,200) is the capital and principal town. (An. C.)

BUKITTINGGI, a hill town of western Sumatra, Indonesia, stands on the Agam plateau, a ridge of high land running parallel to the coast. Pop. (1957 est.) 52,824. Formerly capital of the district of Agam, under the redivision of Sumatra into six provinces in 1957 Bukittinggi became provincial capital of West Sumatra. It is in the Menangkabau country, one of the most beautiful parts of Indonesia, with mountains, lakes, valleys, rich green rice fields and villages among a profusion of palm trees. A characteristic sight of this region is the local house with saddle-shaped roof, the ends pointing upward like buffalo horns.

Bukittinggi is the most important commercial centre in the Menangkabau region. It is connected by road with all other Sumatran provincial capitals and by rail with Padang and Sawahunto. The town has a museum set in botanical gardens. Its ormer name, Fort de Kock, derived from the stronghold built by he Dutch in 1825.

BUKOVINA, a segment of the northeastern Carpathians vith the adjoining plain, the whole having an area of 3,396 sq.mi.; he peace treaty of 1947 divided it between Rumania and the J.S.S.R. Of the total area, 45% is covered with fir and beech orest and only 29% is arable. Timber processing is the main ndustry of the region. There are a number of mineral deposits, ncluding manganese and some oil. The mountain streams are a ource of power. The Dniester, the Prut and the Seret rivers all un southward.

History.—Both Ukrainians (Ruthenians) and Rumanians Moldavians) claim to be the first inhabitants of the country, ut in the 14th century it became an integral part of the principalty of Moldavia (*see* Rumania: *History*). Suceava, in the south f the territory, was the capital of that principality from 1388 to ie 1560s. Bukovina, however, had no separate history or name ntil 1775, when it was detached from Moldavia (then under urkish suzerainty) and annexed by Austria as a strategic link etween Transylvania and Galicia. From 1786 to 1849 Bukovina as administered as part of Galicia; then, as a duchy, it became separate Austrian crown land. In 1861 Chernovtsy (Czernowitz or Cernăuţi) was made the seat of a provincial diet. Under Austrian rule the country was developed, and Chernovtsy, which had been endowed with a university in 1875, became an important trading centre after the opening of the railway in 1886. The Austrians kept the balance between the various nationalities; the population was almost solidly Ukrainian in the north and Rumanian in the south, while there were a number of Germans and Poles and, in the towns, many Jews. When Rumania achieved independence in 1879, Bukovina became an object of irredentism. It was not only the cradle of the Moldavian principality but also the repository of the finest examples of Rumanian art and architecture—its unique painted monastic churches of the 15th and 16th centuries. On the collapse of Austria-Hungary in 1918, a local Ukrainian national committee voted the incorporation of the Ukrainian districts of northern Bukovina into the West Ukrainian Democratic Republic. Rumanian troops marched in soon after, and on Nov. 25 a congress of local Rumanians, Germans and Poles voted the union of the whole province with Rumania. The Rumanian government put through a land reform in 1921 and pursued a policy of Rumanization. In the census of 1930, in a total population of 853,009, the Rumanians stood to the Ukrainians in the ratio of 35 to 28 (as against one of 27 to 30 in 1910). On June 28, 1940, the U.S.S.R., occupied northern Bukovina (2,096 sq.mi.); the Germans of the whole province (more than 93,000) were then repatriated by agreement between Germany and the U.S.S.R. In the summer of 1941 Rumania, as Germany's ally against the U.S.S.R., regained the northern districts; but the Russians reoccupied them in 1944 and secured them for the U.S.S.R. under the peace treaty of 1947. The boundary between north and south took Chernovtsy into the Soviet part but left the ancient Moldavian capital Suceava and the most famous of the monasteries to Rumania. The population of the Rumanian portion was 300,751 in 1948. It later became a part of the region of Suceava in the Rumanian People's Republic. The Soviet portion is now part of the Ukrainian S.S.R. (B. Br.)

BULACAN, a province lying immediately north of Manila on the island of Luzon, Republic of the Philippines. Pop. (1970 est.) 780,000; area 1,032 sq.mi. Its western half lies on the central plain of Luzon and is drained by the Angat and Pampanga river systems which flow into Manila bay. The eastern portion consists of uplands that gradually increase in altitude toward the east, where they become the foothills of the Sierra Madre or Eastern Cordilleras. The Angat watershed and the Ipo dam and reservoir, which supply water to metropolitan Manila, lie in southeastern Bulacan. Climatically there are two distinct seasons, wet from May or June until December and relatively dry the rest of the year. Malolos, the capital (pop., 1970 est., 67,100), is on the plain and has an annual rainfall of 89 in. Ipo, at a higher elevation has 135 in. Typhoons occur, most often between June and September. Temperatures are high and humidity is especially high except during the dryer months.

Agriculture is the chief economic activity and paddy rice is easily the most important crop. Sugar is important around Calumpit. River fishing by means of locally made gear is a subsistence activity, but commercial fishponds on the tidal swamp lands at the head of Manila bay are of much greater significance. With 42,000 ac., Bulacan led all other provinces in fishpond acreage in the mid-1950s. Hagonoy is the largest fishing community. There are a few mineral deposits, principally a low-grade iron ore, now essentially exhausted, and limestone, in the eastern hill section. The province is divided into 24 municipalities, four of which (Malolos [*q.v.*], San Miguel, Hagonoy and Baliuag) had populations of more than 50,000 in 1969. The people are principally Tagalogs. (An. C.)

BULANDSHAHR, a town and district in Uttar Pradesh, India. The town, 42 mi. S.E. of Delhi on the Grand Trunk road, is located on the right bank of the Kali Nadi river on an elevated site, from which it derives its name Bulandshahr ("elevated town"). A district headquarters with population of 44,163 (1961 census), it has one college connected with the Agra university.

Bulandshahr District is situated on a level plain slightly sloping to the south and east, in the upper Doab of the Ganges and Jumna rivers which flow along its eastern and western boundaries respectively. Area 1,887 sq.mi.; pop. (1961) 1,737,397. The district is intensively cultivated and amply irrigated by tubewells and the two main branches of the Ganges canal. The Lower Ganges canal has its headquarters at Narora near Dibai. Wheat, barley, sugar cane, maize (corn), millets, pulses and some cotton are grown. The trade centre is Khurja (pop. [1961] 41,491).

Mahmud of Ghazni received the submission of the Hindu Raja in A.D. 1018. After being much fought over during the 14th century, the district enjoyed a period of peace under the Moguls. Further periods of unrest followed, and in 1805 it passed into the hands of the British, as part of the district of Aligarh (*q.v.*). (S. S. Bh.)

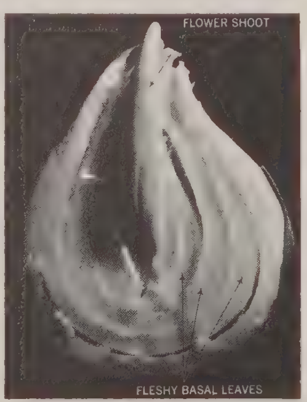
BULAWAYO, the second largest city in Rhodesia and the chief town of the Matabeleland Province, is near the western border at 4,450 ft. (1,360 m.) above sea level in undulating savanna country. It has average daily temperatures from June to October of from 56° to 72° F (13° to 22° C) rising to near 100° (38°) in November and December. Rainfall averages 23 in. (584 mm.). The 1962 census showed 173,441 for the city proper, 210,623 for the metropolitan area; (1962: 176,646 Africans; 1961: 50,140 Europeans, 5,630 Asians and Coloureds).

The locality of Bulawayo was originally the capital of Lobengula, last king of the Amandebele, or Matabele, tribe. Occupied in 1893, the settlement was later moved to what is now the city centre three miles away. It was declared a town on June 1, 1894, by Leander Starr Jameson (*q.v.*); a municipality on Oct. 27, 1897; and became a city on Nov. 4, 1943. Government House, built by Cecil John Rhodes (*q.v.*), now occupies the original site.

Bulawayo is Rhodesia's industrial centre, with major products including vehicle tires, building materials, radios, textiles, clothing, travel goods, sugar, flour, beer, and dairy products. As the headquarters of Rhodesia Railways, the city acts as a main distributing centre for exports and imports of goods to or from the Republic of South Africa, Zambia, and Mozambique.

Principal buildings in the city include local government buildings, a magistrate's court, the National Museum, and hospitals. Rhodesia's Teachers' Training College is in the city and the building of an interdenominational teachers' college costing £1,250,000 was begun in 1969. The city has a technical college, a municipal orchestra, a large public library, and the National Free Library of Rhodesia. A statue of Rhodes is in the city centre and his burial place in the Matopos Hills is 28 mi. S of the city in a national park which has a game reserve. Khami Ruins, 12 mi. W, are relics of ancient cultures. (Ed. S. W.)

BULB, a compound plant organ consisting of a compressed or telescoped stem to which is attached a series of closely overlying leaves, the whole representing a kind of subterranean bud. Anyone who has examined an onion is familiar with a bulb. A bulb's leaves—actually expanded leaf bases—are fleshy, being filled with stored food materials enabling a plant to lie dormant and thus to survive an unfavourable period when active growth is impossible because of lack of necessary water. This period may be a cold winter season, when soil water is frozen and hence unavailable, or one of the periodic droughts characteristic of semiarid regions.



J. HORACE MCFARLAND CO.

LONGITUDINAL SECTION OF TULIP BULB SHOWING THICK BASAL LEAVES AND SHOOT, FROM WHICH FLOWERS AND LEAVES WILL DEVELOP

Botanists recognize two main types of bulbs. One, the tunicated bulb typified by the onion, has a thin papery covering protecting the fleshy leaves. The other, the scaly bulb, to be seen in the true lilies, has naked storage leaves, unprotected by any papery tunic, making the bulb appear to consist of a series of angular scales. Bulbs vary in size from insignificant pea-sized structures to those of the large Crinum lilies whose individual weight may be upward of 15 lb. Because of their bulbs many common garden ornamentals like the narcissus, tulip and hyacinth can produce their flowers rapidly, almost precociously, in early spring when growing conditions are favourable. Other bulbous plants, for example the lilies, are summer-flowering while a few, like meadow saffron, bloom in the fall.

Bulb-producing species are especially abundant in the lily and amaryllis families which are particularly well represented in countries with pronounced dry seasons such as South Africa. Bulbous species are also common among early spring-flowering plants of the north temperate zone. A few bulbous species are of economic importance to man. The onion as well as its relatives the shallot, garlic and leek have served as useful vegetables since the dawn of history. Bulbs often contain poisonous principles. One such is the red squill (*Urginea*) whose bulbs are the source of an important and highly effective rat poison.

In horticulture the term bulb is applied incorrectly to a number of botanical structures with a similar food-storing function. Among such so-called "bulbs" are the solid corms (technically thickened leafless bases of plant stems) of the crocus and gladiolus and the elongated rhizomes (fleshy underground stems) of iris.

Most hardy ornamental bulbs are planted in the garden in the fall, at the end of the growing season. Depth of planting varies with the species, but is in general proportional to the average diameter of the bulb, with small bulbs usually planted a little shallower than larger ones. *See* also STEM. (Wr. H. H.)

BULBUL, a group of starling-sized passerine birds comprising the family Pycnonotidae of Africa, Madagascar, southern Asia and the Philippines. The 109 species are variously gray, brown and olive-green (sexes similar), sometimes boldly streaked, and often with bright contrasting colours, especially on the head or under tail coverts. Several forms are crested. All are essentially arboreal and subsist on insects and fruit. Their abundance, gregarious habits, and varied calls, both harsh and musical, render the bulbuls conspicuous wherever found. The bulbul of Perso-Arabic poetry probably is *Luscinia hafizi,* a nightingale (*q.v.*). (E. R. Be.)

BULDANA (BULDHANA), a town and district in Maharashtra state, India. The town is on the northern edge of the Deccan plateau, 247 mi. N.E. of Bombay and on the main north-south road crossing the Bombay Deccan uplands. Pop. (1961) 15,985. It has an arts college which is affiliated to Nagpur university.

BULDANA DISTRICT (pop. [1961], 1,059,698; area 3,751 sq.mi.) is enclosed west and south by the Ajanta hills; traversed southeastward by the Penganga river, which rises in their northern spur west of Buldana town; and bordered on the north by the Purna, a tributary of the Tapti. The Purna alluvium gives the northern plain a highly fertile black cotton soil. Khamgaon (44,432), 20 mi. N.E. of Buldana, and Malkapur (29,687), 30 mi. farther N.W., are both important cotton markets on the Central railway. Khamgaon has a college of Nagpur university and Malkapur is also a centre of the grain trade. The district has many Hemadpanthi temples, named after Hemadri, minister to the 13th-century Hindu Yadava kings. (D. G. Na.)

BULFINCH, CHARLES (1763–1844), first professional U.S. architect, was born in Boston, Mass., on Aug. 8, 1763. His father, Thomas Bulfinch, a wealthy physician, sent him to the Boston Latin school and Harvard (1778–81). In 1785 he went to Europe. In Paris he met Thomas Jefferson who advised him to see more architectural monuments in Italy and France. He returned, via London, to Boston in 1787. There he married his cousin Hannah Apthorp in 1788. Once established at home, he was sought as architect for many important projects. Among these were the state house, Boston (designed 1787–88, built 1795–98, surviving, though obscured by later additions), the Connecticut state house, Hartford (1796), the three Harrison Gray Otis houses, Boston (1796, 1800, 1805), the Federal Street church (1809, his only Gothic building), University hall, Harvard (1813–15) and the state capitol, Augusta, Maine (1830). While achieving architectural fame he was also chairman of the board of selectmen of Boston (1797–1818) and instrumental in improving the street system. In 1787 he helped promote Robert Gray's (1755–1806) voyage in the "Columbia," the first U.S. ship to sail around the world. When B. H. Latrobe (1764–1820) resigned as architect of the national capitol, Bulfinch succeeded him, used Latrobe's designs to finish the wings, and made a new design for the central rotunda with a high semicircular dome. His architectural ideas were mainly derived from the English Georgian style (*q.v.*). His works are characterized by refined proportions and the use of classical orders. Bulfinch died at Boston on April 4, 1844.

A son, Stephen Greenleaf Bulfinch (1809–70), was a Unitarian clergyman and poet; another son, Thomas Bulfinch (1796–1867), wrote *Bulfinch's Mythology*.

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BULGAKOV, SERGEI NIKOLAEVICH (1871–1944), Russian theologian, developer of the theological system called sophiology and a leader of Orthodox participation in the ecumenical movement, was born in Livny, on June 16, 1871, of a priestly family. He began his clerical training at the seminary of Orel, but under the influence of Marxism broke with the church and became a student of political economics. After extensive studies in Moscow, Berlin, Paris and London, he taught at the universities of Kiev (1901–06) and Moscow (1906–18). During this period he published *Capitalism and Agriculture* (1901) and *Philosophy and Economics* (1912).

An active participant in the intellectual, spiritual and artistic revival that characterized the life of the Russian intelligentsia at the turn of the century, Bulgakov became disillusioned with Marxist philosophy and, with a group of former Marxists, N. Berdyaev, S. Frank and P. Struve, returned to the Orthodox Church. The story of his conversion is told in his book *The Undying Light* (1917). In 1918 he was ordained priest, but the Communist government prevented him from resuming his teaching, and in 1923 expelled him from the Soviet Union. After two years of academic work in Prague, he was appointed professor of theology and dean of the newly founded Russian Orthodox Theological Institute of Paris, where he died on July 12, 1944.

Bulgakov spent the last 20 years of his life elaborating a system of theology known as sophiology, a doctrine centred on the concept of *Sophia* (Gr. "Wisdom"). Taken from the Old Testament (Wisdom of Solomon, Proverbs), this concept was used by medieval mystics and, especially, modern Russian philosophers—V. S. Soloviev and Paul Florensky, in addition to Bulgakov—in an elaboration of cosmology as living and organic unity revealing the Divine Wisdom. In the teaching of Bulgakov, *Sophia* is the link connecting God and the created world. His theories met with strong opposition among certain Orthodox hierarchs and theologians, and were condemned in 1935 by synods of Russian bishops in Yugoslavia and Moscow. Supported, however, by his own bishop and by his colleagues on the faculty of the institute, he was able to teach and write freely. A prolific writer, Bulgakov published more than ten books (*The Unburning Bush*, 1927; *The Ladder of Jacob*, 1929; *The Lamb of God*, 1933; *The Comforter*, 1936; etc.) and innumerable articles. He had great influence as priest and teacher.

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BULGANIN, NIKOLAI ALEKSANDROVICH (1895–), Russian Communist leader who was premier of the U.S.S.R. rom 1955 to 1958, was born on June 11, 1895, of middle-class parnts in Nizhni Novgorod (now Gorki). He joined the Communist Party just before the Bolshevik Revolution and from 1918 to 922 was an official of the Cheka, the first secret police organization, in his native region. For the next nine years he held administrative posts in industry. In 1931 he was made chairman of the Moscow Soviet. Favoured by Stalin and a candidate member of the Central Committee of the Communist Party from 1934, e was premier of the Russian S.F.S.R. in 1937 and a deputy premier of the U.S.S.R. and chairman of the State Bank from 1938 to 1941. In 1939 he became a full member of the Central Committee.

During World War II, Bulganin served on the military councils of several fronts and in 1944 became a member of Stalin's war cabinet and deputy commissar for defense. A candidate member of the Central Committee's Politburo from March 1946, he was made a full member in February 1948. From March 1947 he was a deputy premier of the U.S.S.R. again and also, till March 1949, minister for the armed forces. He was promoted marshal in November 1947.

Still a member of the Central Committee's Presidium (the former Politburo), Bulganin was appointed a deputy premier and minister of defense in G. M. Malenkov's government after Stalin's death (March 1953). On Feb. 8, 1955, he succeeded Malenkov as premier. He and N. S. Khrushchev, first secretary of the Communist Party, for a time professed complete unanimity. Together they met the Western statesmen at Geneva in July, received the West German chancellor, Konrad Adenauer, in Moscow in September, and visited India, Burma, and Afghanistan late in 1955 and Great Britain in April 1956. When Khrushchev overthrew the "antiparty group" (Malenkov, V. M. Molotov, and L. M. Kaganovich) in June 1957, Bulganin's position was not challenged; but on March 27, 1958, Khrushchev took the premiership from him, and Bulganin's influence thereafter declined rapidly. In September he was dropped from the Presidium of the Central Committee. In December 1958 he told the Central Committee that he had to some extent collaborated with the "antiparty group" in 1957. He was not reelected to the Central Committee at the party's 22nd congress (1961), and after the fall of Khrushchev (1964) he was left in obscure retirement. (D. FD.; X.)

BULGARIA (PEOPLE'S REPUBLIC OF BULGARIA; NARODNA REPUBLIKA BULGARIYA) lies in the eastern part of the Balkan peninsula. The southern and western frontiers run through hilly country, separating Bulgaria from European Turkey and Greece on the south and from Yugoslavia on the west. With Rumania, to the north, the frontier is mainly the line of the Danube river, while there is an eastern frontage on the Black sea. Area 42,823 sq.mi. Pop. (1965) 8,226,564. The capital is at Sofia (*q.v.*).

This article contains the following sections and subsections:

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  2. Climate
  3. Vegetation and Animal Life
II. History
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  2. Early Dynasties
  3. First Empire
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III. The People
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IV. Administration and Social Conditions
  1. Constitution
  2. Living Conditions
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  3. Trade and Finance
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I. PHYSICAL GEOGRAPHY

1. Physiography.—The transverse Balkan mountains (Stara Planina) divide the main agricultural area of Bulgaria into two parts: the northern platform sloping gently down to the Danube (*q.v.*) and the basins and valleys of the Upper Maritsa system lying to the south. The latter are separated physically from the open waters of the Aegean sea by the Rhodope (Rodopi) mountains, while the Maritsa lowland is separated from the Burgas coastal lowland by low rounded hills.

The Balkan chain, because of the presence of passes and the slope of the northern tableland, is not, as might be supposed, a serious barrier between the two agricultural areas. Two great highways may be said to converge in the land which has become Bulgaria. One is the route which comes from central Asia by way of the steppes and grasslands of southern Russia and can be continued to the south over the Balkan passes. The other is that which links Asia Minor to Europe by the straits and can be continued along the Maritsa valley and so to the Morava and the Danube at Belgrade. The two unite in southern Bulgaria.

Balkan Mountains.—These extend from the valley of the Timok, near the frontier with Yugoslavia, as an extension of the Alpine-Carpathian folds for a distance of about 375 mi. (600 km.), first in a southeasterly and then in an easterly direction to the Black sea, where they break off abruptly. They are composed largely of granites and slates interspersed with broad bands of limestone, and though in the central part they rise to a height of 7,793 ft. (2,376 m.), their summits are rounded, giving the appearance of an upland rather than a mountain chain. The Zlatishki pass to the west and the Iron Gate pass (north of Sliven) to the east divide them into three sections, of which the central is the highest and narrowest, being about 18 mi. (29 km.) wide. The western section has a maximum height of about 7,000 ft. (2,100 m.) while the eastern is lower and is divided into two or three separate ridges. South of the Balkans and running parallel to them stretches the range of Sredna Gora. The Topolnitsa and Stryama valleys divide this range into three parts, the eastern of which is sometimes known as the Sirnena Gora. This range is separated from the Balkans proper by the discontinuous sub-Balkan depression, made up of several east-west valleys. Its western part is drained by the upper reaches of the Topolnitsa and Tundzha, tributaries of the Maritsa.

Though as a whole scantily peopled, the Balkan region contains a number of valley widenings or basins suitable for settlement, of which those of Troyan, Dryanovo, Kotel and Gabrovo may be mentioned. Despite high elevation and the absence of large tracts of fertile soil, the Balkan mountains have a wide range of products and possible occupations—woodworking and wool-textile industry in addition to agriculture. National feeling has always persisted in this region and certain of the mountain towns and villages served as focuses for the early Bulgarian nationalist movement.

Danubian Platform.—Often called the Balkan foreland, this is an area between the low northern scarp of the folded Balkans and the Danube. It is a tableland floored by horizontally disposed rocks, mainly Cretaceous and Tertiary limestones often concealed by a mantle of loess. The Danube, which forms the northern frontier to a point near Silistra, has a high bank on the Bulgarian side, formed by loess reaching a thickness of 200 ft. (61 m.). To the east of the platform the horizontal stratified rocks are strongly eroded in places, leaving flat upstanding plateaus with scarped edges, especially between Kolarovgrad, Provadiya and Varna. In the west the Iskŭr, the second largest river in Bulgaria, cuts through the whole Balkan chain, thus bringing the high basin of Sofia (*c.* 1,800 ft. [550 m.]) into communication with the Danubian tableland. Both west and east of the Iskŭr smaller streams, rising in the Balkans, flow direct to the Danube. All carry a comparatively small amount of water and some almost dry up in summer, but because of the soft loess, deposits all have cut out deep valleys. At the eastern end of the platform the Provadiya and Kamchiya find their way direct to the Black sea, not by way of the Danube.

The wide plateau levels are dry because of the limestones which underlie the porous loess; exposed to cold winds in winter and to desiccating blasts in summer, they are practically devoid of wood; and, though very productive, not attractive to settlement. The deep river valleys have a better climate due to shelter from winds; spring water is available and a greater variety of crops can be produced. They serve, therefore, as natural sites for towns, though necessitating long daily journeys to the fields above.

The northern part of the platform underwent great changes after the congress of Berlin in 1878. Before that date it was the seat of great feudal domains, the Turkish *çiflik.* Afterward it was divided up into small holdings that were worked by peasants whose industry, frugality and high level of agricultural skill were remarkable.

Valleys and Basins of the Maritsa System.—These comprise a region of young depressions, formed by down-faulting during Alpine earth movements. The Maritsa river rises in the Rila and after leaving the mountains enters the Thracian plain (Trakiyska Nizina), the largest of the areas of depression which are characteristic of the Balkan peninsula. It lies between the Sredna Gora to the north and the Rhodope mountains to the south and thus the river has two sets of tributaries. The left bank tributaries are steep in their upper reaches and, flowing over open slopes, show great fluctuations in volume: in flood they carry large amounts of silt. Tributaries coming from the wooded Rhodope have a fairly even flow. Where the Sredna Gora sinks down eastward to the plain, the Tundzha swings round at a sharp angle, running southward to join the Maritsa at Edirne (Adrianople). The western valleys are thus higher, smaller and more cut off by gorges than the eastern ones. The largest valley is that of the Kazanlŭk in the Tundzha section, always celebrated for it beauty and fertility.

In the western part, sunny and sheltered by the hills to the north, is an area favourable to agriculture. Farther east the climate becomes drier and the country more steppelike, while to the southeast are the wooded slopes of the Strandzha hills.

Rhodope and Rila Massifs.—These form the central core of the Balkan peninsula and are composed of granite and gneiss, chiefly of Archean age though overlain by later deposits. They are formidable mountains; the peaks are bare and rocky with old glacial cirques and moraines and the valleys are deeply cut and steep. From the western Balkan mountains there extends a region of broken country, called Kraishte, along which runs the frontier between Bulgaria and Yugoslavia. The southern part of this passes into the Osogove mountains (Osogovska Planina) and has a certain individuality of its own, due both to its height and to the fact that the Struma river makes a definite line of separation between it and the still higher mountains of Rila and Pirin to the east. The Struma, which has a general north-to-south direction, rises in the Vitoshas, southwest of Sofia, a mountain mass rising to heights of more than 7,500 ft. (2,290 m.). To the east of the valley line is a long belt of mountain country extending from the Vitosha to the Rilas (a beautifully wooded group with glaciated summits reaching a maximum height of nearly 9,600 ft. [2,900 m.] and continuing to the Pirin to the south and into the Rhodope in the southeast. The Iskŭr river, which passes through the basin of Sofia, rises in the Rilas and turns south to the source of the Struma their headwaters overlapping. The Vitoshas form an obstacle to routes from Sofia into the Struma valley but can be turned both to the northwest and the southeast. Woods there are abundant with beech and oak below and pine and fir above. There are extensive summer pastures at the higher levels. Though the more elevated areas are unfit for permanent habitation, the margins and secluded valleys offer opportunities for settlement. This area served as a refuge for fugitives and thus as a centre for the growth of a spirit of revolt.

2. Climate.—Although Bulgaria is near the Mediterranean its climate is more continental in type, particularly in the north, and may be termed temperate continental as a whole. The Danubian tableland is continental in type, with cold winter winds from the Eurasian high-pressure system causing frequent prolonged fros (only 180–215 days are frost-free on the average) which damages the orchards and vineyards; the summer average temperature varies between 21° and 27° C. (70°–80° F.).

The Balkan mountains form the limit of Mediterranean influence, but a true Mediterranean summer drought is found only in the Struma and Mesta valleys of the southwest and the south-fac ing slopes of the Rhodopes. The mountain ranges, which have a high rainfall (*e.g.*, up to 75 in. [1,905 mm.] average annual rainfal in the Rila mountains) and lower temperatures in both summer and winter, generally protect the inland basins and valleys from strong winds. Summers are hot and the winters mild. The Thracian plain in central Bulgaria has a climate that is transitional between Mediterranean and continental (with such extremes as 45° C. [113° F.] recorded near Plovdiv); there are 198–206 days frost-free. Rainfall can be very low (average 20–25 in. [508–635 mm.]) so that small rivers tend to disappear and irrigation is necessary.

The Black sea coast is warmer than the interior in the winter (241–260 days frost-free) but the summer is cooler. There are frequent gale storms, causing great loss in the rural areas, and as many as 320 windy days a year. A wind corresponding to the African sirocco, the "black wind," can have an adverse effect on crops during the calmer summer days. Rainfall tends to be less than 20 in.; an absolute minimum of 7.6 in. (193 mm.) was recorded in the Dobruja region.

3. Vegetation and Animal Life.—The same zones that are apparent geologically, physically and climatically are seen in the natural vegetation although the country as a whole lies in the middle latitudes forest and steppe area.

In the north the Danubian platform is steppelike in character but in the Ludogorie or Deli Orman "forest" to the west of the Dobruja there is some scrubby deciduous woodland. Much of this was cut down or mutilated, and grazing animals, especially goats, have caused much damage. The Balkan range is covered for the most part with oak and beech, with conifers at higher levels. The Thracian plain and the Black sea coastlands have Mediterranean flora, including *maquis*, and also deciduous woodland, but the area is largely cultivated. True Mediterranean vegetation can be seen in the Struma and Mesta valleys and in the Strandzha, where broadleaf evergreen shrubs include the rhododendron. The western mountains and the Rhodopes are forested with fine coniferous forests as well as with deciduous. Roughly one-third of Bulgaria is forested—of this, 52% is high forest and 48% brushwood, which is important as a watershed protection.

Except in the mountainous southwest, deforestation has caused the gradual disappearance of such wild animals as bears, wolves, boars, foxes, elk and wildcats. Fisheries yield poor supplies, mainly of mackerel from the Black sea. Carp, sturgeon and whitefish are found in the rivers. (S. H. Br.)

II. HISTORY

The ancient history of the country that is now Bulgaria is that of regions into which it was divided in classical times, Moesia and Thrace (*qq.v.*). Subjected first to the kingdom of Macedonia (*q.v.*), then to the Romans, the country was overrun by the great immigration of the Slavs (*q.v.; see* also Europe: *History*) that spread over the lands between the Danube and the Aegean sea from the middle of the 6th to the middle of the 7th century A.D. The old Thraco-Illyrian population was partly expelled by the Slavs and partly merged with them. Faint traces of similarities in the Bulgarian and Rumanian languages, as well as tumuli, bas-reliefs and inscriptions on stone tablets, are survivals of the ancient Illyrian race and speech in the eastern half of the Balkan peninsula (for the west *see* Illyria; also Albania). The Slav tribes had no central government. They tilled the land and were organized in democratic local communities. Contact with Roman civilization had considerable effect on their way of life, especially in the areas along the sea coast and near the old garrison centres of the Roman empire.

1. The Bulgars.—The first mention of the Bulgars in European history occurs toward the end of the 5th century A.D., the name being applied to some of the numerous tribes of non-Indo-European origin that had followed in the wake of Attila's invasion and settled down temporarily in the steppes north of the Black sea and to the northeast of the Danube. These tribes of fierce, barbarous horsemen, despotically ruled by their khans (chiefs) and boyars or bolyars (nobles), lived mainly from war and raiding. Little is known about their religion. In A.D. 433 their federation of tribes split into two main groups—the Utiguri to the east and the Kutiguri to the west. About 560 the Avars (*q.v.*) conquered the Kutiguri and assimilated the survivors, so that the Kutiguri then disappeared from history. Less than a decade later the Utiguri were enslaved by the Turks.

The next name to appear is that of the khan Kubrat, ruler of a tribal confederation north of the Black sea that lasted until the middle of the 7th century. One of the Kubrat's sons, Asparukh or Isperikh, moved westward under the impact of the advance of the Khazars (*q.v.*), crossed the Danube in 679 and settled down in Moesia, which was then a province of the Byzantine empire. In 681 the Bulgar state in Moesia was officially recognized by the Byzantine emperor Constantine IV. Asparukh's horde, probably not very numerous, was gradually assimilated by the more advanced Slavs, whose language and ways of life the Bulgars adopted. Only the military aristocracy remained predominantly Bulgar, keeping their names, titles and privileges, against the policy of the khans, whose title changed to the Slavonic one of knez (prince). This dualism in the social organization of the Bulgarian state had far-reaching effects on its fortunes and contributed to its downfall. (Bulgaria on the Volga, a state that emerged later in southern Russia, is the subject of a separate article.)

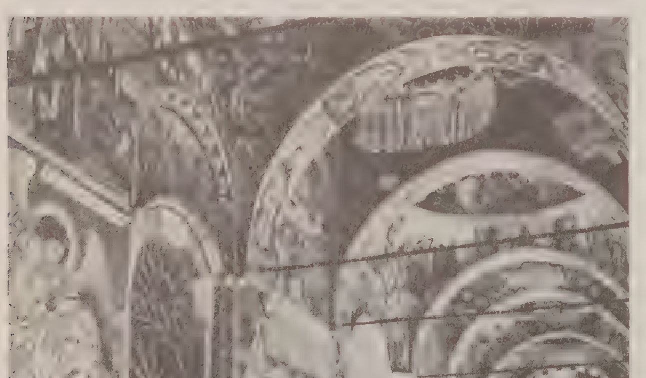
2. Early Dynasties.—The early Bulgarian state lay along both banks of the Danube, although the suzerainty of their princes over the northern bank, which at the time was practically a no-man's-land, was probably always shadowy. To the south, however, the rulers gradually extended their frontiers in numerous campaigns against the Byzantines, from whom Kardam (777–802?) and Krum (802?–814) again exacted the tribute that had been paid to Asparukh. Krum waged a desperate campaign against the emperor Nicephorus, who invaded Bulgaria and burned Preslav; but Krum annihilated the army as it returned through the Balkan passes (811), slew the emperor and converted his skull into a drinking goblet. In the following years he devastated Thrace and besieged Constantinople; the city was saved by his sudden death. Moreover, Krum and his son Omortag (814–831) succeeded to the heritage of the Avars in much of eastern Hungary and Transylvania; but with the arrival of the Magyars and Pechenegs at the end of the 9th century, all territory north of the Danube was abandoned, and even the southern half of the Danube valley was depopulated by raids and filled with alien races who settled there in considerable numbers.

Pressian (836–852) and Boris I (*q.v.;* 852–889) extended the frontier of Bulgaria far to the southwest, to include Dibra (Debar) and Ohrid (Ochrida), now in Yugoslavia, and all the upper Struma valley, as well as the Morava valley on the west. The great majority of the enlarged Bulgarian state was now almost purely Slav; and for 300 years, while the whole of northeastern Bulgaria was repeatedly ravaged by Russians, Magyars, Pechenegs and Kumans, the Slav centre and the southwest were to become even more the centre of gravity of the Bulgarian state. This process was accelerated by the conversion of Bulgaria to Christianity. The adoption of the Slavonic or Old Bulgarian language as that of the official liturgy was the final stage in the assimilation of the original Bulgar race. Boris, who was baptized into the Orthodox Church in 865, probably adopted Christianity from political motives, though according to legend he was frightened into it by the ghastly picture of hell painted on his palace walls by a Byzantine monk, and he ended his days in a monastery. The great controversy between Rome and Constantinople regarding the patriarch Photius had broken out in 860, and after his baptism Boris wavered between the rival churches; but when the pope failed to fulfill the hope that he had held out of Bulgaria's getting an independent and national patriarch, Boris in 870 decided for the Eastern Church. The decision was fraught with momentous consequences for the future of his country. The nation altered its religion in obedience to its sovereign, and some of the boyars who resisted the change paid with their lives for their fidelity to the ancient belief. The independence of the Bulgarian Church was recognized by the patriarch, a fact much dwelt upon in later controversies. The Bulgarian primates subsequently received the title of patriarch; their see was transferred from Preslav to Sofia, Voden and Prespa successively and finally to Ohrid.

3. First Empire.—The national power was at its zenith under Simeon (893–927), a monarch distinguished in the arts of war and peace. In his reign, says Gibbon, "Bulgaria assumed a rank among the civilized powers of the earth." It was under Simeon that the trans-Danubian possessions were finally lost; but he extended his frontiers to the Adriatic in the southwest and as far as the Sava and Drina rivers and also brought the Serbs under his sway. Having become the most powerful monarch in eastern Europe, Simeon assumed the title of "emperor and autocrat of all the Bulgars and Greeks," a style which was recognized by Pope John X. Simeon also aspired, however, to secure the Byzantine imperial crown for himself and so led numerous campaigns against Constantinople. His pursuit of this dream left his country nearly exhausted. While he reigned his people made great progress in civilization; literature flourished, and his capital, Preslav, is described as rivaling Constantinople in magnificence and as full of "high palaces and churches."

4. West Bulgarian Empire.—After Simeon's death, the Bulgar power declined because of internal dissension. The upper classes were demoralized by the Greek manners introduced by the wife of Peter, Simeon's successor, and the peasants, who endured great hardships, embraced in large numbers the doctrines of opposition to the church and to the nobility preached by the Bogomils (*q.v.*), who acquired great prominence at that time. Serbia recovered its independence in 933. New waves of eastern invaders harassed northern Bulgaria; and in 972 the Byzantine emperor John I Tzimisces took advantage of a Russian attack to dethrone Tsar Boris II and recover eastern Bulgaria. Macedonia, however, remained independent under the four sons of a local count, probably of Armenian origin, called Nicolas. One of these four brothers, Samuel (980–1014), assumed the title of tsar, actually recovered Serbia and northern Bulgaria for this new Bulgarian empire and extended his power southward to Thessaly; but in 1014 he was defeated at Belasitsa by the Byzantine emperor Basil II (*q.v.*), thereafter called Bulgaroctonus, who reputedly put out the eyes of 15,000 prisoners taken in the fight. Samuel died of grief. Four years later his dynastry was extinguished; for more than a century and a half (1018–1185) all the former Bulgarian territories remained subject to the Byzantine emperors.

5. Second Empire.—After a general insurrection of Vlachs (*q.v.*) and Bulgars under the brothers Asen and Peter Asen of Turnovo, northern Bulgaria recovered its independence (1185) and Asen assumed the title of Ivan Asen I, "tsar of the Bulgars and Greeks." (*See* ASEN.) The Asens asserted their descent from the old rulers of Bulgaria; but they are said to have been actually of Kuman-Bulgar origin and are generally referred to in contemporary documents as "tsars of the Vlachs and Bulgars." They received great assistance from the Kumans, now settled on the northern banks of the Danube, to whom they were allied by treaty and marriage. Kaloyan, the third of the Asen monarchs, extended his dominions to Belgrade, Nis and Skopje; he acknowledged the supremacy of the pope who, in his own words, "extolled him above all other Christian monarchs," received the royal crown from a papal legate and was certainly the strongest part in the three-cornered warfare which was waged for many years between the Greeks, the crusaders (at that time established in Constantinople) and the Bulgars. The greatest of all Bulgarian rulers was Ivan Asen II (1218–41), a man of humane and enlightened character. After a series of victorious campaigns, particularly after the battle of Klokotnitsa (1230), he established his sway over Albania, Epirus, Macedonia and Thrace and governed his wide dominions with justice, wisdom and moderation. In his time the nation attained a prosperity hitherto unknown: commerce, arts and literature flourished; Turnovo, the capital, was enlarged and embellished and great numbers of churches and monasteries were founded or endowed. At this period, to judge from contemporary chronicles, civilization in Bulgaria was as high as anywhere else in Europe.



BY COURTESY OF THE BULGARIAN EMBASSY, LONDON

ELABORATE MURALS DECORATE THE INTERIOR OF RILA MONASTERY, FOUNDED IN THE 10TH CENTURY

The last representative of the Asens ceased to rule in 1280. None of their successors was able to establish a strong central authority, and feudal anarchy prevailed. Further, northern Bulgaria was repeatedly devastated by Mongol raids. Two other dynasties, both of Kuman origin, followed: the Terter, who ruled at Turnovo; and the Shishman, who founded an independent state at Vidin but later reigned in the national capital. Eventually, on July 28, 1330, the tsar Michael Shishman was defeated and slain by the Serbs, under Stephen Urosh III, at the battle of Velbuzhd (Kyustendil). The Macedonian provinces of Bulgaria then came under Serb rule and formed part of Stephen Dushan's empire (1331–55). For the last time before the Turkish conquest, literature flourished in Bulgaria during the reign of Ivan Alexander (1331–71).

By 1340 Ottoman Turkish invaders had begun to ravage the entire valley of the Maritsa; they took Philippopolis (Plovdiv) in 1362 and seized Sofia in 1382. In 1371 Bulgaria's last tsar, Ivan Shishman, son and heir of Ivan Alexander, was forced to declare himself the vassal of the Ottoman sultan Murad I. The rout of the Serbs, Bosnians and Croats at Kosovo Polje in 1389 sealed the fate of the whole Balkan peninsula. The Turks soon turned on Ivan Shishman. His capital, Turnovo, after a siege of three months, was captured, sacked and burned in 1393. What happened to the tsar is not known; according to national legend he fell in battle near Samokov. Vidin, where his brother Srazhimir had established himself, was taken in 1396, and the last remnant of Bulgarian independence disappeared.

6. Turkish Rule.—The five centuries 1396–1878 form a dark era in Bulgarian history. The invaders carried fire and sword through the land; towns, villages and monasteries were sacked and destroyed, and whole districts were converted into desolate wastes. Inhabitants of the plains fled to the mountains, where they founded new settlements. Many of the nobles embraced Islam; others, together with numbers of the priests and people, took refuge across the Danube. Among the people only the religious sect of the Paulicians adopted Islam in large numbers: the conversion of the Pomaks of the Rhodope mountains was still incomplete at the beginning of the 17th century. Large colonies of true Turks were, however, settled in the plains both north and south of the Balkans, the true Bulgarian element being driven back into the less fertile districts. All the regions formerly ruled by the Bulgarian tsars, including Macedonia and Thrace, were placed under the administration of a governor general, styled the beglerbeg (beylerbey) of Rumili (Rumelia), residing at Sofia; Bulgaria proper was divided into vilayets (provinces) and these into the sanjaks (districts) of Sofia, Nikopol, Vidin, Silistra and

BY COURTESY OF THE BULGARIAN EMBASSY, LONDON

NESEBŬR, A SMALL RESORT TOWN ON THE BLACK SEA

Kyustendil. A new feudal system replaced that of the boyars; fiefs or *spahiliks* were conferred on the Ottoman chiefs and renegade Bulgarian nobles. The Christian population was subjected to heavy imposts, the principal being the *jizié,* or capitation tax, paid to the imperial treasury, and the tithe on agricultural produce, which was collected by the feudal lord. Among the most cruel forms of oppression was the requisitioning of young boys between the ages of 10 and 12, who were sent to Constantinople as recruits for the corps of janizaries. Yet the conquest once completed, the condition of the peasantry during the first three centuries of Turkish government was not worse than it had been under the tyrannical rule of the boyars. Military service was not exacted from the Christians, no systematic effort was made to extinguish either their religion or their language, and within certain limits they were allowed to retain their ancient local administration and the jurisdiction of their clergy in regard to inheritance and family affairs. Many districts and classes enjoyed special privileges: chief of these were the merchants, miners and the inhabitants of the "warrior villages" (*voinishki sela*), who received self-government and exemption from taxation in return for military service. Some of these towns, such as Koprivshtitsa in the Sredna Gora, attained some prosperity, which declined after the establishment of the principality. So long as the Ottoman power was at its height, the lot of the subject races was tolerable. The law was enforced, commerce prospered, good roads were constructed, and the great caravans from Ragusa (Dubrovnik, Yugoslavia) traversed the country. Down to the end of the 17th century there was only one serious attempt at revolt, as distinguished from the guerrilla warfare maintained in the mountains by the haiduks, or outlaws: and that was occasioned by the advance of Prince Sigismund Báthory into Walachia in 1595. Both this revolt and an equally unsuccessful rising in 1688 were arranged in conjunction with Austrian forces; but after the peace of Belgrade (1739) the Austrian government temporarily suspended its active Balkan policy. Its heritage was taken over by Russia, who as early as 1687 had for political reasons assumed the role of protector of the Orthodox Christians of the Balkans, a claim officially put forward in the treaty of Kuchuk Kainarji (Kaynardzha; 1774). As the power of the sultans declined after the unsuccessful siege of Vienna (1683), anarchy spread through the Balkans. Bulgaria suffered less from the oppressions of the feudal lords than the remoter districts. Early in the 18th century the inhabitants suffered terribly from the ravages of the Turkish armies crossing the land during the wars with Austria. Toward its close their condition became worse with the horrors perpetrated by the Kurdzhali, troops of disbanded soldiers and desperadoes who, in defiance of the Turkish authorities, roamed through the country, plundering and committing atrocities. In 1794 Pazvantoglu (1758–1807), a feudal lord who was occasionally in alliance with the Kurdzhali, established himself as an independent sovereign at Vidin, putting to flight three Turkish armies which were dispatched against him. This adventurer possessed many remarkable qualities. He adorned Vidin with handsome buildings, maintained order, levied taxes and issued a separate coinage.

(Left) The town of Bansko in southwest Bulgaria, with the Pirin mountains in the background. (Below) Rock formations in the western Balkans

BY COURTESY OF (BELOW) "BULGARIA" MONTHLY REVIEW; (LEFT) PHOTOGRAPH, J. ALLAN CASH

The National Revival.—At the beginning of the 19th century the existence of the Bulgarian people was almost unknown in Europe. Disheartened by ages of oppression, isolated from Christendom by their geographical position and cowed by the proximity of Istanbul, the Bulgars took no effective part in the insurrectionary movement which resulted in the liberation of Serbia and Greece, though legions of Bulgarian volunteers fought beside the Serbs. The Russian invasions of 1810 and 1828 only added to their sufferings, and great numbers of fugitives took refuge in Bessarabia, annexed by Russia under the treaty of Bucharest in 1812. The people's national consciousness, however, which throughout the centuries of foreign rule had brought forth a fine folklore—ballads, songs and legends—and had kept the Bulgarian language intact, offered fertile ground for those revolutionary aspirations to national independence linked with social reform which had been agitating many parts of Europe since the end of the 18th century and appeared in clearer ideological outline after the Napoleonic Wars, concurrently with the development of socialism.

The precursors of the national movement in Bulgaria were Paisii, a monk of Mt. Athos (in Macedonia, Greece) who wrote a history of the Bulgarian tsars and saints (1762), and Bishop Sofronii of Vratsa. After 1824 several works written in modern Bulgarian began to appear, and in 1835 the first Bulgarian school was founded at Gabrovo. Within ten years about 50 Bulgarian schools came into existence, and 5 Bulgarian printing presses were at work. The literary movement led to a reaction against the influence and authority of the Greek clergy.

The spiritual domination of the Greek patriarchate had tended more effectually than the temporal power of the Turks to the effacement of Bulgarian nationality. After the Turkish conquest of the Greek peninsula the Greek patriarch had become the representative at the Sublime Porte of the *Rum millet,* the Roman nation, in which all the Christian nationalities were comprised. The independent patriarchate of Turnovo was suppressed by the Turks; that of Ohrid was subsequently made Greek. The Phanariot clergy (*see* PHANARIOTES)—unscrupulous, rapacious and corrupt—monopolized the higher ecclesiastical appointments and filled the parishes with Greek priests, whose schools, in which Greek was exclusively taught, were the only means of instruction open to the people. Greek became the fashionable language of the upper classes in many Bulgarian towns, and the Bulgarian language was written in Greek characters.

The Slavonic liturgy was suppressed and in many places the old Bulgarian manuscripts, images, testaments and missals were burned. Thus, although from 1828 sporadic military revolts had been led by Georgi Mamarchev, Georgi Rakovski, Panayot Khitov, Haji Dimitr and Stefan Karadzha, these isolated Bulgarian patriots could not hope for success until the Greek ascendancy had been removed. For 40 years the pioneers of Bulgarian nationality fought for the establishment of an autonomous church. At one time they even secured from the pope the appointment of an archbishop of the Uniate Bulgarian Church, causing Russia to urge the sultan to grant Bulgaria's wishes; and on Feb. 28, 1870, a firman (decree) was issued establishing a Bulgarian exarchate with jurisdiction over 15 dioceses, including Nis, Pirot and Veles (now Titov Veles) in Yugoslavia. The first exarch was elected in Feb. 1872. He and his followers were at once declared schismatics and excommunicated by the patriarch, but national feeling in Bulgaria was now greatly enhanced.

The Revolt of 1876.—A nation-wide rising for the liberation of the country had been in preparation since the 1860s by revolutionary underground organizations in Rumania with numerous local "committees" in Bulgaria. The principal leaders were Vasil Levski, Khristo Botev (*q.v.*) and Lyuben Karavelov. The Turks eventually caught Levski, who was active mostly inside Bulgaria, and executed him. The revolt broke out prematurely in May 1876, at Koprivshtitsa and Panagyurishte, but did not spread much beyond the sanjak of Philippopolis (Plovdiv). It was cruelly repressed by Pomaks, bashi-bazouks and recently settled Circassians and Tatars. About 15,000 Bulgarians were massacred near Philippopolis, including 5,000 in Batak, and 58 villages and 5 monasteries were destroyed. Isolated risings on the northern side of the Balkan mountains were crushed with similar barbarity. These atrocities were denounced by the British statesman W. E. Gladstone (*q.v.*) in a pamphlet which aroused the indignation of Europe. The great powers remained inactive, but Serbia declared war in the following month, and 2,000 Bulgarian volunteers joined the Serbian army. Reforms proposed by a conference of the powers at Istanbul at the end of the year were disregarded by the Porte, and in April 1877 Russia declared war (*see* RUSSO-TURKISH WARS). In the ensuing campaign the Bulgarian volunteer contingent in the Russian army accompanied Gen. I. V. Gurko's advance through the Balkans, behaved with great bravery at Stara Zagora, where it suffered heavy casualties and rendered valuable services in the defense of Shipka.

7. The Principality.—After advancing to Chatalja (Catalca now in Turkey in Europe), Russia dictated the treaty of San Stefano (*see* EASTERN QUESTION), which fulfilled almost all Bulgarian ambitions. A principality was created, the western frontier of which ran down from the Timok river to embrace Pirot, Vranje Skopje, Debar (Dibra), Ohrid and Kastoria. Leaving all Macedonia to Bulgaria (except Salonika and Chalcidice), the proposed frontier left the Aegean coast southeast of Xanthi, ran northward along the Rhodope mountains, then turned eastward passing north of Edirne (Adrianople), reaching the Black sea coast north o Midye. The Dobruja was reserved to Rumania as a reward for help in the war and as compensation for Russia's annexation of Bessarabia. The area included in the new Bulgaria constituted three-fifths of the Balkan peninsula, with a population of abou 4,000,000 inhabitants. The powers, however, fearing that thi state would become practically a Russian dependency, intervened The congress of Berlin (*q.v.*), by the treaty of July 13, 1878, reduced the principality of Bulgaria (which was to be autonomous but under the sovereignty of the Porte) to the territory between the Danube (excluding the Dobruja) and the rest of the Balkan mountains, with Samokov and Kyustendil. Vranje, Pirot and Ni were given to Serbia, Turkey retaining nearly all Macedonia. An autonomous province of Eastern Rumelia, subject to the sultan but with a Christian governor general, a diet and a militia, was created between the Balkan and the Rhodope mountains. A European commission was to draft a constitution for Eastern Rumelia For Bulgaria, an assembly of notables was to meet at Turnovo within nine months, draw up an organic law and elect a prince their choice was to be confirmed by the Porte with the assent o the powers. The country was meanwhile occupied by Russian troops and administered by Russian officials.

Alexander.—The constituent assembly, which met at Turnovo on Feb. 22 (new style; Feb. 10, old style), 1879, was overwhelmingly democratic in character. The majority of its members were peasants, and the Liberal party, under Dragan Tsankov, Lyuben Karavelov and Petko Rachev Slaveikov (*q.v.*), easily predominated over the Conservatives. The constitution adopted at this assembly was among the most democratic in Europe.

On April 29, 1879, the first regular Bulgarian assembly elected to the Bulgarian throne Prince Alexander of Battenberg (*q.v.*), a scion of the grand-ducal house of Hesse and nephew of Emperor Alexander II of Russia. Prince Alexander arrived in Bulgaria and took the oath to the constitution on July 8 amid general rejoicing; but from the first his position was difficult. Elected as Russia's candidate and autocratic by nature and training, the 22-year-old prince was meant to be an agent for his protector's foreign and domestic policy rather than a Bulgarian ruler. Indeed little else was expected of him by the courts of Europe, but on both these scores he came into early conflict with the Bulgarian Liberals, who commanded the bulk of Bulgarian public opinion and were strongly averse to any policy against the national wishes or any infringement of the democratic constitution. The prince first formed a Conservative ministry to take the place of the outgoing Russian officials, but was forced by popular agitation to form a Liberal government under Tsankov. As the Liberals once in power, initiated a violent antiforeign and anti-Russian campaign, the prince dismissed them, formed a new Conservative government under Gen. J. C. Ehrnroth, a Finn in the Russian service, and charged him with arranging new elections to the grand Sobranie (unicameral national assembly). The general obtained a subservient Sobranie which agreed (July 1881) to suspend the constitution and invest the prince with absolute powers for seven years. A period of dictatorship followed, under the Conservatives and the Russian generals L. N. Sobolev and A. V. Kaulbars. The prince's own adherents, however, disagreed among themselves over the question of railway concessions. The prince, whose relationship with Russia was less cordial after the death of Alexander II in 1881, quarreled with Sobolev and began to favour Bulgarian aspirations. In Sept. 1883 he restored the constitution by proclamation and formed a coalition government of Conservatives and moderate Liberals, which was succeeded in July 1884 by a government of the left-wing Liberals under Karavelov.

In Eastern Rumelia, as in Bulgaria, political life had brought forth a Conservative and a Liberal party. The differences between them were rather personal than of principle, for each was equally eager to promote the union with Bulgaria; but the Conservatives, who were Russophile, had declared, in compliance with Russia's wishes, that the time was not yet ripe for the union. The Liberals, who were in opposition, seized the opportunity and in Sept. 1885, having assured themselves at the last moment of Prince Alexander's consent, seized the governor general, Krastevich Pasha, and proclaimed the union. The prince arrived in Plovdiv a few days later, took over the government and mobilized all available troops on the Turkish frontier to resist a possible attack. Turkey, however, beyond massing her troops on the frontier, made no move, but awaited developments in the international situation. The western powers showed Bulgaria sympathy, and Germany preserved a neutral attitude, but Russia, incensed by such independence of action, recalled the Russian officers from the Bulgarian army and, at conferences summoned in Istanbul in September and October, urged that the union be canceled and the sultan's authority be restored in Eastern Rumelia. This was opposed by Great Britain. Meanwhile King Milan of Serbia, announcing that the balance of power in the Balkans was endangered, suddenly declared war (Nov. 14, 1885). The Serbs advanced as far as Slivnitsa; but there they were encountered and defeated by the untrained Bulgarian army, which pursued them across the frontier, took Pirot and was stopped only by the intervention of Austria (*see* SERBO-BULGARIAN WAR). Peace and the *status quo* were restored by the treaty of Bucharest (March 3, 1886) and by the convention of Top-Khané (April 5). Prince Alexander was appointed governor general of Eastern Rumelia, and the Rumelian administrative and military forces united with those of Bulgaria.

Disappointment at these events set afoot a conspiracy among Russophiles in Bulgaria and certain discontented officers who, on Aug. 21, 1886, seized the prince in his palace, forced him to sign his abdication, transported him out of the country and handed him over to the Russians at the Danube port of Reni. The country in general disapproved the plot; Stefan Stambulov (*q.v.*), the president of the assembly, and Col. Sava Mutkurov, commandant of the troops at Plovdiv, initiated a counterrevolution, overthrew the conspirators and recalled the prince. The Russian mperor Alexander III, however, whom he had informed of his eturn, answered: "I cannot approve your return to Bulgaria." As no European power would support him in the face of Russia's ill will, Alexander of Battenberg abdicated on Sept. 8, appointing s regents Stambulov, Karavelov and Mutkurov. The regency was successful, in difficult circumstances, in preserving order and ecuring the good will of Turkey. The election of a new prince was a more difficult task. Russia sent Gen. Nikolai Vasilievich Kaulbars to Bulgaria to arrange for the election of the prince of Mingrelia (region of Georgia) but, finding fresh causes of disontent, broke off relations on Nov. 17. The Bulgarian delegates who toured the courts of Europe found it very hard to select prince who should be agreeable to Russia and to the rest of Europe alike. At last their offer was accepted by Prince Ferdinand f Saxe-Coburg-Gotha.

Ferdinand.—The new prince was elected by the grand Sobranie n July 7, 1887, and took over the government on July 14. His position was difficult, as Russia denounced him as a usurper and brought pressure on the Porte to declare his presence in Bulgaria illegal. Stambulov, who became prime minister on Aug. 3, had to rule almost as a dictator in the face of a raid led by the Russian captain Dmitri Nikolaevich Nabokov, a refusal by the bishops of the Holy Synod to pay homage to the prince and a military conspiracy under Maj. Konstantin Panitsa (1890). Fortunately Stambulov's foreign policy was successful. The powers withheld recognition, but Ferdinand was received personally in Vienna, London and Rome; and relations with Turkey became cordial, the Porte granting the Bulgarian schools and church valuable concessions in 1890, 1892 and 1894. While, however, Stambulov sought the friendship of the Porte, Ferdinand was anxious to recover the favour of Russia and thus secure his own recognition. Relations between the two grew ever more strained, until Stambulov resigned in 1894. Under his successor, Konstantin Stoilov, Ferdinand inaugurated a Russophile policy, which was facilitated by the death of the emperor Alexander III in Nov. 1894. The banished Russophiles and other victims of Stambulov's autocratic regime were amnestied; in July 1895 some of these murdered the prime minister in the streets of Sofia. In the spring of 1893 Ferdinand had married Princess Maria Luisa of Bourbon-Parma and Stambulov had persuaded the grand Sobranie to alter the constitution to allow the issue of the marriage to be brought up in the Roman Catholic faith. However, Ferdinand had his eldest son, Prince Boris, baptized into the Orthodox faith (Feb. 14, 1896) with Tsar Nicholas II as godfather, a step which, although it incurred the grave displeasure of Austria-Hungary, sealed the reconciliation with Russia. On March 14, after the powers signified their assent, Ferdinand was nominated by the Turkish sultan prince of Bulgaria and governor general of Eastern Rumelia. Russian influence again became noticeable in Bulgaria. It was no longer conspicuous in her internal affairs, but a secret military convention was concluded in Dec. 1902.

The question which was now to dwarf all others in importance and to sway all Bulgarian policy was that of Macedonia. The narrow limits drawn by the treaty of Berlin had left Bulgars under foreign rule in Rumania, Serbia and Turkey. The hope of recovering portions of the Dobruja and southeastern Serbia had prevented the Bulgarian government from initiating cordial relations with the former two countries. With Turkey, however, matters were different: Macedonia constituted the largest Bulgaria irredenta; there the sense of Bulgarian nationality was especially strong and genuine; there, too, there was a fair chance that the Turks would soon leave the field, and territorial acquisition prove possible. The Macedonian revolt of 1903 brought Bulgaria to the verge of war with Turkey; and despite a convention of April 8, 1904, Bulgaria had to maintain an army with a view to possible war, which, together with the maintenance of many destitute refugees from Macedonia, proved a heavy drain financially. Nor did the question end there. Other countries laid claim to Macedonia. Serbs, Greeks, Albanians, Vlachs, as well as Bulgars, carried on their rival propagandas, often by force of arms. Outrages committed by Greek bands in 1906 led to reprisals on the Greek population in Bulgaria, while with Serbia the situation was even more strained, especially since the return of the Karageorgevich dynasty in 1903, the consequent increase in Serb propaganda in Macedonia and the favour enjoyed by Serbia in Russia.

8. Kingdom Under Ferdinand.—It was partly the desire to set his country on an equality with Serbia, as well as the growing impatience of prince and people alike with the nominal vassalage to Turkey (even though the tribute imposed in 1878 was never paid) that decided Prince Ferdinand to proclaim Bulgarian independence. On visiting Vienna in Feb. 1908, he was well received; though Bulgaria's aspirations toward the Dobruja and Nis made an alliance with Austria-Hungary impossible, the two states were now in sympathy. After the Young Turk revolution of July 1908 an understanding was reached between Ferdinand and the emperor Francis Joseph I of Austria. Further pretexts were supplied by a diplomatic incident in Istanbul and by a strike in those sections of the Eastern Rumelian railways which were owned by Turkey but leased to the Oriental railways. On Oct. 5, 1908, the day before the Austrian annexation of Bosnia-

Hercegovina, Ferdinand proclaimed Bulgaria (including Eastern Rumelia) an independent kingdom, himself taking the title of tsar. (*See* FERDINAND I [of Bulgaria].)

Balkan Alliance and the First Balkan War.—Bulgarian policy swung back into its old groove. Turkey claimed an indemnity of £4,800,000 for the declaration of independence. Bulgaria had agreed to pay £1,520,000. In Feb. 1909 Russia undertook to advance the difference. A preliminary Russo-Turkish protocol was signed on March 16, and in April, after the final agreement had been signed, the independence of Bulgaria was recognized by the powers.

The cabinet under the Democrat leader Aleksandr Malinov, who had taken office in 1908, fell in March 1911. Ivan Geshov, head of the National party, became prime minister. Negotiations began for a Balkan alliance against Turkey. The first, between Bulgaria and Greece, were conducted through J. D. Bourchier, Balkan correspondent of the *Times* (London). A secret treaty of defensive alliance was signed between Bulgaria and Greece on May 29, 1912. The Serbo-Bulgarian treaty was signed in Sofia on March 13 and supplemented by the secret military conventions of Varna (May 12 and July 12). The great powers tried to prevent war by the tardy offer of a guarantee for the autonomy of Macedonia. On Oct. 8, Montenegro, with which country no formal agreement had been made, declared war on Turkey. On Oct. 13 the Balkan allies sent an ultimatum to the Porte; on Oct. 18 Greece declared war on Turkey.

The successes of the allies were swift, although the casualties of Bulgaria, especially, were heavy. On Dec. 3 an armistice was signed between Turkey, Bulgaria and Serbia. A conference met in London to decide terms of peace, but negotiations broke down over the possession of Edirne (Adrianople). On Feb. 3, 1913, hostilities reopened. Again the allies were everywhere successful, and after the surrender of Edirne to the Bulgars and Serbs the Turks sought the mediation of the powers, and a second armistice was concluded between Bulgaria and Turkey on April 16. On May 30, 1913, the delegates to the second London conference were induced to sign a treaty, the terms of which had been drafted by the powers. The Turks surrendered their possessions in Europe up to a line drawn from Enos (Enez) on the Aegean to Midye (Midia) on the Black sea. Albania was granted independence. (*See* BALKAN WARS.)

Second Balkan War.—Difficulties immediately arose as to the interpretation of the treaty. The Serbs and Greeks held much territory in Macedonia that had originally been assigned to Bulgaria, and they seemed to be preparing for a permanent occupation. Early in 1913 Bulgaria prepared for action.

On June 1 Geshov and Nikola Pasic, the Serbian prime minister, met in the hope of averting war; on the same day a treaty between Serbia and Greece was signed at Salonika. Geshov, finding no support from King Ferdinand in his efforts for peace, resigned; he was succeeded by Stoyan Danev. On June 29 the Bulgarian IV army, acting on orders signed by Gen. Mikhail Savov, made a treacherous attack on its Serbian and Greek allies. Rumanian divisions then marched into northern Bulgaria. The fighting soon ended with Bulgaria's defeat. Geshov states in his memoirs that the reports of the ministerial council contained no minute ordering the attack. A judicial inquiry into the case was opened in Sofia, but never concluded. Savov asserted that Ferdinand as commander in chief had given the order to attack.

The Second Balkan War brought calamity on both Bulgaria and Macedonia. By the treaty of Bucharest (Aug. 10, 1913) Rumania acquired the rich lands of the southern Dobruja, which had belonged to Bulgaria since 1878; Serbia and Greece divided Macedonia between them; Bulgaria was accorded the mountainous region of the Pirin and Dospat down to the Aegean, with the two indifferent ports of Dedeagatch (later Alexandroupolis) and Lagos.

World War I.—The government under Vasil Radoslavov, which took office in July 1913, abandoned the Russophile policy. When France, Great Britain and Russia refused to grant a loan to meet obligations and for constructive work, Bulgaria turned to the Central Powers and in July 1914 obtained a loan of 500,000,000 leva from the Disconto-Gesellschaft of Berlin, the group securing control of the Bulgarian state mines, the port of Lagos and the projected railway to it. Negotiations for a treaty had been going on simultaneously and were approaching completion in August and thus, when World War I broke out, although most Bulgars wished to preserve neutrality, the pro-German sympathies of the king, who also believed Germany invincible, were reinforced by a widespread feeling that the Central Powers, and they alone, migh yet gain Macedonia for Bulgaria. The efforts made by the entente through the summer of 1915 to win over Bulgaria were frustrated by the refusals of Serbia and Greece to cede territory. On Sept. 6 Bulgaria signed a military convention and treaty with the Central Powers at Pless (Pszczyna), and Turkey made the concessions demanded by Bulgaria. On Sept. 15 the entente promised Bulgaria part of Macedonia unconditionally in return for a declaration of war on Turkey. The opposition protested vehemently against the king's policy, Aleksandr Stamboliski (*q.v.*), leader of the Agrarian party, being in consequence condemned to imprisonment for life for *lèse-majesté* but mobilization was decreed on Sept. 22, and Bulgaria declared war on Serbia on Oct. 12. Great Britain, France and Italy declared war on Bulgaria on Oct. 15, 16 and 17 respectively.

In spite of the initial military success in Serbia and later in the Dobruja, there was widespread opposition to the war, particularly among the peasants and radical and left-wing politicians and from the Military league formed in 1913 by army officers resentful of the costly mistakes in Bulgaria's foreign policy. Shortages of food and armaments, exhaustion in the malaria-infested trenches in Macedonia and hopes raised by Pres. Woodrow Wilson's 14 points greatly influenced the numerous agitators to press for a separate peace. The army in the field was on the brink of rebellion when the Democrat leader Malinov replaced Radoslavov in office on June 18, 1918. Three months later (Sept. 15) the Macedonian front collapsed: several divisions simply left the trenches in open mutiny, led by members of the Agrarian party which had provided most of the opposition to war. Stamboliski was released and sent to calm the troops who had proclaimed a republic and were marching on Sofia. The government asked the Allies for an armistice, which was signed unconditionally on Sept. 29. After some fighting, internal order was restored by loyal troops with German assistance. On Oct. 3 King Ferdinand abdicated in favour of his son Boris and left the country.

9. The Reign of Boris III.—Under the treaty of Neuilly Bulgaria was disarmed and condemned to pay a heavy indemnity. The southern Dobruja went to Rumania again, Tsaribrod (Dimitrovgrad) and Strumitsa (Strumica) to Yugoslavia and the recent gains in Macedonia to Greece. The Aegean coastline was occupied by the Allies and associated powers, who assigned it to Greece at the conference of San Remo (April 1920).

Stamboliski.—Postwar revolutionary crisis in Bulgaria took the form of a reaction against the war policy. Aleksandr Stamboliski, its most courageous opponent, was the hero of the hour. The elections of March 28, 1920, gave the Agrarians a large majority, and Stamboliski, as premier of an Agrarian cabinet opened a campaign against the middle classes, which in its methods copied the Russian Bolsheviks; he was also the author of a plan for a "Green international" of peasants. He used the Communists of Bulgaria as a threat to the middle classes but denounced and persecuted them as enemies of property. His valuable measures which survived his fall, were an agrarian law whereby crown and church lands and property of more than a certain size (30 hectares for peasant proprietors and 10 ha. for married and 4 ha. for single urban proprietors who did not themselves cultivate the soil) were expropriated in favour of landless peasants, and the institution of a year's obligatory state service.

Stamboliski's foreign policy was conciliatory. He attempted to live on peaceful terms with his neighbours and to fulfill treaty obligations. In the face of grave economic difficulties, Bulgaria began payment of the reparations, the total of which was finally reduced from £90,000,000 to £22,000,000, payable over 60 years. Despite this, the Bulgars failed at the two conferences of Lausanne to secure an adequate fulfillment of clause 48 of the treaty of Neuilly, which had guaranteed them access to the Aegean (*see*

Thrace), and their relations with neighbouring states were kept in a state of tension by the issue of the Bulgarian minorities in Thrace, Dobruja and Macedonia.

The treaties of Bucharest (1913) and Neuilly had left large numbers of Bulgars under foreign rule. Many took refuge in Bulgaria, while others were brought in under the exchange-of-population scheme with Greece. After 1918 about 260,000 refugees entered Bulgaria, mostly from Macedonia and Thrace; and most of these were landless, destitute and resentful, while the Bulgarian state, with its shattered finances, could do little to relieve their miseries. A large proportion of the population of Bulgaria, refugee or otherwise, was of Macedonian origin, and the powerful and ruthless Internal Macedonian Revolutionary organization (I.M.R.O.; *i.e.*, Vatreshna Makedonska Revolutsionna Organizatsia or V.M.R.O.), under their capable and terrible leader, Todor Aleksandrov, gained much sympathy for its fight for Macedonian autonomy and thus formed an underground factor of importance in Bulgarian politics. While the Bulgarian delegates to the League of Nations (which Bulgaria joined on Dec. 16, 1920) voiced at every opportunity the grievances of the Bulgarian minorities in Macedonia, Thrace and the Dobruja, the refugee organizations, particularly the Macedonians, raided the territory of Bulgaria's neighbours from their strongholds in the Bulgarian mountains and thus helped to perpetuate a state of discord between Bulgaria and its neighbours. The Bulgarian government was not the least of the sufferers from the situation; and an agreement concluded by Stamboliski with the Yugoslav government at Nis (March 1923) was believed to contain a clause directed against the Macedonian committee. Upon this the Macedonians combined with the Bulgarian Nationalists and those of the officers and middle classes who had suffered most from Stamboliski's arbitrary rule. A *coup d'etat* in the night of June 8–9, 1923, overthrew the Agrarian government. Stamboliski was killed, most of his ministers imprisoned, and his Orange Guards dispersed.

Aleksandr Tsankov.—Aleksandr Tsankov now took office at the head of a government subsequently strengthened by the fusion of all political parties, except the Liberals, Communists and Agrarians, into the single Democratic entente. For some time Bulgaria was on the verge of civil war. The Agrarian refugees migrated in large numbers to Yugoslavia, where the government gave them shelter, and allied themselves with the Communists, who attempted to bring about a revolution. In September armed risings broke out in many parts of the country. They were repressed with great severity, and the chief organizers, Georgi Dimitrov (subsequently hero of the Reichstag fire trial) and Vasil Petrov Kolarov, fled to Russia, narrowly escaping capture. Several thousand persons were killed, and others imprisoned for long periods without trial. Meanwhile the *komitaji* raids on the frontier continued. (*Komitaji* were so-called "committeemen" or Irredentist partisans who at various times worked together in he Balkans.) Relations with Greece, especially, became particuarly difficult. Acute dissensions broke out within the Macedonian organization, one group of which wanted autonomy for Macedonia, he other a federative scheme. There was a further disagreement as to how far the help of Moscow ought to be accepted. On Aug. 31, 1924, Aleksandrov was murdered and the subsequent reprisals deprived the organization of most of its coherence and moral justification. The Agraro-Communist agitation, too, coninued unabated. There were about 200 assassinations in 1924; on April 14, 1925, an attempt was made on King Boris' life, and Gen. Kosta Georgiev was killed the next day. At his funeral, which was held on April 16 in the cathedral of Sveta Nedelya, Sofia, a bomb was exploded, killing 123 persons and wounding 323. Martial law was proclaimed. Five persons were later hanged publicly for the crime, but large numbers were either shot summarily or imprisoned.

To maintain order, the government obtained the permission of he Conference of Ambassadors (a session of ambassadors conerned with the execution of treaties) for a temporary increase in its armed forces of 10,000 men; and in fact, its energy prevented any general rising. The Tsankov government also sucessfully survived a fresh frontier incident with Greece, which occurred on Oct. 19, when Greek troops occupied 70 sq.mi. of Bulgarian territory near Petrich. The matter was settled by the League of Nations on appeal from Bulgaria. The repressive measures which Tsankov had taken were, however, more fitted for emergencies than for normal times, and as the Agraro-Communist agitation was checked by the dreadful events of April 1925, Tsankov resigned on Jan. 2, 1926, in favour of a more liberal government under Andrei Liapchev (*q.v.*), a leader of the Democratic party.

Andrei Liapchev.—On Feb. 4 the Liapchev government promulgated for certain political offenders an amnesty which affected 6,325 persons. The results of this change were most beneficial. The Agrarians were allowed to reconstitute their party in Bulgaria, and about 2,000 *émigrés* who remained in Yugoslavia soon lost credit. On June 11, 1926, the council of the League of Nations decided that the state of Bulgaria warranted the grant of a loan for the settlement of the destitute Bulgarian refugees. The question was of supreme importance for Bulgaria, both financially and politically, for it was partly from among these refugees (with whom the population sympathized) that the *komitaji* were recruited, whose incessant frontier raids troubled Bulgaria's relations with neighbouring states. Following the decision of the League, the Bank of England on Aug. 26 advanced £400,000 for immediate work, which was at once set afoot. An arrangement with the bondholders of Bulgaria's prewar debt was signed on Dec. 11 and the loan, for £2,400,000 nominal in England and $4,500,000 in the United States of America, was floated successfully on Dec. 26. Bulgaria had been politically almost isolated for more than a decade; a treaty of friendship signed with Turkey on Oct. 18, 1925, was no compensation for continual tension with Yugoslavia, Greece and Rumania.

The last years of the 1920s were on the whole outwardly quiet. On May 15, 1930, the cabinet of Liapchev was reorganized after a dispute within the Democratic entente between the premier and his rival Tsankov. In the same year King Boris III married Princess Giovanna, a daughter of King Victor Emmanuel III of Italy.

The 1930s.—The Liapchev cabinet fell on June 21, 1931. After a brief ministry under Malinov, a new cabinet under the former minister of the interior, Nikola Mushanov, was appointed on Oct. 12, 1931, and reorganized on Dec. 31, 1932. It comprised representatives of the Democratic, Liberal, Agrarian and Radical parties, all four represented in the government coalition, the so-called National bloc. The year 1932 brought to Bulgaria the full weight of the world financial and economic crisis.

Under these conditions the authoritarian trend noticeable in other Balkan countries made itself felt also in Bulgaria. On May 19, 1934, the ministry was overthrown by the Military league, and King Boris accepted a semidictatorial government under Kimon Georgiev. The government disbanded all political parties and suppressed their newspapers. A strict censorship was introduced and measures were taken to reduce the indebtedness of the population. The government, which represented the so-called Zveno group, closed a large number of high schools, as it was afraid of an overproduction of intelligentsia, and set up a national youth organization after totalitarian pattern. The Zveno group of army officers and radical politicians (the name means link in a chain) under Col. Damian Velchev, leader of the Military league, lost its influence in 1935, when King Boris asserted his authority. Thenceforward Boris himself ruled in an authoritarian way with the help of a cabinet headed by Georgi Kiosseivanov. A new electoral law in Oct. 1937 prohibited all party candidates and fixed the number of seats in the parliament at 160. A return to democracy was impeded by the disunity of the opposition groups. The dictatorial government succeeded in establishing better relations with Yugoslavia and in easing the tension with Turkey. On Jan. 24, 1937, a treaty of "inviolable peace and sincere and perpetual friendship" was signed with Yugoslavia.

10. World War II.—On July 31, 1938, Bulgaria signed a nonaggression pact with the Balkan entente; in exchange it was permitted, officially, to rearm. Bulgaria's revisionists then clamoured for restitution of the former frontiers, and the outbreak of World War II in 1939 seemed to offer them some hope. On Feb. 15,

BY COURTESY OF (ABOVE) "BULGARIA" MONTHLY REVIEW, (RIGHT) BULGARIAN EMBASSY, LONDON

(ABOVE) THE CITY CENTRE, VARNA. (RIGHT) SEPTEMBER 9TH SQUARE, SOFIA, WITH THE HEADQUARTERS OF THE BULGARIAN COMMUNIST PARTY AND, AT LEFT, THE MAUSOLEUM OF THE STATESMAN GEORGI DIMITROV

1940, Bogdan Filov became premier; his government was pronouncedly pro-German, and King Boris himself leaned toward the German cause. On Sept. 7 the Germans forced Rumania to restore southern Dobruja to Bulgaria. On March 1, 1941, the government subscribed to the Anti-Comintern pact. German troops were permitted to enter the country and establish bases for subsequent operations against Greece and Yugoslavia. In return, Bulgarian troops were later permitted to occupy Greek Thrace and Yugoslav Macedonia, as well as part of Serbia.

The Bulgarian government, however, refused to declare war on the U.S.S.R. when Hitler attacked it in 1941, King Boris fearing a revolt of the predominantly pro-Russian masses. He did, however, declare war on Great Britain and the United States.

On Aug. 28, 1943, King Boris died in mysterious circumstances. A Council of Regency headed by his brother, Prince Cyril, was appointed to rule until six-year-old Prince Simeon came of age. A new government, subservient to Germany, was formed by Dobri Bozhilov. Meanwhile, the resistance movement, led by Communists closely supported by the Military league and by the left-wing Agrarians, was gaining ground. Sabotage and armed clashes with the police became more frequent and serious. The Fatherland Front was formed clandestinely in 1942 and by the summer of 1944 had done much work under its national executive committee, which consisted of Kimon Georgiev (Republican, a prominent member of the Military league), Nikola Petkov (leader of the left-wing Agrarians), Kyril Dramaliev (Communist), Grigor Cheshmedzhiev (Social Democrat) and Dimo Kazasov (Independent). A revolutionary rising was planned for Sept. 2.

Confronted with civil war, Bozhilov's government resigned in May 1944. It was replaced by Ivan Bagrianov's cabinet, which tried to cut itself adrift from the Germans and in August approached the Allies for an armistice. While preliminary talks dragged on, the Soviet army was advancing toward the Danube. On Aug. 26 it was announced from Sofia that Bulgaria had withdrawn from the war and had ordered the disarmament of German troops on Bulgarian territory. Bagrianov resigned on Sept. 1, and Kosta Muraviev, an Agrarian, formed a new government which on Sept. 5 proclaimed strict neutrality.

The Soviet government found Bulgaria's neutrality "absolutely insufficient" and on the same night declared war. At midnight, the Bulgarian minister in Ankara informed the Soviet ambassador that Bulgaria was at war with Germany and asked for an armistice with the U.S.S.R., whose troops marched into Bulgaria unopposed. The Fatherland Front had ordered general insurrection on Sept. 2, and groups of armed partisans took control of several districts in the following days. In the night of Sept. 8–9 army formations under the command of Gen. Kyril Stanchev occupied the government offices in the capital, and the Fatherland Front formed a government with Georgiev as premier. An armistice with the Allies was signed on Oct. 28. The Bulgarian army passed under Soviet command and took an active part in the defeat of the German forces in Yugoslavia, Hungary and Austria.

11. Postwar Settlement and the People's Democracy.—The former regents and a number of political and military personalities, civil servants and businessmen were arrested; legislation was passed for dealing with war criminals, as stipulated in the armistice. Trials began in Dec. 1944; on Feb. 2, 1945, the 3 regents, 22 ministers, 68 members of parliament and 8 of King Boris' advisers were executed. Further trials and executions went on until late spring; 2,680 death sentences and 6,870 sentences of imprisonment were pronounced.

On March 16, 1945, Georgi Dimitrov returned to Bulgaria, after years of activity in the Soviet Union. In the summer a grave political crisis broke out when six cabinet ministers (including the deputy premier Petkov) resigned after Georgiev had virtually refused their demand for independent lists of candidates and freedom of vote in the impending election. After representations from the U.S. and Great Britain, the election was postponed. At the Moscow conference of the British, U.S. and Soviet foreign ministers (Dec. 16–26) it was decided that the Soviet government should advise the Bulgarian government to include in the cabinet two suitable representatives of other democratic groups, and that, as soon as this was done, the U.S. and Great Britain would recognize the Bulgarian government—with which the Soviet Union already had diplomatic relations. The Soviet diplomat A. Y. Vyshinski himself went to Sofia and tried without success to persuade Petkov and the Social Democratic leader Kosta Lulchev to join the cabinet. The government resigned, and a new cabinet was formed entirely of Fatherland Front members.

A referendum vote on Sept. 8, 1946, decided by a 92% majority to proclaim Bulgaria a republic. King Simeon II and the queen mother left the country on Sept. 16. After elections on Oct. 27, 1946, Dimitrov became premier in the new government of the Fatherland Front. Great Britain recognized the Bulgarian government in Feb. 1947, the U.S. in October. The treaty of peace with the Allies (Feb. 10) was ratified by the Bulgarian national assembly on Aug. 25. On Dec. 4, a new constitution came into force. At the year's close, Soviet troops had left Bulgaria.

After his resignation Petkov became the most vocal opponent of the Fatherland Front regime. Arrested in June 1947 and charged with plotting to overthrow the government, he was sentenced to death and executed on Sept. 23. A fortnight later, General Stanchev, with whose help the Fatherland Front had seized power in 1944, was sentenced to imprisonment for life on a charge of organizing a military plot. Another prominent member of the Fatherland Front, the Communist Traicho Kostov, deputy premier, was relieved of his post in 1949, excluded from the party's Politburo and later executed. Dimitrov died in July 1949, and Vasil Kolarov, who had taken over from him, died early in 1950. Vulko Chervenkov, secretary of the party's Central committee and Dimitrov's brother-in-law, became premier. In Feb. 1950 the U.S. broke off diplomatic relations with Bulgaria.

The social structure in Bulgaria had to be recast to fit the Communist pattern. Rapid industrialization was enforced without regard to Bulgaria's lack of raw materials and of technically educated manpower for heavy industry; collectivization of peasant holdings was pursued despite the resentment of the population.

The internal tension began to relax after Stalin's death (1953). Terror and political persecution relented somewhat. The party's Central committee was reorganized. Chervenkov gave up his post of secretary-general, and Todor Zhivkov became first secretary. During 1955 the Communist leaders tried to enlist popular support for the party by resuscitating the Fatherland Front and the Agrarian party. In 1956 the change in the political climate was emphasized by the revision of the treason trials of 1949; after Anton Yugov, who had been disgraced in 1950, had succeeded Chervenkov as premier (April 1956), Kostov, the chief victim of the trials, was rehabilitated posthumously in September.

Bulgaria's international relations also reflected the change after Stalin's death. Frontier disputes were settled and diplomatic relations resumed with Greece in 1954. Bulgaria became a member of the United Nations in Dec. 1955. Diplomatic relations with the U.S. were resumed in March 1959.

There were signs of dissension in the Communist party in 1961, apparently over the pace of collectivizing agriculture. An "anti-party group" within the party was discovered, and among many expelled was Todor Prahov, candidate member of the Politburo and chairman of the trade-union organization. Chervenkov, expelled from the Politburo at the end of 1961, was accused of responsibility for "violation of Socialist legality" and expelled from the Central committee in Nov. 1962. Also, Yugov was expelled from both party key bodies for his "Stalinist" methods. He was succeeded as premier by Zhivkov.

Bulgaria and Greece in July 1964 signed agreements covering war reparations and flood controls on the four rivers that flow through both countries. Bulgaria also strengthened contacts with several western European nations.

In April 1965 a coup against the government failed. As a result, a number of high civil servants and army officers, including Gen. Tsvetko Anev, commander of the Sofia military area, were tried and convicted by a military tribunal.

Measures to relax the government's grip on economic planning were discussed by the Central committee in April 1966 and approved by the party congress in November. The Macedonian question, however, cropped up again in the Bulgarian and in the Yugoslav press: after a meeting of Yugoslav-Macedonian and Bulgarian writers in Sofia in November, Georgi Dzhagarov, chairman of the Bulgarian Writers' union, refused to sign a joint statement because it was drafted not only in Bulgarian but also in Macedonian, which he described as a fictitious language—the Macedonians being, in his view, simply Bulgars.

In Oct. 1966 Zhivkov made his first official visit to western Europe when he was received by Gen. Charles de Gaulle. The ninth congress of the Bulgarian Communist party was held in Sofia in November, claiming a membership of 611,179. During 1967 Bulgaria renewed its 20-year treaties of mutual assistance with Poland (April 6) and the Soviet Union (May 12). On Sept. 7, a similar 20-year treaty was concluded for the first time with the German Democratic Republic. On April 26, 1968, a new Bulgarian-Czechoslovak treaty of alliance was signed in Prague. All these treaties proclaimed their partners' support for the recognition of the G.D.R. as an independent and sovereign state, and their opposition to "West German militarism and revanchism." On Aug. 21 Bulgaria participated with four other countries of the Warsaw pact in the military occupation of Czechoslovakia.

(N. I. M.; K. Sm.)

III. THE PEOPLE

The Bulgarian people, generally described as belonging to the Slavonic group of nations, are composed of the Slavs (*q.v.*) who established themselves on the Balkan peninsula in the 7th century A.D., the Bulgars (proto-Bulgarians—a tribe of Turanian stock, which migrated in the second half of the 7th century south of the Danube from the Russian steppes) and the remnants of an ancient population of Thracian origin. The Slavs, being far more numerous than the other elements, gave their language to the people, who became known collectively as Bulgarians. (*See* Bulgarian Language; Bulgarian Literature.)

*Administrative Subdivisions, Area and Population of Bulgaria**

Districts (*okrŭgs*)	Area (sq.mi.)†	Population (1965 census)	Density (per sq.mi.)
Blagoevgrad	2,496	302,503	121
Burgas	2,829	380,817	135
Gabrovo	799	168,629	211
Khaskovo (Haskovo)	1,556	290,297	186
Kŭrdzhali (Kurdjali)	1,552	283,758	183
Kyustendil	1,159	197,096	170
Lovech	1,594	217,342	136
Mikhaylovgrad	1,384	241,060	174
Pazardzhik (Pasardjik)	1,691	296,641	175
Pernik	909	180,883	199
Pleven	1,615	351,585	218
Plovdiv	2,159	645,352	299
Razgrad	1,022	198,464	194
Ruse (Roussé)	1,013	273,226	270
Shumen (Kolarovgrad)	1,303	243,416	187
Silistra	1,111	171,208	154
Sliven	1,440	226,838	158
Smolyan	1,358	160,255	118
Sofia (City)	401	894,604	2,231
Sofia	2,851	317,596	111
Stara Zagora	1,893	352,350	186
Tolbukhin	1,810	235,530	130
Tŭrgovishte	1,063	178,107	168
Turnovo	1,811	339,473	187
Varna	1,475	367,376	249
Vidin	1,201	181,210	151
Vratsa	1,616	308,852	191
Yambol	1,714	223,398	131
Total	42,823	8,227,866	192

*Data reflect the internal reorganization of Jan. 23, 1959. In 1964 Plovdiv city was unified with Plovdiv district and Varna city with Varna district.

†1 sq.mi.=2.59 sq.km.

1. Religion.—About two-thirds of believers in Bulgaria belong to the Eastern Orthodox Church (*see* Orthodox Eastern Church). There are also minorities of Turkish and Bulgarian Muslims, Roman Catholics, Protestants, Armeno-Gregorians and Jews. The national church was disestablished in 1949 and declared to be "in form, substance and spirit a People's Democratic Church." In 1953 the Bulgarian Orthodox patriarchate was revived, with its seat at Sofia. There are 11 dioceses and one for Bulgarian immigrants in the United States, Canada and Australia. Freedom of conscience and of belief is guaranteed by the constitution. Churches, however, are not allowed to maintain schools, colleges (except a theological seminary), hospitals or other institutions, which have been taken over by the state; Orthodox Christian Brotherhoods for religious education, church social work, a religious publishing house and certain church-owned economic enterprises and estates are permitted.

2. Population.—The total population at the 1956 census was 7,613,709; the 1967 estimate was 8,310,200. By the 1965 census the population was 8,227,866, an increase of 8% over 1956. Almost 42% were engaged in agriculture; the main areas of settlement were in the plains and hilly lands below 1,500 ft. (450 m.), particularly in the Sofia basin, Danubian plain and Maritsa, Struma and Mesta valleys. With increasing industrialization, the urban population rose from 21.4% in 1934 to more than 46.4% in 1965. This substantially altered the basic pattern of the population distribution, as some industrial towns grew rapidly; Pernik grew from 19,311 in 1934 to 75,840 (1965); Kŭrdzhali, a nonferrous-metal centre, tripled its population after 1946 to 33,271. Sofia (*q.v.*), the capital and largest city (about 21% of the total urban population), rose from 324,821 in 1934 to 800,953 in 1965. The second largest city is Plovdiv (*q.v.*) with 222,508, and the third is Varna (*q.v.*) with 180,110.

(L. Di.)

IV. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution.—The constitution, approved by the grand national assembly on Dec. 4, 1947, and based on the Soviet model, proclaims that the natural resources and the chief means of production are owned by the state, and that co-operative property and management are protected and encouraged. Local power is based on people's councils (local government bodies), which are elected locally for three-year periods. All citizens of both sexes above the age of 18 have the right to vote and to stand for election. The single-chamber national assembly, consisting of 416 depu-

BY COURTESY OF (LEFT) BULGARIAN EMBASSY, LONDON, (RIGHT AND BELOW) BULGARIA MONTHLY REVIEW

(ABOVE LEFT) PACKING TOMATOES FOR EXPORT. (ABOVE RIGHT) CURING TOBACCO IN THE SUN IN THE VILLAGE OF KOCHERINOVO, KYUSTENDIL DISTRICT. (BELOW) IRRIGATING CORN IN THE PAZARDZHIK DISTRICT

ties (1 per 20,000 persons) and elected by the people for a four-year period, is nominally the supreme organ of state power and the only legislative body. It elects the presidium, consisting of a president, two vice-presidents, a secretary and 15 members; the presidium summons the assembly, fixes the date of elections and exercises certain other essential functions, particularly when the assembly is not in session. The council of ministers, the supreme executive and administrative organ, is elected by the assembly and accountable to it. Although not mentioned in the constitution, the Politburo of the Central committee of the Communist party plays a leading role in society and the state. After reforms carried out in 1959 and 1964, the former administrative counties and districts were abolished and replaced by 27 new districts plus the capital of Sofia, which constitutes a separate administrative unit with the rank of a district (*see* Table). These units have the power to implement local political, economic, social and cultural activities. (A. S. A.)

2. Living Conditions.—There is a fixed minimum salary. Labour norms have been introduced, and workers who exceed them receive extra pay and bonuses. Taxation increases progressively, dependent upon salaries. Indemnities for temporary disablement are exempt. Government loans encourage private and co-operative housing projects; the state also undertakes construction of public housing. Rents of dwellings leased by private landlords are controlled. In the mid-1960s rent for a two-room flat was about 8% of the average worker's income.

3. Welfare Services.—Social insurances are implemented by the Central council of the trade unions. They are compulsory and cover all industrial and office personnel working under a labour contract. Provisions include cash indemnities and aid in case of sickness, employment accident and maternity; also family allowances and pensions for old age, disablement and death. The sums are collected by payments made only by employers. Failure of the employer to pay the insurance premiums does not invalidate the worker's right to receive the insurance. The social-insurance scheme also covers the remaining active population, such as farmers, craftsmen and professional people.

Medical aid is free, except for outpatient medicines. There are more than 1,300 general hospitals, many providing maternity facilities. There are also approximately 3,000 outpatient clinics, as well as sanatoriums, children's welfare centres, crèches and kindergartens. (H. Sp.)

4. Justice.—Justice is administered by the people's and district courts and by the supreme court. Judges and assessors are elected for people's courts directly by the population for a term of three years; for district courts by the people's councils for five years; and for the supreme court by the national assembly for the same term.

In Feb. 1952 a code of criminal procedure based on Soviet law was enacted; later it was substantially democratized by amendments published Nov. 10, 1961, in *Izvestiya* No. 90 of the presidium of the national assembly.

Labour disputes are examined by conciliation commissions, and disputes between economic enterprises go to arbitration courts. Courts have a legally defined responsibility to supervise the acts of the administration, a similar responsibility being also part of the public prosecutors' functions. Citizens have the right to appeal through the appropriate court. The national assembly elects the chief public prosecutor. (A. S. A.)

5. Education and Culture.—Education is compulsory for all children between the ages of 7 and 16. The system has assumed a polytechnic character with the aim of securing a fundamental knowledge of the basic sciences and the foundation of a trade in the secondary school. In 1946, 23% of the population were illiterate, but by the mid-1960s it was claimed that illiteracy had been eliminated among citizens under the age of 50. Official statistics in the mid-1960s claimed more than 7,900 kindergartens (about 360,000 children), 5,800 elementary schools (2,000,000 pupils), 293 secondary schools (116,000 pupils) and 329 vocational schools (94,500 students). There were 45 higher-educational establishments (including teacher-training, communications and library institutes), with 99,000 students. The oldest institution is the Sofiiski Universitet, founded as a high school in 1888. There is a network of research institutes and scientific unions.

The state devotes special attention to cultural development. There are nearly 11,000 libraries, with a total stock of about 36,000,000 volumes. The Cyril and Methodius National library (founded in 1878), the library of the Bulgarian Academy of Sciences, the University of Sofia library and seven state and district libraries receive copies of all Bulgarian publications. There are more than 130 museums, 36 theatres, 2,400 cinemas, 12 daily newspapers and over 14,000 amateur art groups. Radio and television are controlled by the ministry of culture. (G. S. Ko.)

6. Defense.—Defense forces were limited by the peace treaty of 1947. Maximum strength permitted included an army of 55,-

000; a navy of 3,500 with a tonnage up to 7,250; and an air force of 5,200 with up to 90 aircraft but no bombers. In May 1950 a new army command was formed, under Gen. Petar Panchevski, a Soviet officer of Bulgarian origin, and the armed forces were reorganized on the Soviet model. In 1953 they numbered about 220,000 men, including about 40,000 in the forces of the interior. In May 1955 Bulgaria joined the Warsaw Treaty organization. In 1955 the armed forces were reduced by 18,000 men, and in 1958 there was a further reduction of 23,000. In Dec. 1959 Panchevski was succeeded by Gen. Ivan Mihailov, who in March 1962 was replaced by Gen. Dobri Dzhurov. From May 1956 the term of national service was reduced from three years to two in the army and from four years to three in the air force and navy. By the late 1960s the strength of the army was 125,000 (11 divisions, including 3 armoured); of the air force 20,000 (400 aircraft and Soviet-built Guideline anti-aircraft missiles); of the navy 4,000 (2 frigates, 2 submarines, 80 small vessels); of the Security Police 45,000. (X.)

V. THE ECONOMY

State economic planning on the Soviet model began in 1947. After nationalization of private industry in 1947 the first two-year plan was formulated, and by 1952 the private sector in industry was virtually nonexistent. A series of five-year plans followed. It was claimed that the main goals of the 1958–62 plan (*i.e.*, a 60% ncrease in industrial production and a doubling of the power output) had been essentially attained by 1960, although a 30% increase in agricultural production was not achieved. After 1964 decentralization, local planning, profitability and consumer demand were considered. In Nov. 1966 the Communist party endorsed the fifth five-year plan.

1. Agriculture.—Until 1947 Bulgaria presented an agricultural picture typical of the peasant countries of southeastern Europe. Manorial rights were abolished with the proclamation of independence (1878). Small farms were parceled out into very small allotments, and, in 1934, 30% of the cultivated land accounted or 63% of the holdings (all less than 5 ha. [about 12 ac.]) and 3% of the agricultural production. Only 11% of the holdings were more than 10 ha., and these were mainly cereal producing. Between World Wars I and II efforts were made to stop this overdivision of the land, but they were not successful, although the Bulgarian Agricultural and Co-operative bank did much to help in he importing of machinery and in the buying and selling of agriultural products.

After World War II, the co-operative movement spread further, until probably more than 80% of the arable land was in co-operative farms. In 1957 there were 3,202 co-operative and state farms. They were merged by the early 1960s into 867 large units averaging 3,852 ha. (9,419 ac.) of arable land, with increased mechanization, extensive use of fertilizers, and the greater employment of agricultural specialists. Irrigation progress was furthered by the construction of six large dams, including the Vasil Kolarov (completed 1951), Iskar (1956), Studen Kladenets (1957) and Batak (1958), bringing the total of such dams to 70 by the late 1960s.

BY COURTESY OF "BULGARIA" MONTHLY REVIEW

SHIP UNDER CONSTRUCTION IN THE SHIPYARDS AT VARNA

Cereal crops utilize almost two-thirds of the sown land. Wheat is by far the most important with 30% of the sown land, then corn (maize) with nearly 15% and barley 11%; rye, oats and rice are also grown. Other food crops are very varied, as the farmers produce most of their own vegetables and fruits.

Industrial crops are important, particularly tobacco, oil-seed plants such as sunflowers and also cotton and sugar beets. Of these, tobacco is by far the most important. It is good-quality Oriental type and is grown mainly in the southern districts.

Sunflower seed is the chief (about 90%) oil-seed crop; after the extraction of the oil, the pulp forms a valuable cattle food. Sunflowers, like sugar beets, grow mainly on the northern platform and were introduced after 1918. Vines produce a good-quality grape, and more than 65% of the annual crop is produced by co-operative farms. Bulgaria has become a leading exporter of grapes. Vegetable production, especially of tomatoes, and fruit growing are also important. Most farms, private and co-operative, raise animals, especially where mountain slopes give pasturage. The development of animal husbandry accounts for 33% of the agricultural output.

COURTESY OF THE BULGARIAN EMBASSY, LONDON

STUDEN KLADENETS DAM IN THE RHODOPE MOUNTAINS, ONE OF SIX DAMS WHICH HAVE INCREASED THE AREA OF IRRIGATED AGRICULTURAL LAND

2. Industry.—Before World War II industries were of minor importance in Bulgaria. The census of 1934 showed only 266,405 persons (7.8% of the total economically active population) engaged in industry, including 186,200 in handicrafts. By the 1960s more than 900,000 workers were employed outside agriculture.

Under the Socialist system, industrialization became one of the principal aims of economic policy, with particular emphasis on basic industries such as electric power, ferrous and nonferrous metallurgy and chemicals. Central planning of management, production and investment channeled into industry a steadily increasing part of the national resources, and by 1966 industrial output was 24 times as great as before World War II.

Metallurgy and engineering before the war were feebly developed; shipbuilding at Varna and foundries at Sofia, Plovdiv, Ruse and Pernik (Dimitrovo) were the most important. Metallurgical industries developed after the war include iron and steel works at Pernik, based upon local brown coal and iron ore from the Sofia district; a giant steel project at Kremikovtsi, 10 mi. (16 km.) N.E. of Sofia; the lead and zinc works at Kŭrdzhali, based on the ore fields of the Madan-Rudozem district in the Rhodope mountains; and the copper and sulfuric-acid plant at Pirdop. A large chemical industry has developed at Dimitrovgrad (based on the lignite and electric power available there, making fertilizers and other products). Big chemical plants were also built in Stara Zagora, Vratza, Devnya, and Vidin, and a petrochemical plant was built at Burgas. Machine building is a priority branch of the national economy. Its relative share of industrial production has jumped from 2.4% in 1939 to 17.8% in 1966, employing 200,000 workers (only 25,000 in 1948).

Textile industries in factories, as opposed to the almost universal domestic wool working, were, before World War II, mainly to be found in the central part of the country—*e.g.*, Gabrovo, Sliven, Kazanlŭk, Khaskovo—together with Sofia, Varna and Ruse. These used locally produced wool, cotton or silk. Within the five-year plans large new mills were built at Sofia, Sliven and Plovdiv, and the total output of textile fabrics by 1966 rose to 16 times what it was in 1939. Other industries that increased considerably after World War II were food processing and consumer-goods industries such as footwear, pottery and furniture.

Mining.—Coal output increased from 7,400,000 tons in 1952 to more than 26,000,000 tons in the mid-1960s; Bulgaria's own requirements were more than met, and the planned figure was surpassed. About half the output is brown coal from the Pernik field; a large lignite field is being developed in the Maritsa basin (near Dimitrovgrad) and there are smaller deposits of brown coal and lignite at Bobov Dol (Struma basin) and in the Sofia basin, while several small deposits of bituminous coal and anthracite occur in the Balkan mountains.

Petroleum was discovered in the southern Dobruja near Tulenovo, northeast of Varna, in 1951, and by the 1960s more than 40% of the country's total requirements were being produced, though much of this went abroad for refining. There is a small refinery at Ruse (*q.v.*) and another one at Burgas (*q.v.*) with a capacity for about 5,000,000 tons of crude oil.

Power.—The major sources of power in Bulgaria are the Maritsa lignite field, which serves large thermoelectric plants at Dimitrovgrad and Maritza-Iztok, and the hydroelectric potential of the Rhodope mountains. There are large thermal-power stations also at Pernik, Sofia, Plovdiv and Burgas. The network of transmission lines covers most parts of the country, and in the later 1960s the power output amounted to more than 13,000,000 kw.hr. The harnessing of the water resources also resulted in a considerable increase in the area of irrigated agricultural land. An atomic-power station being constructed with Soviet aid at Kozlodu on the Danube was due to come into operation by 1973.

3. Trade and Finance.—Before World War II Bulgaria's trade was principally with western Europe, Germany and Italy, which supplied over 70% of the imports and took about 70% of the exports. At the end of the war the economy was associated with that of other Socialist states and in 1949 Bulgaria became a founder-member of the Council for Mutual Economic Aid (Comecon); many products were exported within the framework of Comecon specialization. In the later 1960s exports to the U.S.S.R. accounted for more than half of Bulgaria's total exports, while the Soviets supplied a similar total of Bulgarian imports. Czechoslovakia, East Germany, West Germany, Poland, Italy and France were the main partners for the remaining imports and exports, though trade with other western countries was increasing. Agricultural produce (tobacco, tomatoes, cereals, fruit, oils and hardwoods) made up the bulk of the exports, while machinery, tools, metals, chemicals, rubber, paper and drugs were the chief imports. In 1939 raw farm products accounted for nearly 40% of exports and in 1966 for only 12%. In 1939 Bulgaria did not export machinery and industrial installations, but in 1966 they accounted for 24% of total exports.

The unit of currency—the lev (plural leva), divided into 100 stotinki—was on May 11, 1952, revalued and pegged to the Soviet ruble. Ready cash was exchanged at 100 old leva for 1 new lev. On Jan. 1, 1962, a new lev equaling 10 old leva (1.30 to 1 [new] ruble, 2.80 to £1, and 1.17 to U.S. $1) was introduced. Wages and prices were adjusted accordingly. All banks, public and private, were nationalized on Dec. 27, 1947, and the National Bank of Bulgaria (Bulgarska Narodna Banka) is the main bank of issue. It regulates the monetary circulation and supervises expenditure out of the Wage Fund and the movement of prices; under its jurisdiction there is also a Bulgarian Industrial Bank and a Bulgarian Agricultural and Commercial Bank. The minister of finance presides over a General Bank Council.

Annually parliament approves a plan for social and economic development and for implementation of the budget, over 65% of whose revenue is from turnover tax of state and co-operative enterprises and deductions from their profit; over 80% of expenditure is on the country's social and economic program.

4. Communications.—Railways are the most important means of transport, and the network extends to over 3,650 mi. (5,900 km.). The main lines are the Orient Express route from Belgrade to Istanbul, passing through Sofia and Plovdiv; the Sofia-Burgas line and the Sofia-Varna line, together with the trans-Balkan line from Gorna Oryakhovitsa to Plovdiv; and the British-built Ruse-Varna line of 1866, the oldest railway in Bulgaria. The road network has been much extended and improved. Balkan (Bulgarian Civil Air Transport) serves the main cities and Sofia airport, which has international connections. Air traffic is increasing, and there are airports at Sofia, Plovdiv, Varna, Haskovo, Burgas, Ruse, Stara Zagora and Gorna Oryakhovitsa, with international connections to 20 countries. There is a small Black sea fleet of merchant vessels based on Varna and Burgas and a river fleet for use in the Danube, where the principal port is Ruse.

See also references under "Bulgaria" in the Index.

(S. H. Br.; X.)

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(N. I. M.; X.)

BULGARIA (ON THE VOLGA), a country of ill-defined boundaries which played a role of varying importance during the 9th–15th centuries in the territories adjoining the middle Volga and Kama river basins in what is now the U.S.S.R. Almost nothing is known of the origins of the Bulgars, though it seems likely that they moved northward from the shores of the Sea of Azov where their presence is reported as early as the 5th century. They can, therefore, be considered as "cousins" of the Bulgars of the Balkan peninsula, who moved there in the 7th century.

Ibn Fadlan, a member of an embassy sent by the caliph of Baghdad to the Bulgars in 921–922, has left a detailed account of this people. At that time the Bulgar country must have stretched far to the north, since contemporary descriptions refer to the aurora borealis and to nights "too short to cook a pot of meat."

When Ibn Fadlan visited them, the Bulgars had already been converted to Islam.

The Bulgar land was not a country in the strict sense of the word, and it would be mistaken to take the Bulgars for a homogeneous nation. In the 10th century they were divided into three hordes of which only one was called Bulgar. At least two languages were in current use: a Turkish dialect and one (different from, though related to, the common Turkish languages) which can be regarded as an ancient form of modern Chuvash. No texts exist, and knowledge of the language is derived from contemporary accounts, short funeral inscriptions and the testimony of Chuvash-ype loanwords in Hungarian.

In the 10th century the civilization of the Bulgars was rudimenary. They practised a primitive form of agriculture, but lived mainly by fishing and hunting eked out by wild honey. They dwelt in huts and felt tents. A flourishing trade—probably mostly in urs—linked them with more southerly lands, particularly with Khwarezm (in Uzbek S.S.R.). This contact with foreign peoples had a favourable effect on the development of their local civilizaion, which looked toward Islam rather than toward Byzantium. In 1024 a Bulgar embassy brought presents "the like of which wonders has never been seen" to Mahmud of Ghazni. By that ime the Bulgars had already at least two flourishing cities: Bulgar tself and Suvar. The name of the second suggests that its inhabitants may have belonged to a different ethnic community, descendants perhaps of the Sabirs. In 1237, when the Mongols occupied Bulgar, the city was already "famous throughout the world for the strength of its position and its ample resources." Under the rule of the Golden Horde (*q.v.*) the city continued to ourish, and even the coins of the Mongol khans were minted here. The final eclipse of the town—last remainder of the once ndependent country—was brought about by growing Russian pressure during the first quarter of the 15th century.

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BULGARIAN LANGUAGE. Bulgarian, one of the southern group of the Slavic languages (*q.v.*), is the mother tongue of over 8,000,000 people living in Bulgaria and in parts of Greece, Rumania, Moldavia and the Ukraine.

History.—The modern literary language is of relatively recent origin. The Old Church Slavonic (*q.v.*) traditions of Old Bulgarian literature were continued in Bulgarian and Macedonian Church Slavonic from the 12th to the 15th centuries. They were mainained only tenuously under the Turkish yoke, in such works as the popular *Damaskini* which consisted of translations of Damascene he Studite into a Church Slavonic mixed with Serbian, Russian, nd more recent Bulgarian elements. The language was so mixed hat the herald of the Bulgarian renascence, the monk Paisij, wrote his Slavo-Bulgarian history (1762) to stir the patriotic feelings of his countrymen. Only in the 19th century did the propoents of a national literary language based on the popular speech in their struggle. Important milestones in the conflict were Peter Beron's primer (1824) and the grammars of Neofyt Rylski (1835) and Ivančo Bogorov (1844). As might be expected from he historical circumstances of its birth, the modern literary lanuage bears in its vocabulary a considerable stratum of Russian, Russian Church Slavonic and Russian loan-translation from western languages. In addition, despite the efforts of purists, it connues to reflect the history of the Bulgarian people in preserving many of its borrowings from Greek and Osmanli Turkish.

Morphology.—Together with Macedonian, Bulgarian contrasts harply with other members of the Slavonic family by its almost omplete loss of case declension and by a number of "Balkanisms," g., features also displayed by neighbouring languages of differnt stocks. As in Albanian and Rumanian, there is a postpositive definite article: *mása* "table," *másata* "the table," *málkata mása* the small table," *másite* "the tables." As in Modern Greek, Alanian and Rumanian (and even Serbian), the infinitive has praccally disappeared, being replaced by a clause: *móga da ímam* I can have," literally "I can that I have." A third Balkan feature is seen in the several tense formations expressing futurity with the auxiliary verbs "to wish" (and the related particle *šte*) and "to have" (in the negative): *šte (pro)četá* "I shall read," *njáma da (pro)četé* "he will not read," *šte sme (pro)čéli* "we shall have read," *štjáxte da (pro)četéte* "you would read." The verb conjugation has been further enriched by the development of special tenses for dependent narration, contrasted with narration for which the speaker assumes independent, immediate responsibility: *V tursko vréme . . . tój bíl* [dependent imperfect] *učítel, i ot osvoboždénieto postojánno dávaše* [indep. impf.] *prošénija za pénsija* (from Elin-Pelin). "In Turkish times he was [*supposedly, as it was said*] a teacher, and after the liberation he *was* forever *submitting* petitions for a pension."

Phonology.—Some conspicuous phonetic characteristics of Bulgarian, as represented in the literary language, are its free stress accent—with consequent reductions of unstressed vowels—which has replaced Common Slavonic (CS) pitch accent and quantitative vocalic oppositions; the almost total absence of consonant palatalization except before back vowels (compare, for example, B [den] with Russian [d'eń], Polish [źeń]); and the clusters *št, žd,* reflecting CS *tj, dj* (CS **svetja,* **medja* > B *svešt, meždá*—compare Russian *svečá, mežá* and Polish *świeca, miedza*). The distinctive vowel *Ъ* (roughly like the vowel of English *but*) and *e* replace the CS nasal vowels (CS **mǫžь,* **pętь* > B *mЪž, pet*) and the ultrashort vowels called *jers* (CS **sЪnЪ,* **bЪrzЪ,* **vьlkЪ,* **dьnь* > B *sЪn, bЪrz* (*brЪz*), *vЪlk, den*). As in the other South Slavonic languages (but also in Czech and Slovak), CS *or, ol, er, el* between consonants have undergone metathesis, with *o* > *a* and *e* > ě (reflected by *e, a* in B): CS **golva,* **melko* > B *glavá, mljáko* (cf. Old Church Slavonic *glava, mlěko* > Czech *hlava, mléko* > Polish *głowa, mleko* > Russian *golová, molokó*).

Dialects.—The dialects are commonly divided into two main groups, according to their treatment of inherited *ě*. Generally speaking, west of a line running from Nikopol through Tatar Pazardžik to Salonika, this vowel has coalesced with *e;* east of the line, under varying conditions of stress and environment, *ě* may also be reflected by *a* (with palatalization of the preceding consonant)—more frequently in the south, less frequently in the north (as in the literary language). The variants may be illustrated by the words for "milk" and "milky": W *mléko, mléčen* > SE *mljáko, mljáčen* > NE and literary *mljáko, mléčen*. The dialect transitions from Bulgarian to Macedonian and Serbian are gradual, and any boundary lines laid down will be largely arbitrary.

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BULGARIAN LITERATURE. The birth of Bulgarian literature is closely linked with the spread of Christianity among the Slavs (*q.v.*) in the 9th century. In 865 the Bulgarian tsar Boris I was baptized, and in 870 he imposed the Eastern Orthodox faith on his country. Somewhat later, at Ohrid (Ochrida; now in Yugoslavia), then seat of the patriarch of the Bulgarian Orthodox Church, a school for the propagation of Slavonic liturgical texts was founded by disciples of Saints Cyril and Methodius (*q.v.*), "the apostles of the Slavs," inventors of the scripts finally called the Cyrillic, and translators of the Scriptures into the language later known as Old Church Slavonic (*q.v.*), or "Old Bulgarian." This became, until the 19th century, the literary language of the Bulgarian people, and the school at Ohrid was the cradle of a national Bulgarian literature.

The first Golden Age of Bulgarian culture dates back to the reign of Simeon (893–927), recognized as first emperor, whose capital, Preslav, rivalled Constantinople. He assembled there such eminent ecclesiastical writers as Bishop Constantine of Preslav, John the Exarch, and the monk Chernorizets Khrabăr (Hrabăr).

Bulgarian literature reached another peak during the period of the second empire, under Ivan Asen II (1218–41), whose capital, Trnovo (Turnovo) was a cultural and religious centre; and again during the reign of Ivan Alexander (1331–71) with the literary and ecclesiastical school of Trnovo, whose most distinguished representative, the last patriarch, Evtimi (Eftimi), was the architect of an important linguistic reform. But although in the Middle Ages Bulgarian ecclesiastical literature (like the Bulgarian Orthodox Church, *q.v.; see* also BULGARIA: *History*) was formed and perfected as a weapon against Byzantine domination, its content remained on the whole dependent on Byzantine tradition (*see* GREEK LITERATURE: *Byzantine*).

National Consciousness and Romanticism.—Literature, in the sense of independent artistic creation, dates from the second half of the 19th century and was a concomitant of the great awakening of national consciousness known as the Bulgarian revival. Its pioneer was Paisii (1722–98), a monk from the Chiliandari monastery on Mt. Athos, whose *Istoriya slavyano-bălgarskaya* ("Slavo-Bulgarian History"; written in 1762 and circulated in manuscript until its publication in 1844), with its romantic glorification of Bulgaria's past, had a decisive influence upon later generations of Bulgarian writers. Outstanding among these were Georgi Rakovski (1821–67), Lyuben Karavelov (1834–79), Khristo Botev (*q.v.;* 1848–76), and Petko Slaveykov (1827–95; *see* SLAVEIKOV, PETKO RACHEV AND PENCHO), who, both as poets and publicists, helped to shape the image of the resurgent nation. The influence of the social and political conditions of their period, with its lack of civil or national freedom, combined with that of certain Russian ideological trends, taught these writers to believe that literature should be subordinated and adapted to the needs of social life. Thus their works deal almost wholly with national and social problems. Karavelov laid the foundations of Bulgarian realism in narrative prose based on close observation of small-town life. Botev, one of the great Bulgarian poets, set the example of a life and art devoted to the ideals of liberty and the fatherland. He wrote impassioned revolutionary poetry; and he put his patriotic beliefs into practice by crossing the Danube at the head of an armed band and dying in an unequal struggle against Turkish forces. In his poetry Slaveykov drew upon the rich store of Bulgarian folktales and popular songs. Folklore, an important influence on the first Bulgarian Romantic writers, remained a source of inspiration.

National Realism.—The liberation of Bulgaria in 1878 created a political and social climate far more favourable to literary development than that of the five centuries of Turkish domination. Ivan Vazov (*q.v.;* 1850–1921) is the most significant of the writers who link the epochs before and after liberation. His immense output of poems, stories, sketches, novels, and plays reflects every facet of his people's life, past and present. His lyrics echo the joys and sorrows, and the social and political aspirations, of the nation. His epic cycle *Epopeya na zabravenite* ("Epic of the Forgotten"; 1881–84) evokes with visionary power the heroes of the struggle for independence. The novella *Chichovtsi* ("Uncles," 1885), a realistic portrait gallery of Bulgarian provincial notables in Turkish times, is reminiscent of Gogol. His narrative gifts are seen at their highest in his novel *Pod Igoto* (1893; trans. as *Under the Yoke,* 1894). It vividly describes the Bulgarian struggle against the Turks, and is a work of art and a faithful picture of political and social Bulgaria at its most decisive moment. In the historical novel *Svetoslav terter* (1907), and in dramas, the best known being *Kăm propast* ("Toward the Abyss," 1910), Vazov evoked the atmosphere of medieval Bulgaria before the Ottoman conquest. His most popular play, however, is *Hăshove* (1894), a stage version of his unfinished novella, *Nemili-nedragi* ("The Unloved-Unwanted"), about Bulgarian exiles in Rumania.

Without equaling Vazov's powers of imagination and synthesis, his friend Konstantin Velichkov (1855–1907) shared his aspirations and ideals. His unusual poetic temperament is best expressed in two collections of sonnets inspired by travels to Constantinople and Italy. He was the exponent of an Italianate cultural influence, and his translations of Dante and Petrarch, and of the work of the patriot, Silvio Pellico (*q.v.*), and others, revealed the wealth of Western poetry to Bulgaria's intelligentsia. He contributed also to the literature of memoirs which flourished in the first decades after the liberation. Its most notable representative was Zahari Stoyanov (1851–89), whose lively reminiscences, *Zapiski po bălgarskite văzstaniya* ("Notes on the Bulgarian Uprisings," 1883–85), contain some of the best pages of modern Bulgarian prose.

While writers like Vazov saw in the new independent state the realized dream of the fighters of the renaissance period, others looked with a more critical eye at the negative aspects of contemporary Bulgarian society and politics. In his satires, fables, and epigrams Stoyan Mikhaylovski (1856–1927) castigated vice and corruption in public life in a style influenced by the French 17th- and 18th-century moralists and philosophers whose work he had studied at the university in Aix-en-Provence. In his most ambitious work, *Kniga za bălgarskiya narod* ("Book on the Bulgarian People," 1897), satire of contemporary society is cast in the form of a moral-philosophical allegory. In a lighter satirical vein Aleko Konstantinov (1863–97) created in *Bai Ganyu* (1895) the comic prototype of the parvenu Bulgarian peasant whose progress through Europe is a series of monumental *faux pas*. In his travelogue *Do Chicago i nazad* ("To Chicago and Back," 1894) Konstantinov contrasted the more advanced cultures of Europe and the United States with that of his own country, but was not blind to their flaws.

New Trends.—From the 1890s Bulgarian literature showed two opposed tendencies. The older school of writers nurtured in the utilitarian literary tradition of the preliberation era was challenged by a younger group known as "Europeans," intent to free art from parochialism and sociopolitical militancy. The spearhead of the new movement was the review *Misăl* ("Thought," 1892–1907), founded by Krăstyu Krăstev (1866–1919), the first real Bulgarian critic, who stressed the importance of the "aesthetic conscience." The *Misăl* group had two outstanding representatives in Pencho Slaveykov and Petko Todorov.

Pencho Slaveykov (1866–1912; *see* SLAVEIKOV, PETKO RACHEV AND PENCHO) broadened the Romantic tradition of Bulgarian poetry by infusing it with more universal content. He helped to forge a poetic language capable of expressing the complexity of human existence. Partial paralysis reinforced his tendency to aristocratic isolation and meditation. Under Nietzschean influence he glorified the heroism of spiritual achievement; his poems on Shelley, Dante, Beethoven, Lenau, and Leopardi are tributes to those he considered to be the giants of the human spirit. His philosophic and aesthetic ideas are expressed mainly in the anthology of apocryphal verse *Na ostrova na blazhenite* ("On the Isle of the Blessed," 1910), while his experiments with poetic form are revealed in the more intimate collection, *Săn za shtastie* ("Dream of Happiness," 1906). His narrative poems *Boyko* and *Ralitsa* interpret folk themes from a psychological angle. His greatest work, *Kărvava Pesen* ("Song of Blood"; publ. 1913), is conceived as a modern epic distilling the essence of Bulgaria's history and spiritual destiny. Even more than Slaveykov, Petko Todorov (1879–1916), originator of the Bulgarian romantic short story, believed that literature is self-sufficient. His *Idilii* ("Idylls," 1908) are imaginative evocations of folklore and popular legends, written in a rhythmic, harmonious prose with symbolic undertones. The delicacy of his poetic touch is evident also in several dramas based on Balkan mythology, the best known of which is *Zidari* ("Masons," 1906).

Meanwhile the realist tradition continued to flower in the works of writers like Georgi Stamatov (1869–1942), Tsanko Tserkovski (1869–1926), Anton Strashimirov (1872–1937), and, especially, Elin Pelin (pseudonym of Dimităr Ivanov; 1877–1949) and Yordan Yovkov (*q.v.;* 1880–1937). Strashimirov was an acute observer of the contemporary social scene in town and countryside. One of his best short stories of peasant life is *Kochalovskata kramola* ("The Kochalovo Quarrel," 1895). Other works include the novels *Esenni dni* ("Autumn Days," 1902), *Krăstopăt* ("Crossroad," 1904), *Sreshta* ("Meeting," 1908), *Khoro* (1926), and the dramas *Vampir* (1902) and *Svekărva* ("Mother-in-Law," 1906).

He influenced Elin Pelin, whose outstanding talent brought new lustre to the Bulgarian short story in his *Razkazi* ("Stories," 1904 and 1911) and whose popularity almost equaled that of Vazov. His novellas *Geratsite* ("The Gerak Family," 1911) and *Zemya* ("Land," 1928) are subtle analyses of peasant psychology and a peak of Bulgarian critical realism. Yovkov excelled at describing the reality of war, the subject of his masterpiece *Zemlyatsi* (1915). His collections of short stories *Staroplaninski legendi* ("Staroplanina Legends," 1927) and *Vecheri v antimovskiya khan* ("Evenings in the Antimovo Inn," 1928) reveal his mastery of narrative prose. He succeeded as a novelist and playwright almost equally.

Symbolism.—With the beginning of the 20th century the avant-garde literary currents of European inspiration gained momentum and led to a phase in Bulgarian literature that can be related to the Symbolist movement in Western poetry (*see* SYMBOLISTS, THE). Constant experimentation with new forms distinguishes the lyric poetry of Kiril Khristov (1875–1944), which is made up of a Nietzschean individualism and a sensuality comparable to that of D'Annunzio. His most modern volume of verse is *Himni na zorata* ("Hymns to the Dawn," 1911). Khristov, who lived much abroad, produced some of the best Bulgarian translations of Pushkin, Shakespeare, Byron, Schiller, Goethe, and Dante.

The greatest Bulgarian Symbolist was Peyo Yavorov (*q.v.;* 1877–1914), the first to transform the Bulgarian language into word music. His work reflects his spiritual development, from the early preoccupation with social and political problems that led to active participation in the Macedonian revolutionary movement, to disillusionment with socialism and an intense introspection. His best work was pure lyric poetry, though his plays showed great promise.

Echoes of Yavorov are found in the melodious and sensuous poetry of Dimcho Debelyanov (1887–1916), whose death in World War I made him a symbol of tragic frustration for the intellectuals. Associated with him in the Symbolist avant-garde were Todor Trayanov (1882–1944), Nikolay Liliev (1885–1960), and Lyudmil Stoyanov (1888–), though Stoyanov later abandoned Symbolism, and in the 1930s wrote several novels inspired by Socialism.

In the aftermath of World War I the literary left was represented by Geo Milev (1895–1925), a convert to revolutionary Marxism by the Russians Blok and Mayakovski; and by Khristo Smirnenski (1898–1923). The youngest, most gifted of this "proletarian triad" was Nikola Vaptsarov (1909–42), who died as a martyr in the anti-Nazi resistance. His poems, *Motorni pesni* ("Motor Songs," 1940) and *Izbrani stihotvoreniya* ("Selected Verses," 1946), hail the dawn of Socialism and the machine age.

Between World Wars I and II.—Although no prose writer in the interwar years challenged the preeminence of Elin Pelin and Yovkov, the younger generation of novelists and writers of short stories, including Stilyan Chilingirov (1881–), Dobri Nemirov (1882–1944), Konstantin Konstantinov (1890–), and Konstantin Petkanov (1891–), brought a sharper artistic refinement to realistic portrayal of Bulgarian life. The mystical-fantastical evocations of ancient Bulgaria by Nikolai Raynov (1889–) represented Bulgarian neo-Romanticism at its best. Expressionist tendencies were seen in the work of the prose writers Angel Karaliychev (1902–), Svetoslav Minkov (1902–), and, especially, Vladimir Polyanov (1899–), as well as in the poetry of Asen Raztsvetnikov (1897–), Nikola Marangozov (1900–), Dimităr Panteleev (1901–), and Nikola Furnaljiev (1903–). The most satisfying fusion of traditional and experimental poetry was found in the work of Elisaveta Bagryana (1893–), with whom the tradition of Bulgarian women writers represented by Dora Gabe (1886–), Anna Kamenova (1894–), and Magda Petkanova reached its highest expression.

Socialist Realism.—The Communist regime set up in 1944 encouraged only writing produced according to the concept of "socialist realism" as defined by Soviet aesthetic theory (*see* RUSSIAN LITERATURE: *Post-Revolutionary Literature*). The resulting uniformity of purpose of literary output in the Bulgarian People's Republic, its devotion to didactic and political aims, makes it difficult to assess the real value of the work of such novelists as Georgi Karaslavov (1904–), Dimităr Dimov (1909–65), Emilyan Stanev (1907–), Dimităr Talev (1898–), Pavel Vezhinov (1914–); such poets as Lamar, Bozhidar Bozhilov, Mladen Isaev; and such playwrights as Orlin Vasilev (1904–) and Kamen Zidarov. By the 1960s literary critics were still engaged in a Marxist revaluation of the past, which, however, seemed decreasingly mandatory amid the wealth of young talent. The originality of such poets as Biaga Dimitrova (1922–) and Lyubomir Levchev (1935–), matched by the indigenous qualities of Asen Khristoforov (1910–), Nikolay Khaytov (1919–), and Yordan Radichkov (1929–) in their stories and novels, augured well for the future.

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BULGARIAN ORTHODOX CHURCH, the national representative in Bulgaria of the Orthodox Eastern Church. The Bulgarian Church was responsible for the creation and preservation of a united nation and for laying the foundation of a Slavonic literature, through which the Slavs became inheritors of the Byzantine civilization. By imposing the Christian faith in the second half of the 9th century, King Boris I aimed at uniting the Slav masses with his small Bulgar tribe. Refused a patriarch of his own by Constantinople, he turned to Rome; after fruitless negotiations he appealed again to Constantinople and was sent an archbishop. The disciples of the two missionaries SS. Cyril and Methodius (*q.v.*), banished from the Moravian state after the death of Methodius, were enthusiastically welcomed by Boris and given every assistance. In Macedonia one of them, St. Clement, for many years celebrated the liturgy and preached in Bulgarian. He also trained a large number of Slavs for the ministry and in this way prepared the ground for a national church. Although Boris' son Simeon proclaimed his archbishop as patriarch, it was not until after Simeon's death that Constantinople recognized the Bulgarian patriarch (927). After 972, when the eastern districts of the country were conquered by Constantinople, the patriarchate moved to western Bulgaria. When Basil II Bulgaroctonus conquered these provinces also (1018) he allowed the Bulgarian Church to remain independent, but turned it into an archbishopric, which soon became Greek in character. Later (12th century) it became known as the archbishopric of Ohrid (Ochrida).

After freeing Bulgaria from Constantinople (1186) the two brothers Peter and Ivan Asen arranged that the Bulgarian priest Basil should be consecrated as bishop of Turnovo (the Bulgarian capital) and recognized as head of the Bulgarian Church. Their brother Kaloyan held lengthy negotiations with Rome, begging for an imperial diadem and a Bulgarian patriarch. Pope Innocent III sent him a royal crown and the archbishop of Turnovo was consecrated as primate (1204). Apparently the Bulgarians then broke off their contact with Rome. (*See* ASEN.) In 1235 the Bulgarian tsar Ivan Asen II obtained the recognition of the independence of the Bulgarian Church and the revival of the Bulgarian patriarchate from the Byzantine emperor John III Ducas (Vatatzes) of Nicaea and from the patriarch of Constantinople. When, however, Turnovo was taken by the Turks (1393) the last patriarch, Eftimi, was exiled and the patriarchate ceased to exist. (*See* also BULGARIA: *History.*)

For nearly five centuries Bulgaria was under Turkish domination and the church was administered by the patriarch of Constantinople, who sent Greek clergy into the country. In the late 18th century began the struggle for an independent Bulgarian Church, in which Bulgarians living in Constantinople took an active part. In this struggle the Turkish government and the Russian representatives in Constantinople (especially Count N. P. Ignatiev) looked favourably on Bulgarian aspirations, and in 1870 the Bulgarian exarchate was established. It was not accepted by the patriarch of Constantinople, who declared the newly formed Bulgarian Church schismatic (1872). In 1877 the Bulgarian exarch Antim was deposed by the Turks and his place was taken by Joseph, metropolitan of Lovech (Lovec), who had to steer the Bulgarian Church through its most hazardous years, caused by political disasters after the liberation of Bulgaria from the Turks (1878); the treaty of Berlin, which much diminished the territory of the exarchate; and the Balkan War of 1913. In 1914 he moved to Sofia where he died a year later. His post remained vacant until 1945 when the metropolitan of Sofia, Stefan, was elected. With his name is connected the healing of the schism with Constantinople in the same year. He resigned in 1948, and in 1953 Kyril, metropolitan of Plovdiv, became patriarch.

In 1925 the Holy Synod published the Bible in Bulgarian. The official paper of the church is the weekly *Tsrkoven Vestnic* and there is a monthly periodical *Dukhovna Kultura.* There is one seminary in the Cheripish monastery in the Balkan mountains and a theological academy in Sofia. The church is separated from the state. *See* ORTHODOX EASTERN CHURCH.

See S. Runciman, *A History of the First Bulgarian Empire* (1930); I. Snegarov, *Kratka Istoria na Svremennite Pravoslavni Tsrkvi,* vol. ii of *Universitetska Biblioteka* (1946). (ME. K.)

BULGARUS (d. 1166), Italian jurist, the most celebrated of the famous "four doctors" of the law school of the University of Bologna, was born at Bologna. He was sometimes erroneously called Bulgarinus, which was properly the name of a jurist of the 15th century. Bulgarus was regarded as the Chrysostom of the gloss writers, being called frequently the "Golden Mouth." He died in 1166 at an advanced age.

Popular tradition represented all the four doctors (Bulgarus, Martinus Gosia, Hugo de Porta Ravennate and Jacobus de Boragine) as pupils of Irnerius, but while there is no insuperable difficulty in point of time in accepting that tradition regarding Bulgarus, it has been held to be inadmissible regarding the others. Martinus Gosia and Bulgarus were the chiefs of two opposite schools at Bologna, Martinus being at the head of a school that accommodated the law to what his opponents called the "equity of the purse" (*aequitas bursalis*), while Bulgarus adhered more closely to the letter of the law. The school of Bulgarus ultimately prevailed, and it numbered among its adherents Joannes Bassianus, Azo and Accursius, each of whom in his turn exercised a commanding influence over the course of legal studies at Bologna. Bulgarus took the leading part among the four doctors at the diet of Roncaglia in 1158 and was one of the most trusted advisers of the emperor Frederick I. His most celebrated work is his commentary *De Regulis Iuris,* which was at one time printed among the writings of Placentius. This commentary, the earliest extant work of its kind emanating from the school of the gloss writers, is a model specimen of the excellence of the method introduced by Irnerius and a striking example of the brilliant results obtained in a short space of time by a constant and exclusive study of the sources of law. *See* GLOSSATORS, LEGAL.

BULL, JOHN (1562/63–1628), English composer of outstanding technical ability and keyboard virtuoso, was born in 1562 or 1563, possibly in Somerset, and educated as a chorister of the Chapel Royal, probably by William Blitheman, its organist. In the surviving fragment of his Gresham lecture, delivered in 1597, Bull appears to make oblique reference to Byrd also as "my master," but this may refer to a later period. From Dec. 1582 to Jan. 1585 Bull was organist at Hereford cathedral, but then returned to the Chapel Royal, where in 1591 he succeeded Blitheman as organist. He became a doctor of music of both Oxford and Cambridge universities, though he was opposed in Oxford, according to Anthony Wood's *Fasti,* by "clowns and rigid puritans who could not endure church music." A fine portrait dated 1589, in possession of the Oxford music school, shows him as a handsome and saturnine young man.

Elizabeth I had already contributed to the cost of Bull's studies, and in 1596 she appointed him to the professorship of music in the college newly founded in London by Sir Thomas Gresham. In 1601 he traveled in France, Germany and the Netherlands, where his virtuosity as a keyboard-player was much admired. On his return to England he continued in the royal service, and although he resigned his professorship in 1607 in order to marry, he was evidently highly esteemed at court, being named "doctor of music to the king" in 1612. In 1613, however, he left England without permission and entered the service of the Archduke Albert in Brussels; the British ambassador claimed that he was a fugitive from the just punishment of numerous misdeeds, but this has not been otherwise confirmed. Bull remained in the Netherlands, becoming in 1617 organist at the cathedral of Antwerp, where he died in 1628.

Little of Bull's vocal music survives, and his reputation rests on his extensive compositions for virginals and organ (some 150 extant pieces), published in *Musica Britannica* (1951–). It is distinguished less by emotional depth or freshness of invention than by an unfailing resourcefulness in devising keyboard figuration—a characteristic that helps to explain the great length of some of his sets of variations. Bull combined with an essentially conservative outlook a taste for technical experiment and the solution of unusual problems—enharmonic modulations, for example, and asymmetrical rhythmic patterns. His command of the English virginalists' technique undoubtedly had an influence on his friend and contemporary, J. P. Sweelinck (*q.v.*), the Amsterdam organist, and through him on Samuel Scheidt and the north German school.

See W. Mellers, "John Bull and English Keyboard Music," *Musical Quarterly* (July–Oct. 1954). (J. J. N.)

BULL, OLAF JACOB MARTIN LUTHER (1883–1933), Norwegian poet, commonly considered the greatest of his generation. He was born at Christiania (Oslo) on Nov. 10, 1883. Bull's first poems, *Digte* (1909), showed him as a worthy heir to the tradition of Wergeland and Bjørnson. Many of these poems describe scenes of spring and reveal unusual sensitivity and perception and the power to convey a wide range of emotion. Though attached to his native town, Bull lived for long periods in Rome and Paris and was influenced by the French Symbolists and by the philosophy of Henri Bergson. His early work is chiefly descriptive, but later he became more introverted and reflective. In *Stjernene* ("The Stars," 1924), *Metope* (1927) and *Oinos og Eros* (1930) his themes are his memories and meditations on death and loneliness. Throughout his work, especially in the last collections, one is conscious of his forceful intellect which, notably in the university cantata *Ignis ardens* (1932), enables him to convey a cosmic vision, inspired by the thought of Bergson and Einstein. Intellectual fervour animates *De hundrede aar* (1928), a long poem about Norwegian achievement in the 19th century *Oslo-hus* (1931) shows his love for his native town, where he died on June 23, 1933. Bull's collected poems, *Samlede digte,* were published in 1942. (G. RN.)

BULL, OLE BORNEMANN (1810–1880), Norwegian violinist widely acclaimed for performances of his own compositions in a light virtuoso style and of arrangements of Norwegian folk tunes. Born at Bergen on Feb. 5, 1810, he was mainly self-taught and at the age of nine became a member of the Bergen orchestra. In 1831 he went to Paris where he set himself the aim of emulating Niccolo Paganini. His career as a virtuoso violinist began in 1832 when he gave a concert in Paris assisted by Chopin. Between 1843 and 1879 he made five visits to the United States. In 1850 he established a Norse theatre at Bergen and later attempted to establish a Norwegian colony in Pennsylvania. Bull's violin playing was remarkable for its chord effects which he achieved by using an almost flat bridge and a heavy and unusually long bow. He died at Lysø, near Bergen, on Aug. 17, 1880.

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BULL. For the use of this term for animals *see* CATTLE: *Terminology;* BEEF: *Classes and Grades;* for the use of the term as an implement of sealing and in relation to papal documents, *see* SEALS: *European Seals;* DIPLOMATIC: *Papal Chancery;* and GOLDEN BULL; for the use of the term in speculative markets, *see* STOCK EXCHANGE.

BULLER, SIR REDVERS HENRY (1839–1908), English general, who was unsuccessful as commander in chief in the South African War despite his distinguished previous record, was born near Crediton, Devon, on Dec. 7, 1839. He was educated at Eton and entered the army in 1858. He gained wide experience of staff duties and command in the China campaign (1860), the Red River expedition in Canada (1870), the Kaffir and Zulu wars (1878–79) the Transvaal rebellion (1881) and the expedition to Khartoum to relieve General Gordon (1884). He won the Victoria cross in 1879, and was knighted in 1882. He became quartermaster general to the war office in 1887 and adjutant general in 1890. He ook a leading part in the military reforms of the period, in particular reorganizing the army's transport and supply system on new and sound lines.

In 1899, however, when he was appointed commander in chief in the South African War he was unfortunately past his best and failed to overcome the difficulties of the vast theatre of operations, the small forces at his disposal and the early advantages gained by the Boers. In Dec. 1899 after two of his subordinates had been defeated at Stormberg and Magersfontein, and the Natal field force under his personal command had been repulsed at Colenso in ts first attempt to relieve Ladysmith, Buller was replaced in supreme command by Lord Roberts. Buller made two more unsuccessful attempts before finally breaking through to Ladysmith, but he did not quickly follow up his advantage. When he had finally occupied the eastern Transvaal he returned home (Oct. 900) to take over the Aldershot command. His appointment was violently criticized, and after a tactless speech in answer to his critics (Oct. 10, 1901), he was retired from his command (Oct. 21). He died near Crediton on June 2, 1908.

See C. H. Melville, *Life of . . . Sir Redvers Buller* (1923).

(E. W. Sh.)

BULLFIGHTING, the Spanish national spectacle. (It is not a sport, any more than ballet, and should not be evaluated as uch.) The Spanish name is *corrida de toros,* from the Latin *cur-ere,* "to run," and *taurus,* "bull." Bulls used in *corridas de toros* re not the commonly known variety of meat or milk cattle, which s basically domesticated, but a distinctly savage breed.

Combats and spectacles with bulls were common in ancient Crete, Thessaly and imperial Rome but depended on the inherent rait of domesticated cattle to flee their attackers; the distinguish-ng trait of savage Iberian stock is its spirited and continuous at-ack without the slightest provocation.

History.—Prior to the Punic Wars the Celtiberians knew the peculiarities of the savage cattle that inhabited their forests, having developed their hunt into a game and also having herded them alive for use as an auxiliary in war where advantage was taken of their ferocity. Thus, when in 228 B.C. the Carthaginian Hamilcar Barca marched on Ilici and blockaded the city, the defenders athered a great herd of savage horned beasts, attached wagons, or carts, loaded with resinous wood to them, which they lighted with torches, and drove them at the enemy. In the ensuing battle Barca was killed and his army annihilated. Carthaginians and Romans, disputing the known world between them, were astounded by accounts of Barca's annihilation. They were equally amazed at subsequent tales of games held in Baetica (the Spanish province of Andalusia) in which men exhibited dexterity and valour before sealing the death blow with ax or lance to a savage horned beast. The Iberians were reported to use skins or cloaks to avoid the repeated attacks of their savage bulls before killing them.

Conquest of the Iberian peninsula by Vandals, Swabians (Sueves or Suebi) and Visigoths modified the customs of the people. Three enturies of Visigoth rule (A.D. 415–711) evolved a spectacle fea-uring brute strength of men over bulls (*forcados* or *pegadores*) ter adopted by the Lusitanos (Portuguese) and still retained as ne of their specialties. The Muslims from Africa who overran ndalusia in A.D. 711 gradually modified the existing games by dding delicate arabesque grace and mystic oriental fancy to the Helleno-Latin solidity and sense of rhythm. But as the Muslims ere great horsemen, their dignity demanded that they take the nce from their vassals, relegating the peons to the inferior posi-on of simply maneuvering the animals on foot so that their ounted masters might perform to better advantage. The crumbling Roman amphitheatres of Seville, Córdoba, Toledo, Tarragona, Mérida and Cádiz were rebuilt and embellished. Tournaments developed as a result of the rivalry between Moorish chieftains and Christian Iberian knights and, except in large cities which boasted amphitheatres, most festive occasions were held in the city square or plaza, from which all bull rings derive their names, or in the open fields outside the town.

The first Castilian to lance a bull from horseback is thought to have been Rodrigo Díaz de Vivar, "El Cid Campeador" (1043–99). After the Muslims were driven from Spain in the 15th century, bull-lancing tournaments continued to be the favourite sport of the aristocracy. By the time of the Austrian accession it had become an indispensable accessory of every court function, and Charles V endeared himself to his subjects by lancing a bull on the birthday of his son Philip II. During the reign of Philip IV the lance was discarded in favour of the *rejoncillo* (short spear) and the leg armour (still worn by the picadors) was introduced. As knowledge of the nobles' prowess spread beyond their domains, they were invited to competitive jousts in provincial tournaments. The nobles' unfamiliarity with the spirit of bulls other than their own caused the vassals to gain greater experience and fame than their masters. By 1700 they were performing on foot and had relegated their peons to a subordinate role on horseback (picador).

By the early 1700s bull breeding had become financially profitable, and herds were bred for specific characteristics. The royal houses of Spain, France, Portugal, Italy and even the Catholic Church in Spain competed feverishly to present the best specimens in the ring. The *banderillas* (short barbed darts) were adopted and the *perros de presa,* or dogs of prey, were developed from the Pyrenee mastiff by Spanish breeders so that the receded nostrils and protruding underjaw would permit the dog to breathe while hanging on indefinitely to worry bulls of poor spirit.

Papal threats of excommunication gradually wrought a radical transformation in the character of the *lidia* (bull joust), forcing the nobles to relinquish their role to professional subordinates who, because of class consciousness, discarded the lance in favour of the sword. One of the first great professional *espadas, i.e.,* the man who actually kills the bull, was Francisco Romero of Ronda in Andalusia (about 1700), who introduced the *estoque* (the sword still used to kill the bull) and the muleta (small heart-shaped red worsted serge type cloth folded lengthwise over a 56-cm. staff), used in conjunction with the *estoque.* At the height of his fame, the artist Francisco José de Goya y Lucientes (1746–1828) designed a distinctive professional uniform (worn only on commemorative gala occasions in Goya-style *corridas* or *corridas goyescas*). Performers began using a net to hold back their shoulder-length hair, later tying it in a knot at the base of the skull for protection in falls when tossed by the bull, just as football and soccer players used their hair to protect the head before the innovation of the helmet. This hair style later developed into the *moña y coleta,* the satin-covered semispherical cork headpiece and short queue which became the distinguishing mark of the profession.

Expense and lack of native spirited stock prevented bullfighting from taking root in France proper (*corridas* are held in southern France, however) and Italy. Portugal retained the *rejoneadores* or *cabaleiros en praça* (lancers mounted on highly trained well-bred horses) who, with the *forcados* or *pegadores* and *salteadores* (men who pole vault over a charging bull), comprise what is known as Portugal's *corridas* in which the bull's horns are padded or brass-ball tipped; thus the horses and bulls are rarely killed. After the introduction of railways, the *plazas de toros* in Spain, Portugal and Latin America (where the conquistadors introduced *corridas* in the early 1500s) greatly multiplied. Spain in the second half of the 20th century had about 400 *plazas de toros* of all sizes, from those of Madrid and Barcelona, seating 28,000 spectators, to those of the small towns accommodating 1,500. The arena floor never varies more than several metres, those at higher altitudes being smaller than those at sea level to help compensate for altitude fatigue. The *plaza de toros* in Mexico City, inaugurated during the 1945–46 season, seats approximately 50,000.

Bull Breeding.—The bulls used in *corridas* are invariably of pedigreed lineage reared on special ranches (*ganaderías*), the most celebrated being those of Miura, from Seville, which have killed more famous matadors, including the great Manolete, than any others. Shortly after weaning, vaccinating and branding, the yearling males are tested in the open fields (*tienta de acoso y derribo*, hazing and tumbling), and only those displaying the proper spirit are retained for future *corridas*. Some yearlings of remarkable pedigree, true coloration and fine physical construction are separated and when three years old are put through a series of tests (*tentadero de sementales*, stud tests) designed to prove the animal's spirit beyond a doubt. If acceptable, such bulls are then used exclusively at stud, usually 15 years; if not, they are sent to the slaughterhouse. At two to three years the heifers are tested in a small ring at the ranch (*tentadero de vaquillas*, test of heifers to be used for breeding) through all the phases of the *corrida* and only those acceptable are used; the rejects or culls go to the slaughterhouse. Royalty attended these tests which became fortnightly social events at which famous matadors practiced new maneuvers (heifers being smaller are theoretically less dangerous than full-grown bulls, but many matadors have been almost fatally wounded by heifers which were little more than calves).

Bulls are never used a second time in the *corrida*. First, their memory is remarkable and former experience would not permit the type of performance expected; and second, to be acceptable for a *corrida*, they must be physically virgin as well as virgin of contact with any phase of the *corrida*. All cattle are colour-blind. The colour red has been adopted for the work cape and muleta since it minimizes the sight of blood and other stains and produces a more colourful spectacle; the inside of the cape is yellow and the bulls charge just as readily at it as they do the red.

Performers.—*Toreros* or professional bull men consist of matadors; *banderilleros*, assistants on foot who work with the cape and also place *banderillas;* and picadors, mounted assistants with pike poles. Six bulls usually are killed during one *corrida*, the matadors, whose *cuadrillas* or troupes consist of two or three *banderilleros* and two or three picadors to each, alternating in the performance according to seniority in the profession. Matadors must pass through a trying novitiate as *novilleros* (professional novices) before receiving the *alternativa*, the ritualistic ceremony in which the senior matador confers on the novice professional status and acceptance as a professional equal, capable of dispatching any bull properly.

The Ceremony.—The *corrida* begins with the grand entry procession of the *cuadrillas* led by one or two mounted *alguaciles* (bailiffs in 16th-century costume). The matadors wear short jackets, waistcoats and knee-length skintight trousers of silk and satin richly embroidered in gold, silver or silk; dress capes of satin, heavily embroidered in gold, silver and silk or combinations of them, worn only during the entry procession; hand-drawn linen lace shirtwaists; coral-pink heavy silk stockings; flat heelless black slippers; and *monteras* or hats made of tiny black silk chenille balls hand sewn in special designs on heavy buckram. *Banderilleros* wear similar garments, lacking only the gold embroidery which is reserved exclusively for the matadors. Picadors wear broad-brimmed, low-crowned, heavy beige-coloured hats called *castoreños*, jackets and waistcoats similar to those of the matadors but not as ornate, hip-to-ankle armour of steel one-eighth inch thick on the right leg and knee-length left-leg armour covered by tightly fitting trousers of heavy cream-coloured chamois and heavily protected chamois ankle boots.

After the opening procession has crossed the arena, the *presidente municipal* (the mayor or his legal representative) throws down to one of the *alguaciles* the key to the *toriles* or bull pens. When the *cuadrillas* not performing with this bull have left the arena and the others have taken their respective positions, the *toril* door is opened. As the bull passes through the *toril* door, an attendant perched above attaches a silken rosette made of the ranch colours into the shoulder muscles of the bull. A *banderillero* capes the bull with one hand only, so that the matador may judge whether the bull shows marked preference in the use of either horn or attacks equally from both sides. Then the matador goes into the arena and performs the initial passes, usually the basic *verónica*, working as gracefully and as close to the horns as possible. The picadors enter the arena and move into position, after a bugle signal, during the cape work. The bull then charges the horse and it is the picador's duty to fend off the attack by the use of his pike pole, planting the point in the bull at the junction of the neck and shoulder blades. Because of shocking and unnecessary disembowelment of the horses, complete protective armour made of three-inch thick compressed cotton encased in leather and canvas, encouraged by Sidney Franklin, the first U.S.-born professional matador, was officially adopted in March 1930, thus virtually eliminating harm to the horses.

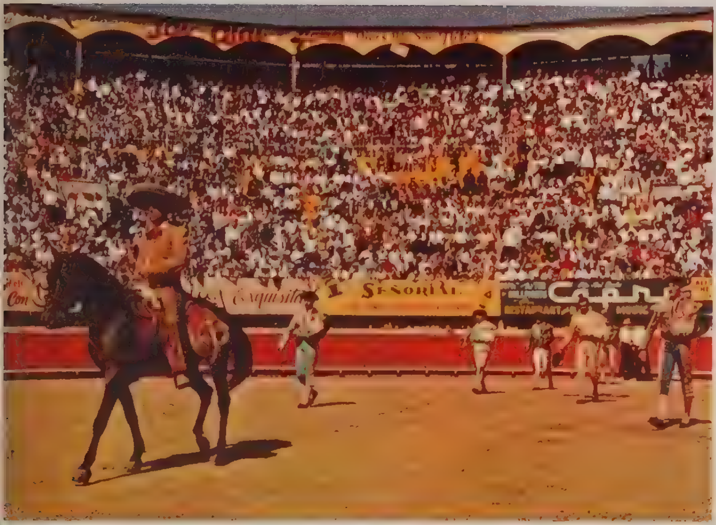
The three matadors vie in series of passes (*quites*) as gracefully as possible, taking turns in order of seniority (the matador performing with this bull coming first, the others following in turn) This is done a minimum of two times and a maximum of four stamina and spirit of the bull dictating the number. A bugle call announces the *tercio de banderillas* and the picadors retire from the arena. *Banderilleros* alternate in planting two to four pairs of *banderillas* (72-cm. staves decorated with coloured paper and with a 3-cm. barb at one end) in the bull's shoulders at the junction with the neck. This is done by attracting the bull's attention with violent gestures and shouts from a distance of 20 to 30 yd As the bull charges, the *banderillero* runs forward and slightly to one side, and as both come together, the *banderillas* are deftly planted, the man spins away to safety, and the bull's momentum takes it out of goring range. The main object of both the *banderillas* and the picadors' use of the pike pole is to weaken the grea neck muscle of the bull so that his head will be low enough a the end of the fight for the matador to kill him with the sword Some matadors, especially the Mexicans, are highly skilled with the *banderillas* and plant their own.

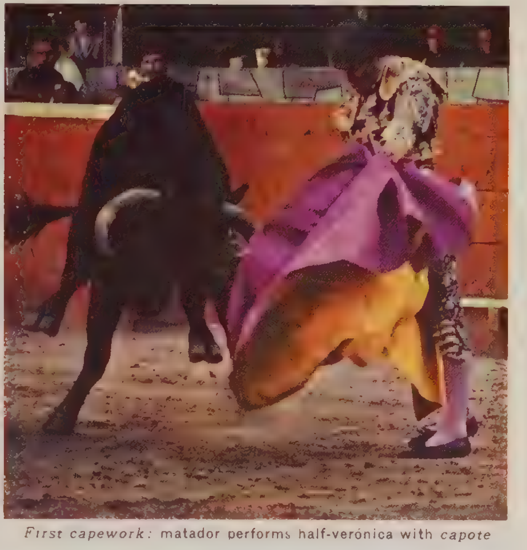
Another trumpet call signals the third and final *tercio*, the killing, known as the Hour of Truth. This is done by the matador alone, his *banderilleros* being present only in case of emergency or should he request their assistance.

The matador takes a position below the *presidente's* box and with *montera* held aloft in his right hand, muleta and *estoque* in his left, he formally requests permission to *brindar* (dedicate) the bull to some personage or friend to whom he tosses his *montera* After the matador has performed many dangerous and gracefu passes with the bull to prove complete mastery (using only the muleta which may be spread wider with the *estoque*), he prepares for the kill. This is done *al volapié* or "fleet-foot," in which man and bull attack each other from a standstill position, or *recibiendo* where the man stands still and receives the bull. The latter is rarely done because of the great precision and courage required At no time is the matador permitted to touch the bull with the *estoque* except for the kill. Improper ethics on the part of any *torero* during a *corrida* may result in heavy fines or incarceration or both.

The kill is executed by the matador thrusting forward the muleta with his left hand, causing the bull to lower his head in ques of his adversary, while with his right hand the matador sinks the *estoque* between the bull's shoulder blades at the junction with the neck. The blade should penetrate diagonally, severing the aorta or great artery and if well executed, it causes almost instant death.

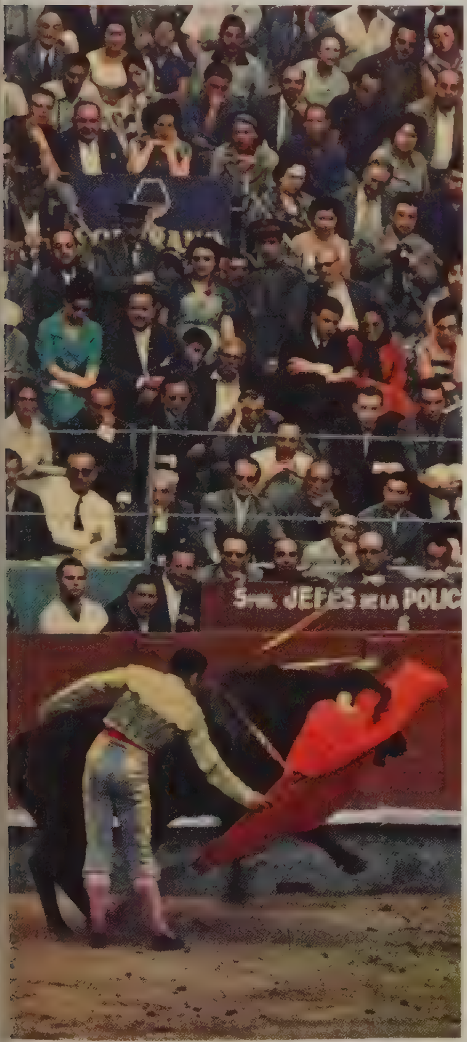
After the kill the matador, with his *banderilleros*, if acclaimed circles the arena to the applause of the spectators. Then he returns to the person honoured by his *brindis* to retrieve his *montera* which invariably is returned with money or a gift. If the performance has been excellent the matador receives, as a token of popular esteem, one ear of the bull. If it has been exceptiona he receives two ears. But if his success should be extravagant he receives both ears and the tail. While the matador is being acclaimed, a *puntillero* (an attendant armed with a short blade) severs the bull's spinal cord at the base of the skull and the bull's carcass is dragged from the arena, quartered and dressed. Sometimes the bull's meat is given to the poor, but usually it is sold right at the *plaza de toros*. The ring is raked over by the *chulos* the next bull is introduced, and the spectacle begins anew.

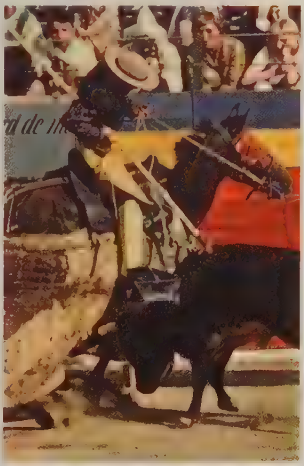

The paseo, or entrance of the *cuadrillas*, led by mounted and costumed bailiff

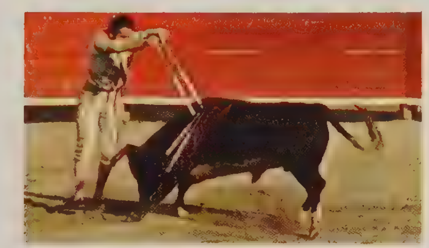

First capework: matador performs half-verónica with *capote*

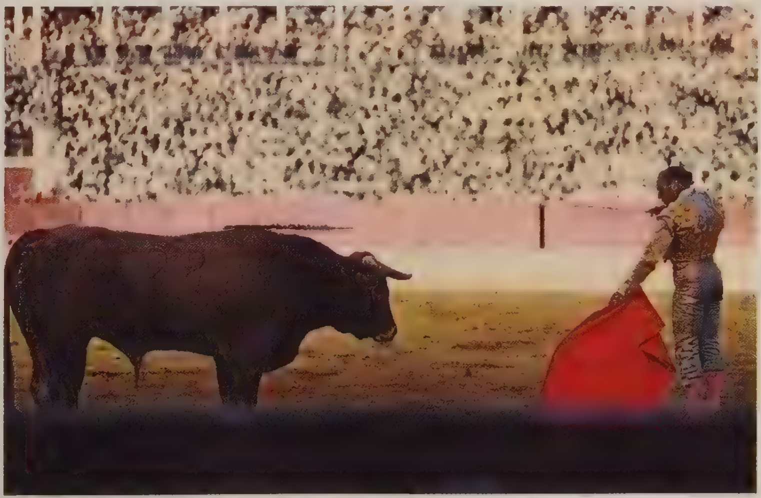
THE CEREMONY

From the Renaissance pageantry of the paseo (top left) to the killing of the bull (bottom right), the bullfight follows a centuries-old ritual. On this plate are shown six acts in the drama: the next plate shows several famous bullfighters in action


aena: matador seeks to display his mastery over the ull with a graceful *pase* using the small cape, or muleta


Picing: mounted picador strives to weaken bull's neck muscles with lance

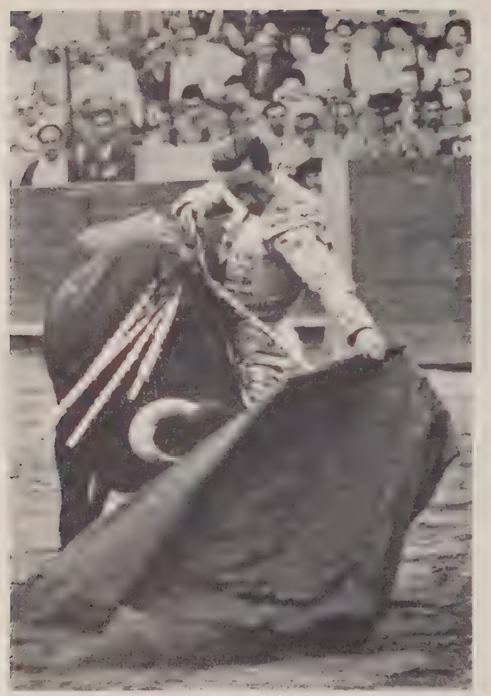

Placing of the banderillas: banderillero twists to avoid horns as he places barbs in the bull's shoulders


The kill: matador lines up bull and prepares to plunge sword between its shoulders

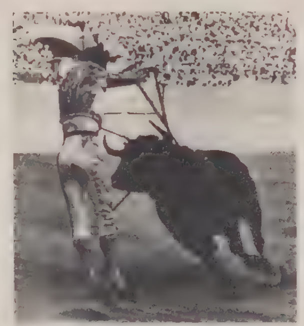
PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) C. DON MENGASON; (CENTRE, CENTRE RIGHT, BOTTOM RIGHT) JERRY COOKE; (BOTTOM LEFT) MARVIN E. NEWMAN

PLATE II

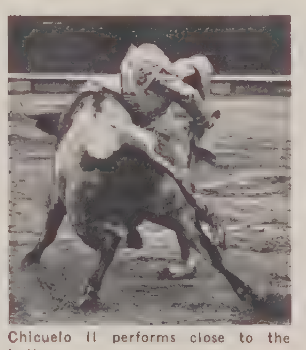
BULLFIGHTING



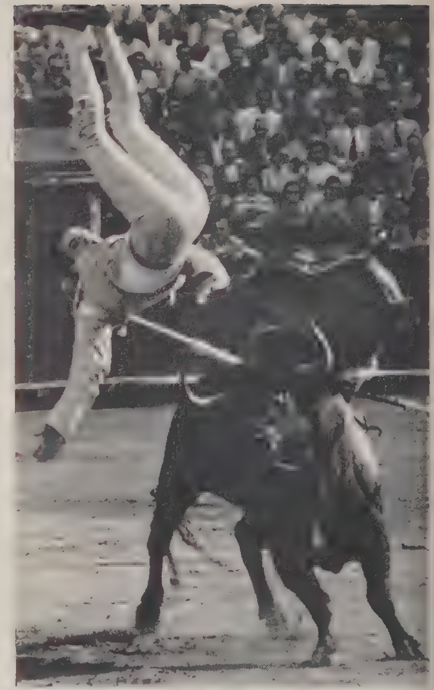
Manolete executes a natural, a close *pase* with the muleta in the left hand



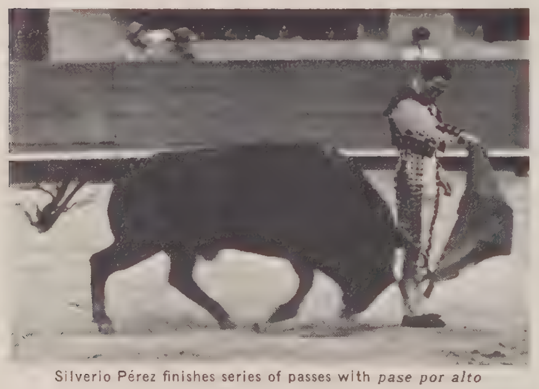
Matador Carlos Arruza places own *banderillas*



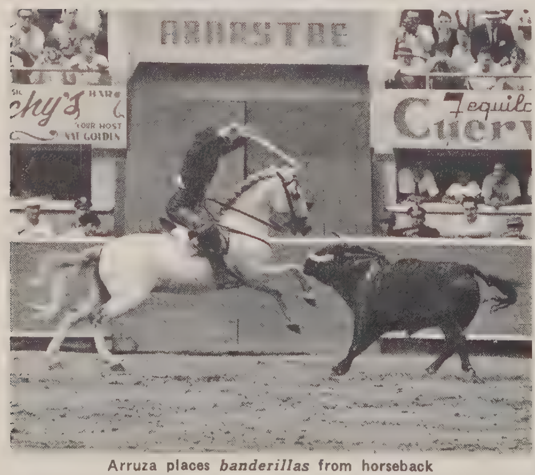
Chicuelo II performs close to the bull



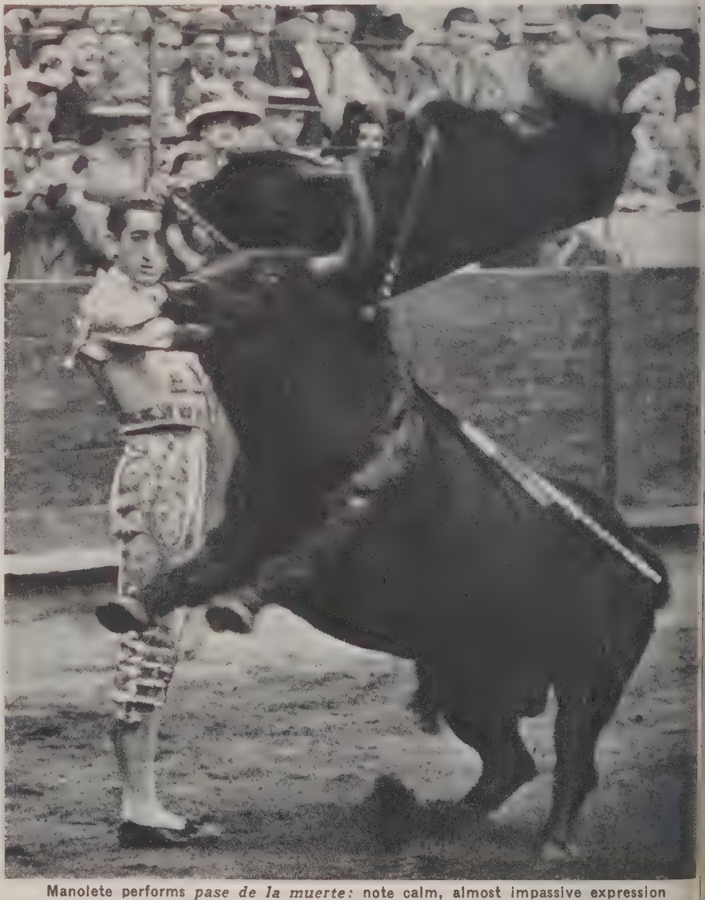
Bull tosses *torero*



Silverio Pérez finishes series of passes with *pase por alto*



Arruza places *banderillas* from horseback



Manolete performs *pase de la muerte:* note calm, almost impassive expression

PHOTOGRAPHS, (ALL BUT BOTTOM LEFT) BARNABY CONRAD; (BOTTOM LEFT) C. DON MENGASON

Great Matadors.—The star performer of this spectacle, the matador, can be and often is a wealthy man. When Manolete was killed at the age of thirty in 1947, he had made the equivalent of four million U.S. dollars. Many *toreros* (never "toreadors," a word popularized by Bizet in his opera *Carmen*) risk their lives for ten years or so, amass a fortune and then retire to a large ranch where they raise bulls for younger men to fight, as the great Juan Belmonte did.

It was Belmonte who truly revolutionized the ancient spectacle about 1914. Formerly, the main object of the fight had been only to prepare the bull for the sword thrust; Belmonte, a small, frail Andalusian, emphasized the danger to the man by close and graceful capework, and the kill became secondary. He worked closer to the horns than people had ever believed possible and became an overnight sensation. The crowd does not actually wish to see a man killed, but the *possibility* of death and the man's disdain and skilful avoidance of injury thrills a crowd.

The audience is not interested in simply seeing a man go into an arena, kill an animal in the safest manner and emerge unscathed; they want to see skill, grace and daring. Therefore a *corrida* is not really a struggle between a man and a bull but rather between a man and himself: how close will he dare to let the horns come, how far will he go to please the crowd?

Joselito (José Gómez), Belmonte's great friend and rival, considered the greatest bullfighter of all time, gave his life for the crowds in 1920, as have many men. Virtually every matador is gored at least once a season in varying degrees of severity. Belmonte was gored more than 50 times. Of the approximately 125 major matadors (since 1700), 42 have been killed in the ring; this does not include the beginning matadors or the *banderilleros* or picadors who have been killed.

The greatest matadors of the 20th century have been the Mexicans Rodolfo Gaona, Armillita (Fermín Espinosa) and Carlos Arruza; and the Spaniards Belmonte, Joselito, Domingo Ortega and Manolete (Manuel Rodríguez).

In the second half of the 20th century bullfighting appeared to be attracting bigger crowds than ever; the *mano-a-manos* (the competitive *corridas* between just two matadors) of Antonio Ordóñez and Luis Miguel Dominguín in the 1959 season excited as much interest in the countries where bulls are fought as any *corridas* in history.

Bullfighting developed in Spain and that country still is the hub of *la fiesta brava,* but there is also keen interest in Mexico, Peru, Colombia and Venezuela.

GLOSSARY

Following are definitions of some common bullfighting terms, in addition to those defined in the text of the article:

Aliño.—A *faena de aliño* is one where the bullfighter limits himself to a few functional passes, lining up the bull to kill as soon as possible.

Alto, pase por.—A muleta pass.

Arrancada.—The bull's charge.

Arrimarse.—To work close to the bull.

Ayudado.—*Un pase ayudado* is any pass where the muleta is "helped" with the sword.

Barrera.—Red wooden fence around arena; also, first rows in stands.

Becerro.—Calf, up to three years. Within that classification: *añojo* yearling), *eral* (2-year-old) and *utrero* (between 2 and 3).

Boleto.—Ticket for bull ring (Mexico); *billete* (Spain).

Bravo.—Wild; *un toro bravo* means a wild, fighting bull in a generic sense rather than simply "a brave bull" as opposed to a cowardly one.

Cajón.—Reinforced crate in which bull is shipped to the arena.

Capote.—The big work cape.

Chicuelina.—Cape pass.

Cojo.—Lame.

Costadillo, pase de.—A right-handed muleta pass.

Cruz.—The place on the bull where the sword should enter.

Doblando.—The initial capework.

Embestida.—The charge.

Entrar a matar.—To go in for the kill.

Estampa.—General appearance of bull, size, coat condition, etc.

Estatuario.—Statuesque pass.

Faena.—All work done with muleta.

Farol.—A two-handed spinning pass with cape.

Fracaso.—Flop performance.

Gaonera.—Pass with cape.

Gitano.—Gypsy. There are always *gitanos* in bullfighting, and many of its terms come from the gypsy language (*caló*).

Hierro.—Brand. Bulls are branded when about a year old.

Larga cambiada.—One-handed pass with the cape.

Manoletina.—Muleta pass.

Manso.—Tame, as opposed to *bravo.*

Mariposa.—Pass with the cape.

Media-verónica.—Half-verónica.

Molinete.—Muleta pass.

Muletazo.—Any pass with the muleta.

Olé.—Roughly, "bravo."

Orteguina or *fregolina.*—Variation of the *gaonera,* in which cape is flipped from one hand to the other behind the man's back after each charge.

Orticina.—A fancy *quite* pass.

Parar.—To stand still; one of the three rules of good capework, the other two being *mandar,* to control, and *templar,* to move the cape or muleta very slowly and smoothly.

Parón.—Any pass where bullfighter does not move his feet until after the bull has passed.

Recorte.—Any pass where the bull is turned so sharply that he is stopped.

Rodillas, de.—Pass made on the knees.

Serpentina.—Swirling cape pass.

Tanda.—A set or series of passes.

Tantear.—First passes of *a faena,* in which the *torero* merely tries to size up how the bull is charging.

Traje de luces.—"Suit of sequins" or "suit of lights," the costume of the *banderilleros* and matadors.

Tumbos.—The spills taken by picadors.

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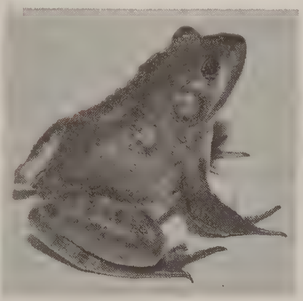
(S. FN.; B. Co.)

BULLFROG (*Rana catesbeiana*), the largest North American frog, native to the eastern states, so-named because of its roaring call. It has been introduced successfully into western North America, Hawaii, Japan, Cuba and Puerto Rico. The name is also applied to other large frogs (*Rana grylio* in southeastern U.S., *R. adspersa* in Africa, *R. tigrina* in India).



ISABELLE HUNT CONANT

BULLFROG (RANA CATESBEIANA)

The bullfrog has a greenish brown back, white to yellowish belly and dark-barred legs. Body length reaches 7–8 in. and hind legs, 10 in. A large adult weighs more than a pound. Bullfrogs are usually found in or near permanent bodies of water. They breed in the spring when the weather becomes warm; their loud calls serve to attract mates. Each female lays 10,000 to 20,000 very small, blackish eggs. The dark spotted, greenish-brown tadpoles may attain a six-inch length before transforming. Depending on climate, the tadpole stage lasts one to three years. After metamorphosis bullfrogs grow to breeding size in two to three years. Small individuals eat insects, large ones will take almost any animal they can swallow.

Many bullfrogs are caught for human food, the estimated commercial catch amounting to 3,000,000 lb. yearly. Large numbers are also used in biological laboratories. (G. B. R.)

BULLHEAD, a name applied to four North American catfishes (Ictaluridae). Black bullheads (*Ictalurus melas*) inhabit the Mississippi valley; yellow (*I. natalis*) and brown bullheads (*I. nebulosus*) inhabit the area east of the Rocky mountains; and flat bullheads (*I. platycephalus*) inhabit coastal streams between North Carolina and Florida. The four groups have been introduced elsewhere.

Female bullheads lay 2,000 to 10,000 eggs in the spring. The parents guard the young in compact schools until they are about two inches long. Young that leave the school are taken into the mouth of one of the parents and spat back into the school. Barbels (feelers) around the mouth help the bullhead locate its food, which may consist of almost any dead or living organic matter. Adults usually do not exceed one foot in length, and often lakes

JOHN H. GERARD

(TOP) BLACK BULLHEAD (ICTALURUS MELAS); (BOTTOM) YELLOW BULLHEAD (ICTALURUS NATALIS)

and streams are so overpopulated that no bullhead exceeds seven inches. Bullheads of sufficient size are good eating.

The miller's thumb (*q.v.*) and other sculpins are sometimes called bullheads. *See* CATFISH. (C. HU.)

BULLI, a town in New South Wales, Austr., within the city of Greater Wollongong, of which Bulli shire became a part in 1947, lies on the coast 44 mi. S. of Sydney by road and 43 mi. by rail. Pop. (1961) 4,829. Bulli has a courthouse (1881), a library (1947), a high school (1957), an excellent surfing beach, and a sports ground and racing track. It is the centre of the Illawarra coal seams, the most productive of the Bulli coal beds which extend from Sydney to the Clyde river. The Illawarra seams attain a maximum thickness of 1,000 ft. and the collieries, most of which are mechanized, produce about 25,000 tons daily, while estimated coal reserves exceed 600,000,000 tons. The coal is mostly used by the heavy industries at Port Kembla, by electrical power stations feeding the state grid and by the railways. Bricks and textiles are manufactured locally but most of the population work in the mines or at Port Kembla.

Access by land to the Illawarra coastal strip was first obtained (1815) by Charles Throsby, who cut a track, later known as the Bulli pass, down the escarpment of the Illawarra range (1,100 ft.). (W. H. ML.)

BULLINGER, HEINRICH (1504–1575), Swiss reformer, an influential associate and successor of Huldreich Zwingli, was born at Bremgarten, Aargau, July 18, 1504. He studied at Emmerich, then at Cologne, where through the schoolmen (Peter Lombard and Gratian) and the Fathers (Origen, Chrysostom, Ambrose and Augustine) he came to the Bible, also consulting Luther and the *Loci Communes* of Philipp Melanchthon (1521). On graduation he taught in the cloister school at Kappel, later becoming pastor. Further study at Zürich brought him into touch with Zwingli, whom he assisted in the Bern convocation (Jan. 1528). He then moved to Bremgarten (1529) as Reformed pastor, marrying the former nun Anna Adlischweiler. With Zwingli's death at the battle of Kappel (Oct. 11, 1531), Bullinger succeeded him at Zürich, where, in addition to his long pastoral ministry, he had much influence through his writings and correspondence, hospitality to religious refugees and ecumenical labours. He had a hand in the First Helvetic Confession (1536), reached the *Consensus Tigurinus,* on the Lord's Supper, with Calvin and Geneva (1549) and drew up the popular Second Helvetic Confession (1566). Though unable to reach agreement with Luther on the Eucharist, he deepened the Zwinglian conception and displayed an equable spirit. Close relations with the exiles under Mary Tudor gave him great influence on the English settlement under Elizabeth I, as seen in the *Zürich Letters* and his famous sermon series *The Decades*. Bullinger died at Zürich on Sept. 17, 1575.

His works, mostly expository and polemical, have never been collected, but a useful list is found in the Parker society edition in English of *The Decades of Henry Bullinger* (1849–52). His *Diarium* (ed. by E. Egli, 1904) and *History of the Swiss Reformation* are of particular historical interest. For portrait *see* article REFORMATION.

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BULLION, the name applied to gold and silver considered solely as metal without regard to any value arising from its form as coins or ornaments. The bullion value of a coin is determined by its weight, fineness (proportion of precious metal to total weight) and the current price of the metal.

The work of weighing and assaying bullion is done by bullion brokers, who deal with bars, gold dust and coins.

As most countries dropped silver as standard money, the silver bullion in subsidiary coins became worth considerably less than face value. An exception exists when the issuing government inflates its paper currency and reduces its purchasing power to the point that it becomes profitable to melt coins for their bullion value. Gold coins as standard money enjoy a value established by world markets for their bullion content. The value of gold stems from its use in industry and as money. The price of gold in a country that uses it as the standard money is determined by government action.

The bulk of the world's monetary gold is held in bars rather than coins and moves between countries to settle trade balances when the gold standard is operative. Individuals hoard gold when they fear either monetary or political instability. In doing so they lose any profit they might gain by investing the money and they incur storage costs. They also risk confiscation by the government of any profits resulting from currency devaluation, such as occurred in many countries during the great depression of the early 1930s. (H. G. GN.)

BULLROARER, a device which, when swung round in the air by a string produces a whirring or roaring sound. It is most commonly made of a flat, elongated piece of wood, from a few inches to a foot in length, with a hole in one end through which the string is fastened. Although used only as a toy by Europeans in recent times, it has had the highest mystic significance and sanctity among ancient and primitive peoples. The *rhombos* (*see* TOP) used at Greek mysteries is an example of such practice. The bullroarer is still highly regarded by natives of Australia, where it is prominent in initiation ceremonies for males and where it symbolizes the sky heroes or totemic ancestors of the people. It has been observed in all other major world areas where primitive peoples live. The bullroarer has been reported for almost half the North American Indian tribes, most frequently being used to control the weather. In South America it is found among the marginal and tropical forest peoples who live east of the Andes. The following uses illustrate its range of meaning to primitive people: to bring on or drive away sickness, to assemble people for religious ceremonies, to warn women and children to stay away from men's sacred ceremonies, to promote fertility of game animals and crops, and as a fishing charm.

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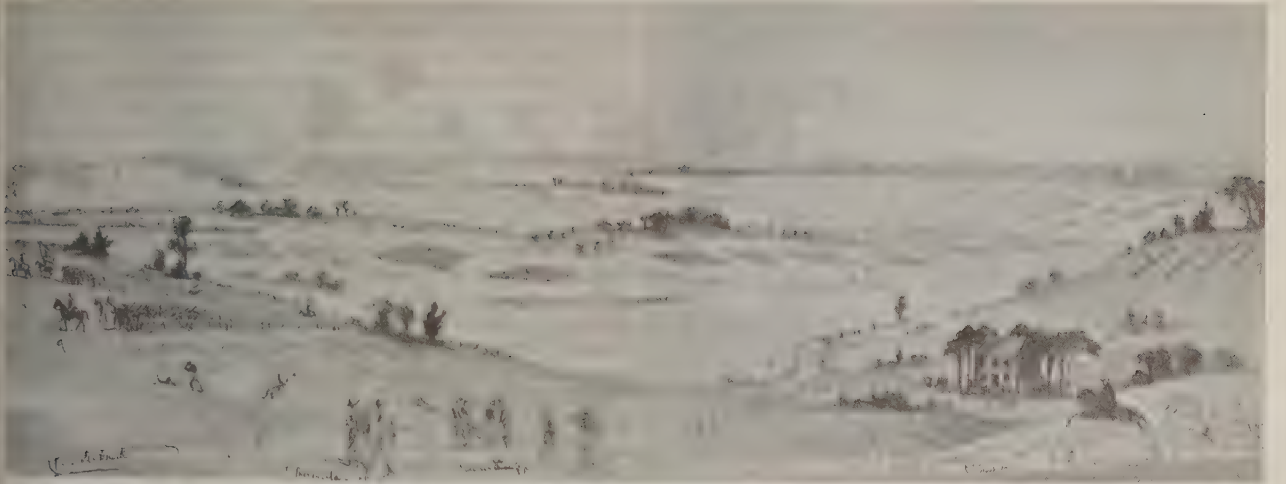
BULL RUN, a small stream in northern Virginia, after which two famous battles of the American Civil War (*q.v.*) were named. The military importance of this area stemmed from the fact that the adjacent town of Manassas was the junction of the Manassas Gap railroad extending west to the Shenandoah valley and the Orange and Alexandria railroad running south to Gordonsville.

The first battle of Bull Run (called First Manassas by the Confederates) was fought July 21, 1861. Although neither army was adequately prepared at this early stage of the war, political considerations and popular pressures caused the Union government to order Gen. Irvin McDowell to advance southwest of Washington to Bull Run in a move against Richmond. The 22,000 Confederates



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SECOND BATTLE OF BULL RUN, AUGUST 29–30, 1862. A WASH DRAWING BY EDWIN FORBES

under Gen. *P. G. T. Beauregard,*[1] after initial skirmishing at Blackburn's Ford on July 18, retired behind Bull Run in defensive positions. McDowell, discovering that the Confederate right and centre were too strong for a frontal assault, determined upon a lanking movement around the enemy left, but his delay in advancing was fatal for the Union cause.

Upon perceiving the Union movements *Beauregard* notified the authorities in Richmond by telegraph and Gen. *Joseph E. Johnston,* hen facing a Union army under Gen. Robert Patterson near Winchester, was ordered to join *Beauregard* as quickly as possible. *Johnston* was able to mask his intentions and, utilizing the Maassas Gap railroad, moved 10,000 troops to Bull Run. *Johnston* arrived on the scene July 20 and as ranking general accepted *Beauregard's* plan of attack against Centreville, but before it ould be launched the Union army assaulted the Confederate left on July 21.

McDowell, in personal command of two divisions, controlled the urning movement at Sudley Ford while one division demonstrated t the Stone Bridge and the other remained at Blackburn's Ford n reserve. McDowell's inexperienced troops arrived at Sudley Ford more than two hours late, and Colonel *Evans,* who had been left to guard the Stone Bridge, was able to move 11 of his 15 ompanies to Matthews Hill above Sudley Springs, supported by brigades of Gens. *Bee, Bartow* and *T. J. Jackson.* About 9:15 A.M. he Federal troops came under Confederate fire and were forced to eploy, but two hours later McDowell's flanking threat caused *Evans, Bee* and *Bartow* to withdraw in disorder to the Henry House Hill. Here *Jackson's* brigade stood "like a stone wall," as *Bee* houted to his men, and the Union assault was checked. Continued ttacks by McDowell against the Confederate positions made no eadway, and the arrival of the last brigade of *Johnston's* army y railroad forced the Federals into a disorganized retreat to Washington. The victors were also exhausted and did not pursue lthough *Johnston* moved to the heights around Centreville. Estimates of losses (killed, wounded and missing) from McDowell's rmy of 37,000 range from about 2,600 to more than 3,300. Estimates of losses from the combined Confederate forces of approximately 35,000 range from about 1,700 to nearly 2,000.

The second battle was fought (Aug. 29–30, 1862) between the rmy of northern Virginia under Gen. *R. E. Lee* and a newly-formed Federal force under Maj. Gen. John Pope. With the withdrawal of McClellan's army of the Potomac from the Peninsula after an unsuccessful campaign, it became Pope's responsibility to cover Washington until the two armies could be combined for a new ssault upon Richmond. Pope withdrew from the Rapidan to the Rappahannock river (Aug. 19) and was able to prevent *Lee's* advance until Aug. 24. *Lee,* determined to defeat Pope before the Union forces could be joined, took the calculated risk of splitting his army by ordering *Jackson,* screened by *Stuart's* cavalry, to march around Pope's right flank. Within two days *Jackson* had moved 54 mi. through Thoroughfare Gap to Bristoe and had captured Pope's supply depot at Manassas by midnight of Aug. 26. *Jackson* then withdrew his force north of the Warrenton turnpike, and by noon of Aug. 28 his three divisions were hidden in the woods on a flat-topped ridge about a mile northwest of Groveton.

Pope had learned of *Jackson's* march and believed the Confederates were bound for the valley, but when the Union commander discovered (Aug. 27) that all of *Jackson's* corps had moved to Manassas, he determined to surround and destroy it. Without considering the presence of *Longstreet's* corps beyond the Rappahannock river, Pope marched to Manassas by noon of Aug. 28 but found that *Jackson* had disappeared. Arriving at the conclusion that *Jackson's* whole force had retreated north to Centreville, Pope ordered his whole army to move upon that position. Meanwhile *Lee* with *Longstreet's* corps had followed *Jackson,* and on Aug. 28 his advanced guard moved through Thoroughfare Gap after dark.

Jackson realized that if Pope were allowed to concentrate his forces behind Bull Run the Union army would be entrenched in strong defensive positions where it could await reinforcements, and he, therefore, decided to reveal his own location deliberately to lure Pope back into *Lee's* clutches. In the late afternoon of Aug. 28 King's division of McDowell's corps was attacked by two of *Jackson's* divisions near Groveton. Pope fell into the trap and in spite of the fact that he had lost contact with some of his units and had misread the military situation determined to move against *Jackson* on the morning of Aug. 29. Two frontal assaults by Brig. Gen. Franz Sigel and six major attacks after Pope had reached the front at noon failed because of lack of co-ordination and *Jackson's* strong defensive positions. Moreover by noon of Aug. 29 *Longstreet* had deployed across the Warrenton turnpike, holding Porter and McDowell from attacking *Jackson's* right flank and rear. By dark *Jackson's* position near Groveton was still completely intact.

Mistakenly believing that *Jackson* was retreating, Pope at noon of Aug. 30 ordered a pursuit of the unbeaten and reinforced enemy and thereby relieved *Longstreet* of any opposition. McDowell, in charge of the pursuit, soon realized Pope's mistake and attempted to secure his exposed flank by occupying the Bald and Henry House Hills while at the same time organizing his attack against *Jackson.* Enfilading artillery fire by *Longstreet* prevented the success of the Union assault on *Jackson's* positions, and shortly after 4 P.M. *Lee* ordered the entire Confederate army forward in a grand counterattack. *Longstreet* bore down on the Federal left while *Jackson* pressed the right toward the turnpike. The Confederate victory was not complete, because the Union forces withstood repeated assaults against Henry House Hill although Chinn's

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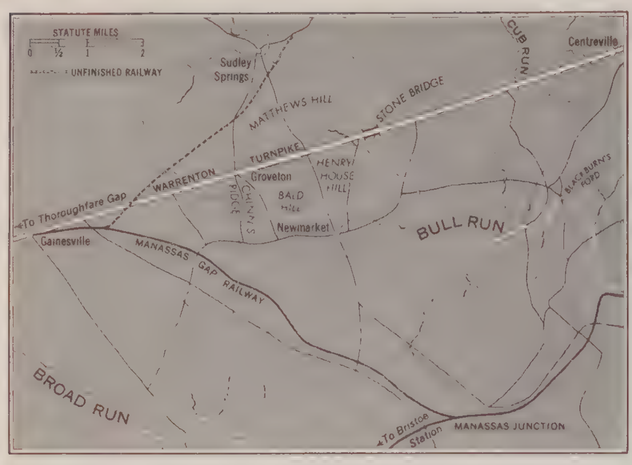
[1] In this and other American Civil War articles the names of *Confederate* enerals, statesmen and ships are given in italics.



BULL RUN, SITE OF TWO BATTLES DURING THE AMERICAN CIVIL WAR: JULY 21, 1861, AND AUGUST 29–30, 1862

Ridge and Bald Hill fell. Pope withdrew his defeated army across Bull Run and eventually retreated to the fortifications of Washington.

Estimates of Pope's losses range from about 14,000 to 16,000 men from a total force of more than 70,000 while *Lee's* casualties were about 9,000 from an army of about 56,000. (J. R. Co.)

BULNES, MANUEL (1799–1866), Chilean military figure and president for two terms (1841–51), was born in Concepción in 1799. The important victory he won, commanding the Chilean forces against the Bolivian-Peruvian confederation in 1839, assured his election to the presidency in 1841. Although he was the spokesman of the Conservative oligarchy, Bulnes found posts for many liberals in his government. His regime is notable in Chilean history for a number of reasons. Foreign investment and technological development were vigorously promoted. A wave of nationalism led to Chilean occupation in the Strait of Magellan and to the partial opening of the Araucanian Indian frontier. Social and political stability made Chile a haven for many intellectual refugees—among whom were Andrés Bello and Domingo Sarmiento (*qq.v.*)—from dictatorships in neighbouring republics. Public schools and institutions of higher learning were established, including the University of Chile, the first normal school in Latin America, a school of architecture and painting and a national conservatory of music. The new interest in learning produced a generation of young intellectuals who openly opposed the oligarchical domination that Bulnes represented. In the face of growing discontent Bulnes named his successor, Manuel Montt (*q.v.*), and had him duly elected; he was obliged, however, to resort to military action to quell a brief but bitter civil war before Montt's tenure was secured. Bulnes died in Santiago in 1866. (J. J. J.)

BÜLOW, BERNHARD, Prince von (1849–1929), German statesman, imperial chancellor from 1900 to 1909, was born at Klein-Flottbeck near Altona on May 3, 1849, the son of B. E. von Bülow, who from 1873 was Bismarck's state secretary for foreign affairs. From the first the young Bülow was assured of a career in the highest circles of imperial Germany by his family connections, by his brilliant and urbane personality and by his undeniable talents and assiduity. On leaving the Francke institute at Halle, he went to study law at Lausanne, Berlin and Leipzig. He served as a volunteer in the Bonn hussars during the Franco-German War of 1870–71. In 1874 he entered the German foreign service. After holding posts in Rome, in St. Petersburg, in Vienna and in Athens, he served in the secretariat of the congress of Berlin (1878) and then went to Paris to be secretary of the embassy under Prince Chlodwig Hohenlohe. Having been embassy councilor in St. Petersburg (1884), minister in Bucharest (1888) and ambassador in Rome (appointed in the autumn of 1893), he was in 1897 made state secretary for the foreign department, under Hohenlohe. Created count in 1899 he succeeded Hohenlohe as imperial chancellor in Oct. 1900.

Chancellor.—Born and bred in the diplomatic world, Bülow knew the continental European capitals as no German statesman since Bismarck had known them. To the German public, indeed, he long appeared as the continuator of the Bismarck tradition though in fact he stood rather for the developments and deviations from that tradition to which late 19th-century imperialism had given rise. In 1886, moreover, he had strengthened his own international connections by his marriage: this was to Maria Beccadelli di Bologna, daughter of Domenico, 5th principe di Camporeale. Her mother, Laura Acton, was a cousin of the English historian Lord Acton and had married as her second husband the Italian statesman Marco Minghetti. Maria's earlier marriage to Karl, Graf Dönhoff, had been dissolved. Bülow encountered some opposition in his plans for marriage with her.

As chancellor from 1900 to 1909 Bülow stood at the peak of his brilliant career. To his contemporaries he seemed to be the most talented of Bismarck's successors. It was only after World War I, when the records and official documents of the prewar period were made available, that a critical revaluation of Bülow began—with Johannes Haller's passionate survey, *Die Ära Bülow: eine historisch-politische Studie* (1922). Bülow, however, whose own memoirs show him to have been thoroughly critical of the emperor William II's weaknesses, is far more open than either of his predecessors in the chancellorship, Caprivi and Hohenlohe, or his successor Bethmann Hollweg, to the charge of having lent himself to these weaknesses to facilitate his rise to power and then to maintain himself. His pliancy is often barely distinguishable from flattery. He fully understood the theory of the monarchical power as based on the constitution of 1871 and experienced it for himself. Meanwhile, in both his foreign and his domestic policy, he trusted in his ability to overcome serious difficulties with adroit tactics and to avoid involvement with fundamental issues.

Foreign Affairs.—In his foreign policy, both as state secretary and as chancellor, Bülow was no doubt strongly influenced by Friedrich von Holstein (*q.v.*). Even so, he had more than a formal responsibility for what was done. His whole conduct of foreign affairs bears the stamp of the facile confidence with which he sought to employ the tradition of Bismarckian *Realpolitik* in the service of William II's policy of securing for the *Reich* "a place in the sun" among the world powers. He met at first with some easy but limited successes, such as the acquisition of Kiaochow bay, the Caroline islands and Samoa (1898–99). The idea of the Baghdad railway (*q.v.*) rested on the conviction that the perpetual conflict between Russia and Great Britain would allow the Germans to play one power against the other until they had made their way to the Persian gulf. Likewise, for Europe, Bülow and his advisers optimistically believed that by adhering to the Bismarckian policy of the "free hand" they could guarantee Germany's freedom of movement between the great powers of east and west. Even the Franco-Russian alliance did not seem to limit Germany's choice in the matter of continental power blocs, since it was hoped that the attention to German-Russian relations, as exemplified in the Björkö treaty of 1905, might force France over to Germany's side in Russia's wake. This optimism lay behind the reserve with which Bülow and Holstein conducted their negotiations with Great Britain from 1898 to 1901. These were aimed at a readjustment of the system of alliances in Europe, and the most that could have been expected of them was an experimental entente, such as Great Britain and France were to reach in 1904. As late as 1901, however, Holstein and Bülow still did not see that a British alliance, with British guarantees for Austria-Hungary, was impossible, and they offered no concessions to Joseph

CULVER PICTURES

BÜLOW

Chamberlain. The negotiations were further embarrassed by the emotional reaction of German public opinion against the South African War and were damaged by the fact that Bülow allowed Alfred von Tirpitz a free hand in his development of the German fleet. The "all or nothing" which Bülow allowed to weigh upon the conclusion to the negotiations became a parting of the ways. The rival blocs—the Triple alliance of Germany, Austria-Hungary and Italy against the Franco-Russian alliance and the Anglo-French entente—were to be consolidated until World War I broke out.

On Holstein's advice, Bülow twice tried to tear down the net of alliances that he had helped to weave, as it obstructed his policy of the free hand. The Morocco crisis of 1905–06, linked with the profitless Björkö treaty with Russia, was intended to demonstrate the basic weakness of the Anglo-French entente but in fact strengthened it. While Holstein did not aim at war but was prepared to face catastrophe if it came, Bülow dissociated himself from him at the climax of the Morocco crisis and disregarded his opinion. Both emperor and chancellor were determined at all costs to avoid a decision by war. This, however, did not hinder Bülow from accepting Holstein's and A. von Kiderlen-Wächter's advice at the time of the crisis of 1908–09 over the Austro-Hungarian annexation of Bosnia-Hercegovina. On this occasion the full weight of German power was used to ensure the European recognition for the annexation when it seemed in danger from the support given by Russia, with Great Britain's approval, to Serbia's objections. This show of "Nibelung loyalty" to Germany's last reliable ally was accounted a great victory to Bülow by German public opinion, as he had thereby bypassed the danger of the *Reich's* encirclement.

In fact Bülow must have appreciated the true seriousness of the situation by the end of his period of office. The damage done to Anglo-German relations by Germany's naval program caused him great misgivings, and with unwonted vigour he insisted on a decision of the question whether there should be a change in preference from heavy battleships to smaller armaments such as cruisers, torpedo boats and submarines. By this time, however, William II's faith in his adroit adviser was exhausted and Bülow had to leave this fateful question to his successor Bethmann Hollweg. Though he later accused Bethmann of stumbling into World War I through incompetence, it is beyond question that Bülow himself, for all his brilliance, bore a decisive part of the responsibility for the critical development in the European and German situation.

Domestic Affairs.—In domestic affairs Bülow also had some early successes, but his tenure of the chancellorship was characterized by the way in which the major problems of Prussia and the *Reich,* at first obscured, were left finally unsolved. Bülow adhered to the tradition of government with the support of "varying majorities." This was intended to maintain power in the hands of the monarch and the administration, but became increasingly questionable under the pressure of the rising power of the masses. In the empire and Prussia it depended on the support of the Conservatives and of the Centre and, in certain connections, even that of the National Liberals. In Prussia, Bülow sacrificed the Rhine-Elbe canal project to the Conservatives and thereby gained acceptance of the hotly contested protective tariffs of 1902 (the increased cost of agricultural and industrial produce had to be met by the consumer). Though he took no steps to repress the Social Democrats and even introduced some cautious social measures through his state secretary, Artur Posadowsky, he made sure that the workers and their party should reap no political advantages. He studiously bypassed the truly urgent problems such as the repeal of the Prussian three-class suffrage laws, resolution of the dualism between Prussia and the empire, the radical reform of the imperial finances and the development of direct taxation.

Even so—unlike William II, the court and the Prussian Conservatives—Bülow saw the necessity of co-operating with the *Reichstag.* Thus he facilitated the transition from constitutional monarchy of the Bismarck type to a parliamentary government, though his administration up to 1905–06 can hardly be described as even semiparliamentary. In 1905, however, when his relations with the emperor had already deteriorated (not least on account of questions of foreign policy), he made use of the opposition of the Centre on colonial questions as pretext for the dissolution of the *Reichstag*—a measure directed against the Centre and the Social Democrats. The "bloc" system of politics then introduced by Bülow with the assistance of the Conservatives, the National Liberals and the Liberals could have led in the long run to liberal constitutionalism if it had not collapsed in 1909, when the coalition parties objected to the inclusion of death duties in a project for the reform of the imperial finances.

Resignation.—Already in 1908 Bülow had become estranged from the emperor for his handling of the *Daily Telegraph* affair. That newspaper's account of an interview with the emperor, intended to conciliate British opinion, had instead provoked great indignation among readers, and Bülow had to admit that he had not read the proof of it submitted to him before publication. The emperor, however, who then had to promise not to intervene in politics without consulting the chancellor, felt that Bülow had deliberately passed the proof to bring about his humiliation. Thereafter his antipathy to Bülow was ineradicable, and when the Conservatives and the Centre reunited on the question of death duties they had no difficulty in forcing Bülow to resign. The emperor then accepted his resignation (July 14, 1909). The inheritance that he left to Bethmann Hollweg, one of the men whom he had proposed for his successor, was a problematical one.

Later Years.—After his dismissal Bülow consistently attempted to regain power but was always met by the emperor's firm refusal. The criticism of Bethmann which appears in his memoirs is especially painful reading because of the writer's total blindness toward his own weaknesses and mistakes. In Dec. 1914 he was sent as ambassador to Rome to dissuade the Italians from entering World War I, but failed; and his charge that Bethmann was too weak in his dealings with Vienna ignores Bülow's own conduct of affairs during the Bosnia-Hercegovina crisis. In July on his last bid for power, a large section of the parties was prepared to support his return to office, and he even approached the Social Democrats, but once again the emperor refused his candidature.

Bülow spent his last years either in his home town or in Rome. He died in Rome on Oct. 28. 1929.

Bülow's memoirs, *Denkwürdigkeiten,* were published posthumously at his own request edited by Franz von Stockhammer, four volumes (1930–31; Eng. trans. 1931–32). Indispensable to the historian, they nevertheless require a critical approach and represent a major attempt to dispute his personal responsibility for the German collapse. In these memoirs, however, the strengths and weaknesses of his personality are mercilessly reflected, and he does not make good his contention that he left to his successors an intact inheritance which they squandered away. The memoirs, in fact, do little to make him seem anything more than a moderately successful opportunist, with no real statesmanship. His was a talent whose intellectual and human weaknesses cannot be conjured out of the history of pre-1914 Germany.

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BÜLOW, DIETRICH ADAM HEINRICH, BARON VON (1757–1807), Prussian soldier and military writer, brother of Gen. Friedrich Wilhelm von Bülow, entered the Prussian army in 1773 and remained in the service for 16 years. He wrote a number of brilliant but unorthodox books on military science and history in the opening years of the 19th century. These works—distinguished by an open contempt for the Prussian system, cosmopolitanism hardly to be distinguished from high treason, and the mordant sarcasm of a disappointed man—brought upon Bülow the enmity of the official classes and of the government. He was arrested as insane, but medical examination disproved the charge and he was then lodged as a prisoner in Kolberg, where he was harshly treated, though Count Neithardt von Gneisenau obtained some mitigation of his condition. From there he passed into Russian hands and died in prison at Riga in 1807, probably as a result of ill treatment.

Bülow was an enthusiastic supporter of the method of fighting in small columns covered by skirmishers, which, more of necessity than from judgment, the French revolutionary generals had adopted. Battles, he maintained, were won by skirmishers. But his tactics, like his strategy, were vitiated by their dependence on the realization of an unattainable standard of bravery.

BÜLOW, HANS GUIDO, Freiherr von (1830–1894), German pianist and conductor, esteemed for his performances of Beethoven and as the interpreter of the music of Liszt and Wagner, was born at Dresden on Jan. 8, 1830. He studied the piano under Friedrich Wieck and Liszt and conducting under Wagner and Karl Ritter. In 1857 he married Liszt's daughter Cosima. In 1864 he was appointed director of music to Ludwig II at Munich where he conducted the first performances of Wagner's *Tristan und Isolde* (1865) and *Die Meistersinger* (1868). Abandoned by Cosima, who married Wagner in 1870, Bülow continued to propagate Wagner's work both in performance and his critical writings. He conducted at Hanover (1877–80) and at Meiningen (1880–85), where his orchestra became one of the finest in Europe and where he largely established the later vogue of the virtuoso conductor. Bülow was also among the earliest interpreters of Brahms and Richard Strauss. He was admired for his performances of the Beethoven sonatas though his edition of them was criticized. He died in Cairo, Egy., on Feb. 12, 1894.

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BULRUSH, a name correctly applied to *Scirpus lacustris,* a member of the family Cyperaceae (*q.v.*), which includes also the papyrus and sedges. It is a common plant in wet places, with tall, spongy, usually leafless stems and bearing a tuft of many-flowered spikelets. The stems are used for matting, etc. In the United States the name bulrush is commonly given also to other species of *Scirpus,* especially *S. validus.* In Great Britain *Typha latifolia,* the reed mace or club rush, also is called bulrush, while in the United States species of *Typha* usually are called cattail.

The club rush grows in lakes, along the edges of rivers and in other such localities. It has a creeping underground stem; narrow, nearly flat leaves, three to six feet long, arranged in opposite rows; and a tall stem ending in a cylindrical brown spike, six inches to one foot long, of closely packed male (above) and female (below) flowers. The spike is a dense mass of minute one-seeded fruits, each on a long hairlike stalk and covered with long downy hairs, which render the fruits light and readily carried by the wind.

The bulrush of Scripture, associated with the hiding of Moses, was *Cyperus papyrus,* the Egyptian papyrus, which was abundant in the Nile. *See* also Rush.

BULTMANN, RUDOLF (1884–), German theologian and New Testament scholar, whose demand for demythologizing the New Testament evoked a tremendous theological controversy in Germany and the world, was born Aug. 20, 1884, at Wiefelstede, Oldenburg. He studied at Marburg, Tübingen and Berlin, and was *Privatdozent* at Marburg (1912) and professor of New Testament studies at Breslau (1916), Giessen (1920) and Marburg (1921), retiring in 1951. With Martin Dibelius (*q.v.*) and K. L. Schmidt, Bultmann was a pioneer of form criticism, the study of the origin and development of the oral tradition behind the Gospels (*Die Geschichte der synoptischen Tradition,* 1921, enlarged 1931; Eng. trans., 1963).

For Bultmann the Gospels are products of the believing community, not biographies of the historical Jesus, of whom little can be known except his preaching of radical decision in view of the coming Reign of God (*Jesus,* 1926; Eng. trans., 1934). Historical skepticism does not undermine faith, since faith's object is not the historical Jesus but Christ preached by the church as God's redemptive act.

In 1941 Bultmann launched a demand for the demythologizing of the Church's preaching. Not only the Virgin Birth and the Empty Tomb but also the Incarnation, Resurrection, Ascension and Second Coming are derived from the mythology of Jewish apocalyptic and Hellenistic Gnosticism. The mythology requires not elimination (as in liberal theology) but interpretation, specifically in existentialist terms. Man is a prey to "inauthentic existence," but can be delivered only by an act of God, which the New Testament proclaims in Christ (*Kerygma und Mythos,* 5 vol., 1948–55).

Other of Bultmann's major works are *Das Evangelium des Johannes* (1941); *Das Urchristentum im Rahmen der antiken Religionen* (1949; Eng. trans., 1956); *Glauben und Verstehen* (collected essays; 1933–52; Eng. trans., vol. ii, 1955); *Theologie des Neuen Testaments* (1948–53; Eng. trans., 1952–55). In English also are *The Presence of Eternity: History and Eschatology* (1957); *Jesus Christ and Mythology* (1958). (R. H. F.)

BUMBLEBEE (Humblebee), the common name for bees of the genus *Bombus,* which have a thick hairy body, often banded with bright colours. There are numerous species, found generally throughout the world except the Australian region, where, however, they have been introduced as agents of pollination for some of the cultivated species of clover. *See* Bee; Hymenoptera; Social Insects.

BUNCHE, RALPH JOHNSON (1904–), U.S. political scientist, was born on Aug. 7, 1904, in Detroit, Mich. He was graduated from the University of California at Los Angeles in 1927, received a master's degree in government from Harvard university in 1928 and a Ph.D. in 1934. He taught political science at Howard university, Washington, D.C., becoming a full professor in 1938. In the meantime, he traveled through French West Africa on a Rosenwald field fellowship, studying and comparing the administration of French Togoland, a mandated area, and Dahomey, a colony. He later did postdoctoral work at Northwestern university, Evanston, Ill., and at the London School of Economics in 1936 and 1937, before returning to Africa for further studies of colonial policy.

During World War II he served with the U.S. joint chiefs of staff, the Office of Strategic Services and the department of state. He joined the United Nations secretariat as director of the division of trusteeship in 1946. He was assisting Count Folke Bernadotte of Sweden in mediating the Jewish-Arab warfare in Palestine when Bernadotte was assassinated in 1948. Afterward Bunche supervised the truce and armistice agreements there. For this and his other efforts in behalf of the UN, Bunche was awarded the Nobel peace prize for 1950, the first Negro to win the award, which amounted to $31,410. He later headed a United Nations committee to study water-development projects in the middle east, including the disputed diversion of Jordan river waters in Palestine. He was principal director of the UN department of trusteeship from 1948 to 1954 and UN undersecretary for special political affairs from 1958. For a portrait *see* article Negro, American.

BUNCRANA (Bun Crannaighe), an urban district and market town of County Donegal, Ire., lies on the eastern shore of Lough Swilly, 14 mi. N.W. of Londonderry by road. Pop. (1966) 2,921. An agricultural centre and vacation resort, Buncrana also has a salmon fishery, sea fisheries and clothing factories. The town is sheltered on three sides by high hills, of which East Slieve Snaght (2,008 ft.) lies 6 mi. N.E. The square keep of the 15th-century O'Doherty's castle remains, but Buncrana castle is a residence erected in 1717.

BUNDELKHAND, a tract in central India, now included like the broadly similar tract of Baghelkhand to the east in the northern part of Madhya Pradesh (*q.v.*).

The surface of the country is uneven and hilly, except in the northeast part, which forms an irregular plain cut up by ravines. Isolated hills rising abruptly from a common level presented their steep and nearly inaccessible scarps eligible sites for castles and strongholds, whence the mountaineers of Bundelkhand frequently set at defiance the most powerful of the Indian states. The chief streams flow in deep ravine-fringed channels and are of little use for irrigation though the waters of the Betwa (*q.v.*) have been impounded for an important canal. The main sources of irrigation are numerous artificial lakes.

Diamonds are found over a considerable area of country, but particularly near Panna. The output in Akbar's time is said to have been worth £100,000 a year; a magnificent jewel from the Gadasia mine was among the treasures in Kalinjar fort. Though the quality is good, the size of the finds is now small.

History.—The earliest dynasty recorded to have ruled Bundelkhand, or Jekakabhukti, was that of the Gaharwars, who were succeeded by the Pratiharas. About A.D. 800 the Pratiharas were ousted by the Chandels, who were probably of Gond origin. By the early part of the 11th century the Chandels had extended their sway over the country between the Jumna and the Narmada. They proved no match for the Muslim invaders and their ruler, Ganda, surrendered to Mahmud of Ghazni. In 1182 the Chandel dynasty was overthrown by Prithvi Raj, the ruler of Ajmer and Delhi, after which the country remained in ruinous anarchy until the close of the 14th century, when the Bundelas, who claimed descent from the Gaharwars, established themselves on the right bank of the Jumna. In 1545 Sher Shah Sur, who had ousted the Mogul emperor Humayun, invaded Bundelkhand but lost his life while besieging the strong fortress of Kalinjar. In 1569 Kalinjar surrendered to Akbar. Guerrilla warfare continued but the Bundelas were never fully subdued. With the decline of Mogul power the Marathas gradually extended their influence over Bundelkhand, and in 1792 the peshwa was acknowledged as the lord paramount of the country.

The Maratha power was, however, on the decline; and by the treaty concluded between the peshwa and the British government, the districts of Banda and Hamirpur were transferred to the latter. In 1809 Ajaigarh was besieged by a British force, and again three years later Kalinjar was besieged and taken after a heavy loss. In 1817, by the treaty of Poona, the British government acquired from the peshwa all his rights, interests and pretensions, territorial or pecuniary, in Bundelkhand. It was in Bundelkhand that the rani of Jhansi revolted against British rule during the 1857 disturbances.

Historically Bundelkhand included Hamirpur, Jhansi, Banda (*qq.v.*) and Jalaun districts, which now compose the Jhansi division of Uttar Pradesh, but politically prior to 1947 it was restricted to the princely states of the Bundelkhand agency, a subagency of the British Central India administration. These were Ajaigarh, Charkhari, Chhatarpur, Datia, Orchha, Baoni, Bijawar, Panna, Samthar and several small estates. The agency headquarters were at Nowgong (Chhatarpur state). On April 2, 1948, they merged with the states of the former Baghelkhand agency (Rewa [*q.v.*] and minor states and estates) to form Vindhya Pradesh. Baoni, Charkhari and Samthar, enclaves in Uttar Pradesh, were transferred to that state on Jan. 25, 1950. Vindhya Pradesh became a part of Madhya Pradesh on Nov. 1, 1956. Both Bundelkhand and Baghelkhand have thus lost any political identity.

See V. A. Smith, "History of Bundelkhand," *J. Asiat. Soc. Beng.* (1881); C. U. Aitchison, *Treaties, Engagement and Sanads*, vol. v (1933). (L. D. S.; C. C. D.)

BUNDI, a town and district in Rajasthan, India. The town, 95 mi. S.E. of Ajmer, had a population in 1961 of 26,478, and is on the main road from Ajmer to Kotah.

BUNDI DISTRICT includes many parts of the wild and hilly tract known historically as Haroti, inhabited by a large Mina population. It is watered by the Chambal and Mej rivers. Area 2,148 sq.mi.; pop. (1961) 338,010.

The princely state of Bundi, with which the modern district corresponds, was founded about A.D. 1342 by the Chauhan Rajput chief Rao Dewa or Deoraj, who captured the town from the Minas. Its importance, however, dates from the time of Rao Surjan, who succeeded to the chieftainship in 1554 and by throwing in his ot with the Muslim emperors of Delhi (1569) received a considerable accession of territory. In the 17th century their power was curtailed by the division of Haroti into the two states of Kotah and Bundi; but the title of maharao raja was conferred on Budh Singh for the part played by him in securing the imperial throne for Bahadur Shah I after the death of Aurangzeb in 1707. In 1804 he maharao raja Bishan Singh gave valuable assistance to Col. William Monson in his disastrous retreat before Jaswant Rao Holkar and in 1818, by a treaty concluded with Bishan Singh, Bundi was taken under British protection, and was subsequently controlled through the Eastern Rajputana subagency of Rajputana. It was absorbed into Rajasthan on April 18, 1948. (S. M. T. R.)

BUNGALOW, a form of dwelling, typically of one story and with a wide veranda, which originated in India and became popular in Europe and the U.S.

BUNIN, IVAN ALEKSEEVICH (1870–1953) Russian poet and novelist, the first Russian to receive the Nobel prize for literature (1933), was born in Voronezh, Oct. 22 (new style; old style, 10), 1870. He worked as a journalist and as a clerk and later wrote and translated poetry, publishing his first volume of verse in 1891. For his translation of Longfellow's *Hiawatha* he was awarded a Pushkin prize in 1903 by the Russian Academy, which later elected him an honorary fellow (1909). He also translated Byron's *Manfred* and *Cain*. Bunin, whose poetry had a Parnassian ring, belonged to the post-Pushkin tradition and had no use for modern avant-garde trends. He made his name as a short-story writer, with such masterpieces as "Gospodin iz San-Frantsisko," the title piece in one of his collections (1916; Eng. trans. by D. H. Lawrence, S. S. Koteliansky and Leonard Woolf, *The Gentleman from San Francisco*, 1922). His last book of stories, *Tëmnye allei* (Eng. trans. *Dark Avenues*, 1949), was published in 1943. His longer works include *Derevnya* (1910; Eng. trans. *The Village* 1923), *Mitina lyubov* (1925; Eng. trans. *Mitya's Love*, 1926), *Zhizn Arsenyeva* ("The Life of Arsenev"), a fictional autobiography (1930; Eng. trans. *The Well of Days*, 1933) and its sequel, *Lika* (1939), and two volumes of memoirs, *Okayannye dni* (1926, "The Accursed Days") and *Vospominaniya* (1950; Eng. trans. *Memories and Portraits*, 1951). He also wrote books on Tolstoy (*Osvobozhdenie Tolstogo*, "Tolstoy's Liberation," 1937) and Chekhov, both of whom he knew personally. The latter book, *O Chekhove*, remained unfinished and was published posthumously (1955). Bunin traveled much, visiting Palestine, Egypt, India and Ceylon. In 1919 he left Russia and settled in France. He died in Paris, Nov. 8, 1953. Bunin is one of the best Russian stylists. Most of his work has been translated into other languages. After his death some of his works were reissued in the U.S.S.R.

NOVOSTI PRESS AGENCY

BUNIN

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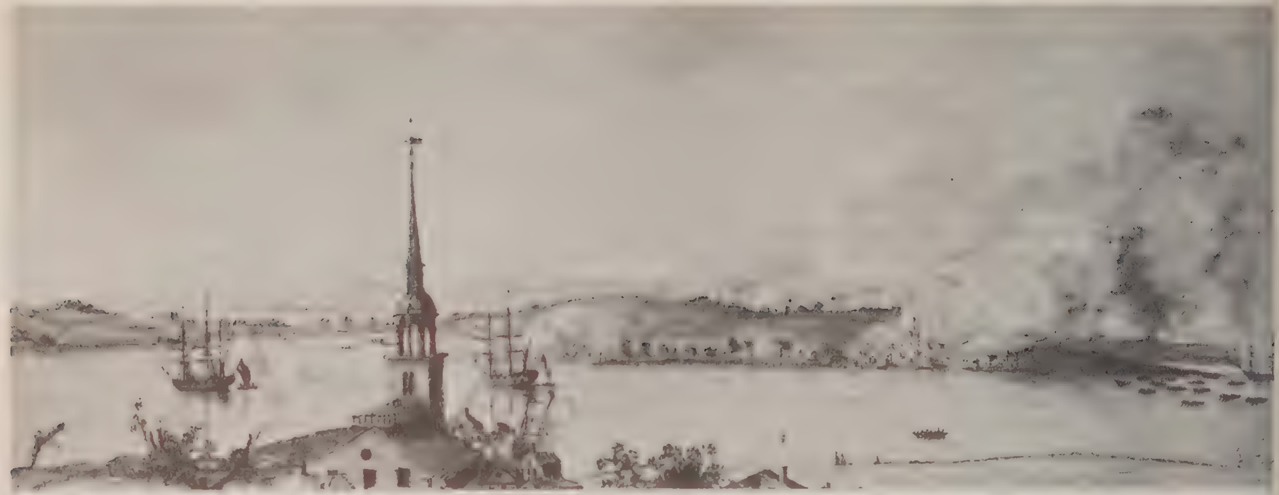
BUNKER HILL, the name of a hill in Charlestown, Mass., famous in connection with one of the most important engagements, June 17, 1775, in the American Revolution. Within two months after the day of Lexington and Concord (April 19, 1775), Massachusetts, Connecticut, New Hampshire and Rhode Island had assembled over 15,000 troops in the neighbourhood of Boston to prevent the 5,000 or more British troops stationed there under Gen. Thomas Gage from making further sallies, and perhaps, when enough heavy artillery and ammunition had been collected, to drive them away. Gen. Artemas Ward, with headquarters at Cambridge, was commander in chief of the Massachusetts troops and the senior New England officer.

There were two obvious points from which Boston was vulnerable to artillery fire. One was Dorchester heights, southeast of Boston, at that time confined to a peninsula extending into Boston bay from the south. The other consisted of two high hills, Bunker's (107 ft.) and Breed's (83 ft.) on the Charlestown peninsula jutting southeastward into the bay, to within about a quarter of a mile of the north shore of Boston. As early as May 12 the Massachu-



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BURNING OF CHARLESTOWN AND THE BATTLE OF BUNKER HILL VIEWED FROM BEACON HILL, BOSTON. SKETCH BY A BRITISH OFFICER

setts committee of safety had recommended fortifying Bunker's hill but nothing had come of the proposal. By the middle of June, hearing that Gage was about to occupy this hill (he was, in fact, planning first to occupy Dorchester heights), the committee of safety and a council of war from among the higher officers of the besieging forces decided to forestall him.

On the evening of June 16 about 800 Massachusetts and 200 Connecticut troops, under the command of Col. William Prescott of Massachusetts, were detached to carry out the project, but by some error, never explained, Prescott was ordered to fortify Breed's hill, which, though nearer Boston than Bunker's, was not only lower but could be more easily surrounded by the British.

Prescott and his men had completed a redoubt (dirt fort), about 44 yards square, on the top of Breed's hill (now commonly called Bunker hill) by the time they were discovered by the British at daybreak of the 17th. Despite a cannonade by guns from British men-of-war in the harbour and from a battery on Copp's hill in north Boston, they were able further to strengthen their position during the morning by building a breastwork about 100 yd. long running northward down the slope of the hill toward the Mystic river.

On learning of the New Englanders' seizure of Breed's hill, Gage sent over a detachment of 2,300 or more troops under Maj. Gen. William Howe, with Brig. Gen. Robert Pigot, second in command, to dislodge or capture them. The British, landing without opposition under protection of British artillery fire, were divided into two wings, the left under Pigot to attack the redoubt from the southeast, the right under Howe to get behind the fort and breastwork by marching northward along the bank of the Mystic.

Howe's advance was stopped by a deadly fire from a body of Connecticut, New Hampshire and Massachusetts troops, some detached by Prescott, others sent to the front when the British movement to attack became known. Posting themselves behind a rail fence hastily stuffed with grass, hay and brush, they pluckily held their fire until the British were very near. Pigot, too, was at first checked by a heavy fire from the redoubt and adjacent breastwork, but, on the second or third advance, he carried the redoubt and forced the surviving defenders, many of whom had exhausted their ammunition and were without bayonets, to flee. Their retreat was covered by the men at the fence, who now also retreated, and by New England reinforcements, spurred to the front by Gen. Israel Putnam of Connecticut.

The casualties, particularly the British, were extremely heavy in proportion to the number of troops engaged. The Americans lost about 450 killed, wounded and captured, the British 1,054 killed and wounded, including 89 officers. Among the Americans who were killed was Gen. Joseph Warren of Massachusetts who had entered the redoubt as a volunteer.

If the British had followed their taking of the Charlestown peninsula by the seizure of Dorchester heights their victory at Breed's hill might perhaps have been worth the heavy cost. But, presumably because of their heavy losses there and the fighting spirit displayed by the "rebels," the British commanders abandoned or indefinitely postponed their plan to occupy Dorchester heights. Consequently, when Washington (who took command two weeks later) had collected enough heavy guns and ammunition to threaten Boston, he was able, in March 1776, to seize and fortify Dorchester heights without opposition and compel the British to evacuate the town and harbour. Another important effect from the American standpoint was that the lack of organization and discipline, especially among the Massachusetts officers and men, many of whom held back when sent to reinforce the troops at Breed's hill, gave impetus to Washington's efforts to correct these defects. Had the American volunteers been easily driven from their fortified position on Breed's hill by the troops of George III, resistance to the British government conceivably would have died out in North America through the colonists' lack of confidence. The battle of Bunker Hill, as it is commonly called, reassured the colonists that the odds against them were not so overwhelming as to deny the prospect of ultimate success. *See* also AMERICAN REVOLUTION.

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BUNKERING, SHIP. This term denotes the process of fueling a ship and is derived from the word "bunker," a compartment on shipboard for storing fuel. Coal bunkering has naturally been in use ever since steamships came into existence. In the early days it was performed by hand and was an extremely slow process. To decrease the time required for bunkering, either for fuel or for cargo, and thus decrease the cost of the operation, various types of mechanical bunkering devices have been developed to reduce a ship's time in port, an important economic aspect in ship operation Coal as a fuel has been replaced, except for small commercial vessels, by oil; thus the loading of coal applies primarily to coal as a cargo.

Coal Bunkering Devices.—The De Mayo bunkering device is a completely enclosed bucket elevator, suspended singly or in series from the ship's tackle or from the boom of a coaling barge; it discharges coal from barges alongside, both inshore and offshore and at the intake porthole. With this system, portable conveyors are sometimes employed for trimming the coal in the bunkers, *i.e.* moving it from one spot to another, or for loading through deck hatches in connection with a portable elevator.

The Suisted bunkering elevator consists essentially of a bucket elevator and band conveyor mounted on two pontoons with room between for the coal barges; one of the pontoons contains the generating plant for power and light while the other provides accom modations for the crew. It is so built that the upper structure straddles the barges to be unloaded, devouring their contents and disgorging them into the bunkers of a vessel. The important feature is the way in which the bucket elevator is mounted between the two pontoons, so that it can be raised and lowered mechanically from side to side in order to pick up the coal with the minimum amount of trimming.

Oil Fuel Bunkering.—Until such time as the propulsion of vessels by nuclear fission has become commonplace and ships no longer require conventional fuels, oil will be the fuel that propels them over the sea lanes. Oil has a great many points in its favour. There are approximately 18,500 British thermal units (B.T.U.) per pound in liquid residual fuel against only 14,300 B.T.U. per pound in coal. Oil can be carried in spaces aboard ship that would be impractical for the carriage of coal—as in shallow double bottoms. It requires less bunker space, less handling and lends itself to speedy dispatch. When using oil there is no dust and very little smoke; trimming is no longer necessary and no ashes have to be disposed of. Oil also makes unnecessary the large engine-room crew needed to handle coal. In addition, modern high-pressure boilers cannot be fired with coal.

The physical task of bunkering a ship with oil, compared to coal, is an extremely simple one. Vessels can be bunkered at a loading pier, oil dock or at anchor; in specialized cases vessels can even be bunkered while underway at sea. In essence, bunkering entails a hose or pipe connection between a storage tank and the ship with valves to control the flow. Most modern ports can bunker ships either by a system of fixed pipes and portable hoses or from oil barges without interfering with cargo or passenger operations.

Fueling Stations.—In the latter half of the 19th century, as steam vessels replaced sailing ships in ocean transport, the trade of the world began to settle down upon fixed routes and, with the opening of the Suez and Panama canals, the great sea lanes encompassing the globe were completed. Along these lanes fueling stations sprang up at ports where merchant ships found it convenient to replenish their bunkers. The increased size of ships, improvements in the steam engine, the use of oil fuel and the introduction of the internal-combustion engine added greatly to the time that ships could remain at sea without refueling. As a result some of the older coaling stations decreased in importance, while others, under the influence of oil, grew rapidly. At terminal ports on the great trade routes the bunkering trade, which carried oil or coal from its sources to the fueling stations, formed no small part of the commerce of the world. Modern navies depended almost entirely upon oil for fuel and the fueling stations were consequently reorganized according to the needs of each individual nation.

Bunkering At Sea.—Naval vessels of all the great maritime powers are able to transfer fuel, supplies, water, ammunition and personnel from one ship to another at sea. This greatly increases their ability to stay at sea for long periods. During World War II, for example, some ships cruised for several months without having to return to port.

In general the method of bunkering at sea may be summarized as follows. Let us say the ship to be fueled is a destroyer and the ship furnishing the fuel is a tanker. The smaller ship makes the approach on the larger one. Before the approach is made, preliminary preparations must be completed on the tanker and destroyer—the oil hoses readied, a red flag placed over the side to indicate the fueling station, telephones made ready for communication between the bridges of the two ships and the fueling stations, heaving lines, blocks and various gear readied for the operation.

The destroyer approaches the tanker at a speed of three to four knots faster than the tanker and slows down to the same speed as the tanker when her forward fueling connection is abreast of the red flag. In good weather the ships are approximately 50 ft. apart; in rough weather this interval may be increased to as much as 120 ft. The desired distance abeam is indicated by a distance line. When the ships are in position the tanker throws a small line to the destroyer or, if the distance is too great, shoots a line over by a line-throwing gun. Distance line and telephones are attached to the heaving line and hauled to the destroyer. A larger line, about 3 in. in circumference, called a messenger, is sent over to the destroyer. The messenger is used to haul the fuel oil hose aboard the destroyer. The oil hose is then attached to a fueling connection and the fueling begins. One ship does not tow the other during the fueling operation. At completion of fueling, oil hoses and lines are hauled aboard the tanker, the destroyer increases speed and goes on out ahead.

Alertness of all hands plus the cushioning effect of the seas entering the narrow space between the ships renders the danger of collision during a fueling operation very slight.

The U.S. navy uses three systems, or rigs, to transfer fuel at sea: the close-in rig, the Elkwood rig and the Elkomin rig. These rigs are similar, the principal difference being in the manner of attaching and supporting the oil hose between the ships.

The transfer of supplies, personnel and ammunition is made as follows: The supply ship sends to the receiving ship a rope or wire which is made fast on the receiving ship and kept taut by the supplying ship. A single block is rolled back and forth on the rope or wire by two lines, one to haul out and one to haul in. Supplies and mail are handled by a hook suspended from the block. Men are transferred in special chairs, or in litters if they are injured.

Bunkering at sea is mainly a support function for combat ships and is only an emergency measure for merchant ships.

(M. O'N.)

BUNNER, HENRY CUYLER (1855–1896), U.S. writer of verse and fiction set mainly in New York city. He was born in Oswego, N.Y., Aug. 3, 1855, and died in Nutley, N.J., May 11, 1896. Educated in New York city, Bunner, after a brief experience as clerk in an importing house, turned to journalism, serving on the staff of the *Arcadian* and at 22 becoming assistant editor and later editor of *Puck* until his death on May 11, 1896. Since the staff of the comic weekly was very small and the funds were limited, there were many weeks when he wrote nearly half the issue. He developed *Puck* from a new, struggling periodical into a powerful social and political organ. In both his fiction and his charming *vers de société*, French influence is dominant. *Made in France, French Tales Retold with a United States Twist* (1893) and to a lesser extent his other stories reveal his indebtedness to Maupassant and other French masters. Technical dexterity, playfulness and smoothness of finish mark his prose as well as his verse—*Airs from Arcady and Elsewhere* (1884), *Rowen* (1892) and, posthumously, *Poems* (1896).

Bunner published several novels, including *The Midge* (1886) and *The Story of a New York House* (1887), but these are surpassed by his stories and sketches, *Short Sixes* (1890), *More Short Sixes* (1894), *In Partnership* (with Brander Matthews, 1884), *Zadoc Pine* (1891), *Love in Old Clothes* (1896) and *Jersey Street and Jersey Lane* (1896). A collected edition of his *Poems*, with an introductory note by Brander Matthews, appeared in 1912. The best of his *Stories* were republished in 1916. An edition of them in 1917 included *Short Sixes* and *The Suburban Sage*, the latter originally published in 1896. Of several plays (chiefly written in collaboration) the best was the *Tower of Babel* (1883).

See Gerard E. Jensen, *Life and Letters* (1940).

BUNSEN, CHRISTIAN KARL JOSIAS, Freiherr von (1791–1860), Prussian diplomat, orientalist and theologian, especially distinguished in the ecclesiastical politics of his time, was born at Korbach in Waldeck on Aug. 25, 1791, the son of an indigent officer of Dutch origin. He studied theology, law and classical and oriental languages and literature at Marburg, Göttingen and Jena and traveled extensively with the young W. B. Astor, son of the U.S. financier J. J. Astor. In 1817 he married a rich Englishwoman, Frances Waddington. A true child of German classical idealism and the Romantic age and a scholar of great ability, he made the acquaintance of B. G. Niebuhr (*q.v.*), who, after his appointment as Prussian minister to the Vatican (1816), secured for Bunsen the post of secretary to the mission there.

Himself minister in succession to Niebuhr from 1823 to 1838, Bunsen continued the activities by which Niebuhr had made the Prussian legation the centre of the German cultural circle in Rome;

he also brought about the foundation of the archaeological institute there. His attempt, however, in collaboration with F. A. von Spiegel, the Catholic archbishop of Cologne, to resolve the conflict between Prussia and the Vatican over marriages between Catholics and Protestants by a circumvention of the ambiguous papal brief of 1830 led to his recall from the mission.

Meanwhile Bunsen's work on the liturgy of the Evangelical Union inaugurated by King Frederick William III of Prussia had resulted in his enjoying a close understanding both with the king and with the future Frederick William IV, based on their common religious attitude. It was in the spirit of this understanding that Bunsen conducted the successful negotiations for the foundation of an Anglo-Prussian bishopric of Jerusalem in 1841. After a short period in Bern (1839–41) he became Prussian minister to London (1842–54)—perhaps the most exalted post in the Prussian diplomatic service. There he proved his worth as an intermediary between English and German scientific and cultural circles.

Frederick William IV shared Bunsen's romantic-conservative outlook, as is manifest in their correspondence, which was used by the historian Leopold von Ranke in his study of Frederick William (1873). Bunsen, however, was less orthodox in the manner of the post-Napoleonic restoration than this correspondence would suggest. Theologically, he remained a man of peace and reconciliation who rejected Catholicism but nevertheless respected it and who strove toward a unity of reconciliation between the various Evangelical churches, including the Anglican. His book *Zeichen der Zeit* (1855; 3rd ed., 1856) defended the freedom of the Christian conscience against the then dominant reaction exemplified by F. J. Stahl and W. E. von Ketteler.

Politically, Bunsen was unable either to persuade Frederick William IV to make timely concessions to the constitutional demands of the period or to ease the tension between Prussia and Great Britain created by the Schleswig-Holstein question (it was much against his will that he signed the London protocol of May 8, 1852). His attempt at the outbreak of the Crimean War to bring Prussia over to the western camp came to nothing because of the opposition of the Prussian Conservatives, who persuaded the king to recall him from London in 1854. The last years of his life were spent in Heidelberg and in Bonn, where he devoted himself to the defense of his arguments in *Zeichen der Zeit* and to his always extensive researches in Egyptology, patristics, religious history and philosophy. He died in Bonn on Nov. 28, 1860.

Bunsen's publications include *Aegyptens Stelle in der Weltgeschichte*, five parts (1845–57); *Die Deutsche Bundesverfassung* ... (1848); and *Gott in der Geschichte* ..., three parts (1857–58).

See Frances von Bunsen, *A Memoir of Baron Bunsen* (1870); also the larger German edition by F. Nippold, *C. C. Josias Freiherr von Bunsen. Aus seinen Briefen* ..., 3 vol. (1868–71). (HA. H.)

BUNSEN, ROBERT WILHELM (1811–1899), German chemist and pioneer in the field of spectrum analysis, was born at Göttingen on March 31, 1811. He was professor of chemistry at Kassel, Marburg, Breslau and, from 1852 to a few months before his death on Aug. 16, 1899, at Heidelberg. His first important research work was concerned with the cacodyl compounds, though he had already, in 1834, discovered the virtues of freshly precipitated hydrated ferric oxide as an antidote to arsenical poisoning. He began his research in cacodyl compounds in 1837 at Kassel, and during the six years he spent upon it he not only lost the sight of one eye through an explosion but nearly killed himself by arsenical poisoning. It represents almost his only excursion into organic chemistry, and is of historical interest as being the forerunner of the fruitful investigations on the organometallic compounds subsequently carried out by his English pupil, Edward Frankland. Simultaneously with his work on cacodyl, he was studying the composition of the gases given off from blast furnaces. He showed that in German furnaces nearly half the heat yielded by the fuel was being allowed to escape with the waste gases, and when he investigated the conditions in English furnaces, he found the waste to amount to over 80%. These researches led to the elaboration of Bunsen's famous methods of measuring gaseous volumes, etc., which form the subject of the only book he ever published (*Gasometrische Methoden*, 1857). In 1841 he invented the carbon-zinc electric cell, which is known by his name; he first employed it to produce the electric arc, and showed that from 44 cells a light equal to 1,171.3 candles could be obtained with the consumption of one pound of zinc per hour. To measure this light he designed in 1844 the grease-spot photometer. In 1852 he began to carry out electrolytical decompositions by the aid of the battery. He obtained magnesium for the first time in the metallic state, and studied its chemical and physical properties, among other things demonstrating the brilliance and high actinic qualities of the flame it gives when burned in air. From 1855 to 1863 he published with H. E. Roscoe a series of investigations on photochemical measurements, which W. Ostwald has called the "classical example for all future researches in physical chemistry." He is generally credited with the invention of the Bunsen burner (*q.v.*).

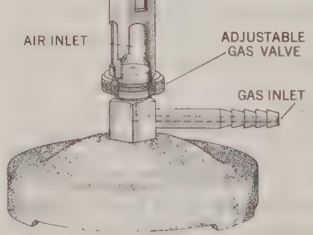
Other appliances invented by him were the ice calorimeter (1870), the vapour calorimeter (1887) and the filter pump (1868). In 1846 he paid a visit to Iceland. There he investigated the phenomena of the geysers.

But the most far-reaching of his many achievements was the elaboration, about 1859, jointly with G. R. Kirchhoff, of spectrum analysis. It led Bunsen himself almost immediately to the isolation of two new elements of the alkali group, cesium and rubidium. Having noticed some unknown lines in the spectra of certain salts he was examining, he set to work to obtain the substance or substances to which these were due. To this end he evaporated large quantities of the Dürkheim mineral water; he dealt with 40 tons of the water to get about 17 grams of the mixed chlorides of the two substances, and with about one-third of that quantity of cesium chloride was able to prepare the most important compounds of the element and determine their characteristics, even making goniometrical measurements of their crystals. *See* CHEMISTRY: *Analytical Chemistry*. *See* also Index references under "Bunsen, Robert Wilhelm" in the Index volume.

See Sir Henry Roscoe's "Bunsen Memorial Lecture," *Trans. Chem. Soc.*, 1900, which is reprinted (in German) with other obituary notices in an edition of Bunsen's collected works published by Ostwald and Bodenstein in 3 vol. at Leipzig in 1904.

BUNSEN BURNER, a burner so designed that it mixes a predetermined quantity of air with the stream of gas before the gas is ignited. If the proportions of gas and air are correct the resulting flame is hot and nonluminous. The invention of this widely-used burner is ascribed to Robert Wilhelm Bunsen (*q.v.*), though investigations have proved that the credit for the actual design should go to Peter Desdga, if not to Michael Faraday (*q.v.*) who had previously designed an adjustable burner on this principle.

The simple idea, attributed to Bunsen, of admitting air into a tube along with gas to produce a hot nonluminous flame is incorporated in the construction of millions of burners for heating and lighting purposes. The Bunsen flame results when air and gas are admitted in the proportion of about three volumes of air to one of gas; this mixture produces the inner lower cone of the flame, evolving a mixture of water vapour, carbon monoxide, hydrogen, carbon dioxide and nitrogen. The water gas and nitrogen reach the outer combustion zone where the water gas becomes burned up by the ordinary, or secondary, air supply. Various effects, as fusion, oxidation and reduction, are obtainable with the flame and blowpipe. Certain metallic salts impart characteristic coloration to the otherwise colourless flame.



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ADJUSTABLE BUNSEN BURNER

Varieties of laboratory Bunsens are chiefly distinguished by improvements in the control and mixing of the air and gas, giving greater heating powers and enabling different sizes of flames to be obtained. Among the most efficient of these are the Meker and the Fisher burners. Numerous fittings are made to go on the top of the tube for spreading the flame, or for taking special holding devices. Several designs avoid the fault of the ordinary central gas jet, which may become choked up by matter falling down the tube, the gas being brought in at the side and the air at the bottom, with a coned regulator raised and lowered by a knob. Marshall's burner has a flat regulator working beneath the base. Burners may be constructed to burn coal gas, oil gas, acetylene or natural gas.

The Bunsen burners fitted to incandescent lights, the so-called Welsbach burners, require careful manufacture to ensure satisfactory results. The jet or injector must be exactly central with the Bunsen tube, and the interior surfaces finished smoothly and straight, with no raggedness at the orifice; otherwise the flame will not "fit" and heat the mantle properly. (F. H.)

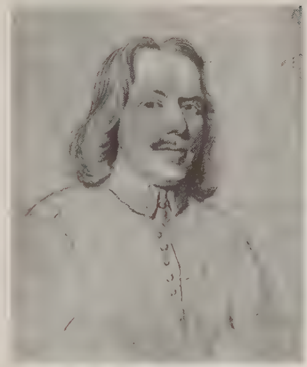
BUNTING, JABEZ (1779–1858), English Wesleyan minister whose determination to implement Wesley's ideas of ministerial supervision led him into conflict with the Methodist conference, was born in Manchester on May 13, 1779. After four years studying medicine, he began at the age of 19 to preach, being officially accepted as a minister in 1803. In 1835 he was appointed president of the first Wesleyan theological college at Hoxton, after the secession of Samuel Warren, a violent defender of lay privileges. Bunting was president of the conference in 1820, 1828, 1836 and 1844 and also acted as secretary of the "Legal Hundred," one of its committees, and, for 18 years, as secretary of the Wesleyan Missionary society. His attempts to secure what he called "the rightful authority of the pastorate" were defeated only after his death with the admission in 1878 of laymen to the annual conference. He died in London on June 16, 1858. His eldest son, William, was also a distinguished Wesleyan minister.

See T. P. Bunting, *Life of Jabez Bunting* (1859); J. Kent, *Jabez Bunting, the last Wesleyan* (1955).

BUNTLINE, NED: *see* JUDSON, EDWARD ZANE CARROLL.

BUNYAN, JOHN (1628–1688), English Puritan minister and preacher, and the author of *The Pilgrim's Progress,* was the greatest literary genius produced by the Puritan movement. He was born at Elstow near Bedford in Nov. 1628, the son of Thomas Bunyan, a brazier or traveling tinker, and came of a local yeoman family which in the 17th century was in decline. He learned to read and write at a local school, perhaps a grammar school; when in *The Pilgrim's Progress* he quotes a phrase in Latin he says: "The Latine I borrow"; and he declares elsewhere that he was brought up "among a multitude of poor plowmen's children." He probably left school early to learn the family trade.

More important than formal schooling in the training of Bunyan's mind and imagination in these early years was his reading. He absorbed with delight the chapbooks of chivalric adventure such as *Bevis of Southampton* and *The Seven Champions of Christendom,* which were sold at fairs like the great one held annually at Stourbridge near Cambridge; and also the varied popular literature of English Puritanism: tracts and sermons, books of melodramatic judgments and providences, sugared pills of doctrine in the form of homely dialogue and plain-spoken anecdote, and Foxe's *Book of Martyrs,* with the fearsome woodcuts of the Elizabethan edition. Above all, he read the English Bible which he seems to have known both in the Authorized Version and in the Geneva one preferred by many Puritans up to the mid-17th century. It was wholly to the advantage of his development as an imaginative writer that his parents should have been "of the national church" (that is, the Church of England), and that he should have had access as a boy to the general store of country lore and tradition of which a narrower sectarian upbringing might have deprived him. Little else is known of his childhood, but he speaks in his autobiography (*Grace Abounding*) of being troubled by fearful dreams and visions. It may be that there was a pathological side to the nervous intensity of these fears; in the religious crisis of his early manhood his sense of guilt took the form of delusions of hearing and touch. Certainly it seems to have been an abnormal sensitiveness combined with the convert's tendency to exaggeration which made him look back on himself in early youth as "the very ring-leader of all the Youth that kept me company, into all manner of vice and ungodliness."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BUNYAN, PENCIL DRAWING ON VELLUM BY ROBERT WHITE

In 1644 a series of hammer blows separated the country boy from his family and drove him into the world. His mother died in June, his younger sister Margaret in July; in August his father married a third wife. In November he was mustered in a parliamentary levy and sent to reinforce the garrison at Newport Pagnell, an important point on the lines of communication between the midlands and the south during the Civil War. The governor was Sir Samuel Luke, immortalized by Samuel Butler in *Hudibras.* In Newport Bunyan remained till June 1647 and saw little fighting, though once when he was "drawn out to go to such a place to besiege it," a comrade took his place and was shot, so that he later felt he had been preserved by divine providence.

Bunyan's military service, even if uneventful, brought him in touch with the seething religious life of the left-wing sects within the army, the preaching captains, and those Quakers, Seekers and Ranters who questioned the authority of the army itself. Luke had trouble with many such religious agitators passing through his garrison; in this atmosphere Bunyan became acquainted with the prime notion of the enthusiastic sectaries, shared alike by Cromwell and his meanest trooper, that the effort toward religious truth meant an obstinate search, often from sect to sect, relying on free grace revealed to the individual, and condemning all forms of organization as "legal and dark." The devotion both in prayer and tactics of the New Model army left an indelible impression on him which is recalled later in the preaching, drilling captains, Credence and Boanerges, of the army of Shaddai in *The Holy War.*

Some time after his discharge from the army (in July 1647), and before 1649, Bunyan married. He says that he and his wife "came together as poor as poor might be, not having so much houshold-stuff as a dish or spoon betwixt us both." Their first child, a blind daughter Mary, was baptized in July 1650. Three more children, Elizabeth, John and Thomas, were born to Bunyan's first wife before her death in 1658. The record of Elizabeth's birth in the transcript register of Elstow shows that she, too, was baptized there in 1654, though Bunyan had himself by this time been baptized by immersion as a member of the Bedford separatist church. As her dowry his first wife brought to him the awakening books Arthur Dent's *The Plain Man's Path-way to Heaven* and Lewis Bayly's *The Practice of Piety;* the former taught him that even a manual of instruction could employ racy colloquialisms and salt its precepts with homely proverbs.

Marriage was followed by a gradual process of conversion (1650–55) described in the autobiography, and including agonizing temptations to spiritual despair which lasted for many years. After an initial period of legal conformity in which he went regularly to church and looked with awe at the "priest" and his "vestments" (probably at this period a plain Geneva gown) he gave up, slowly and grudgingly, his favourite recreations of dancing and bell ringing and engaging in sports on the village green, and began to concentrate solely on his inner life. Calvinism led him by means of the grim doctrine of election and reprobation to question his own chances of salvation. The "storms" of temptation, as he calls them, buffeted him with almost physical violence; voices urged him to blasphemy; the texts of scripture which most alarmed him took on personal shape and "did pinch him very sore." Finally one morning he believed that he had surrendered to these voices of Satan and betrayed Christ: "Down I fell as a bird that is shot from the tree." It was only slowly and painfully that he emerged from this period of spiritual darkness, feeling that his sin was "not unto death" and that there were texts to comfort as well as to terrify; he was aided in his recovery by his discovery of the separatist church of Bedford and its dynamic leader John Gifford. He entered into full communion with it about 1655.

The Bedford community was not strictly Baptist, though it practised adult baptism by immersion, but an open-communion church, admitting all who professed "faith in Christ and holiness of life."

Bunyan soon proved his talents as an arousing preacher; fresh from his own experience of spiritual desperation, he was fitted to warn and console others: "I went myself in Chains to preach to them in Chains, and carried that Fire in my own Conscience that I persuaded them to beware of." He was also active in visiting and exhorting the Brethren.

The Restoration of Charles II brought to an end the ten years in which the separatists had enjoyed freedom of worship and exercised a measure of influence on public policy. On Nov. 12, 1660, at Lower Samsell in south Bedfordshire, Bunyan was brought before a local magistrate and charged under an old Elizabethan act with holding a conventicle. Since he refused to give an assurance that he would not preach again, he was condemned at the assizes in Jan. 1661 and imprisoned in the county jail in Bedford. (It was a county offense and, in spite of a persistent legend, he can at no time have been imprisoned in the small town lockup on the bridge across the Ouse.) In spite of the courageous efforts of his second wife (he had married again in 1659) to have his case brought up at the assizes he remained in prison for 12 years. He relieved his family by making and selling "many hundred gross of long Tagg'd laces" (*An Account of the Life and Death of Mr. John Bunyan*, 1692); at times conditions were lenient enough for him to be let out to visit friends and family and even to address meetings.

He was released in March 1672 under Charles II's Declaration of Indulgence; the Bedford community had chosen him their pastor in January, "after much seeking God by prayer" (*The Church Book of Bedford Meeting*) and a new meetinghouse was obtained. In May he received a licence to preach together with 25 other Nonconformist ministers in Bedfordshire and the surrounding counties. His nickname "Bishop Bunyan" suggests that he became the organizing genius in the area. As persecution was renewed, he was again imprisoned for preaching to conventicles, this time for a period of about six months; a bond of surety for his release has survived dated June 1677, so it is likely that this second imprisonment was in the first half of that year. Since *The Pilgrim's Progress* was published soon after this, in Feb. 1678, Bunyan had probably begun to write it, not in the second imprisonment but in the first, soon after the composition of *Grace Abounding* and when the examination of his inner life contained in that book was still strong upon him. The composition of the allegory was thus dated by those contemporaries who wrote obituary accounts and the knowledge remained current to be repeated by Robert Southey and Lord Macaulay.

In 1672–73 Bunyan entered into controversy with William Kiffin and other London Baptists for his open-communion principles. In succeeding years he often preached in Congregational churches in London, for his fame as a preacher was now increased by his literary reputation. The spiritual autobiography, *Grace Abounding to the Chief of Sinners*, had been published in 1666; there followed, after *The Pilgrim's Progress* (1678), *The Life and Death of Mr. Badman* (1680), *The Holy War* (1682), and the Second Part of *The Pilgrim's Progress* (1684), as well as a stream of doctrinal and controversial treatises. But it was *The Pilgrim's Progress* which speedily found its way into every home and carried Bunyan's reputation to every part of the British Isles, to Europe and to America.

Under James II, when the last wave of persecution overtook the dissenters, Bunyan protected his family by a deed of gift transferring all his property to "my well-beloved wife, Elizabeth Bunyan" (Dec. 1685). In 1687 he shrewdly resisted the blandishments of James II's agent Lord Aylesbury, and his offer of an official position, while at the same time obtaining seats for members of his church on the reorganized corporation of Bedford. He died on Aug. 31, 1688, in London after one of his journeys to preach there; he had ridden out of his way through heavy rain to Reading to settle a quarrel between father and son, and contracted a fever (probably pneumonia). He was buried in Bunhill Fields, the burying-ground for Nonconformists in the City of London.

An anonymous biographer describes him as "Tall of Stature, strong boned, though not corpulent somewhat of a Ruddy Face, with sparkling eyes, wearing his hair on his upper lip, after the old British fashion . . . his forehead something high and his habit always plain and modest." This agrees with the fine pencil drawing by Robert White (British museum, London, Cracherode collection) where the heavy face is given distinction by the strong nose and alert, humorous eyes.

THE WRITER AND HIS WORKS

Bunyan's missionary activity on the liberal wing of the churches was of major importance in the fenland counties and in certain London congregations; the broad, "open-communion" stand he took long prevented him from receiving the attention he deserved as a religious leader from Baptist or Congregational historians, but this was amply compensated for by his fame as a writer. (*See* also CONGREGATIONALISM.)

Style.—His literary achievement, in his finest works, is by no means that of a naïvely simple talent, sustained by earnest forcefulness and the occasional happy expression which redeems the general crudity of uneducated speech (though this has been the view of many of his critics). His handling of language, colloquial or biblical, is that of an accomplished artist; so is his application of it to purposes as different as social satire, humour, heroic splendour or the expression of religious fervour. He brings to his treatment of human behaviour shrewd awareness and moral subtlety, and in both his autobiography and his allegories he demonstrates a faculty for endowing the conceptions of evangelical theology with concrete life and acting out the theological drama in terms of flesh and blood.

He thus presents a paradox, since the impulse which originally drove him to write was purely to celebrate his faith and to convert others, and like other Puritans he was schooled to despise the adornments of style and to treat literature as a means to an end. As he says in the preface to *Grace Abounding:*

> I could have stepped into a Style much higher than this in which I have here Discoursed, and could have adorned all things more than here I have seemed to do; but I dare not. God did not play in convincing of me; the Devil did not play in tempting of me . . . wherefore I may not . . . but be plain and simple, and set down the thing as it was.

This effort to reach behind literary adornments so as to obtain an absolutely naked rendering of the truth about his own spiritual experience causes him in *Grace Abounding* to forge a highly original style. In this style, rich in powerful physical imagery, the inner life of the Christian is described; body and soul are so involved that it is impossible to separate bodily from mental suffering in the descriptions of his temptations. He feels "a clogging and a heat at my breast-bone as if my bowels would have burst out"; a preacher's call to abandon the sin of idle pastimes "did benumb the sinews of my best delights"; and he can say of one of the texts of scripture that echoed in his head and seemed to him to spell his damnation that it "stood like a mill-post at my back." The attempt to communicate the existential crisis of the human person without style has created a style of its own.

The prose of subjective analysis is Bunyan's first creative achievement. It was not produced without some external stimulation. The Calvinist tendency anxiously to probe the soul for tokens of election (*i.e.*, predestined salvation) had led thousands of Bunyan's fellow countrymen to think in this way, and some of them left spiritual autobiographies generally similar to his in form and treatment, if not in genius. What characterizes his treatment is his emphasis on the extreme loneliness of the convert' situation, the dreamlike isolation in which he interprets his inne conflicts.

> I lifted up my head, but methought I saw as if the sun that shineth in the heavens did grudge to give light, and as if the very stones in the street, and tiles upon the houses, did bend them-

> selves against me; methought that they all combined together to banish me out of the world.

In this isolation he attempts to see every incident, and every passage in the Bible, even if it is a historical one, as a guide to the condition of his soul:

> With a loud cry these words Simon, Simon, sounded in my ears.
> These texts did pinch me very sore.
> I had also once a sweet glance from that in Cor. 5.21

He may have learned this method of reading the Scriptures from the Quakers and Ranters in the years of sectarian ferment about 1650 (years crucial for his own growth), though he strenuously resisted their theology and their fanaticism.

As well as this original instrument of a highly subjective prose style to express personal states of mind, Bunyan had at his disposal the more traditional style he used in sermon, treatise and scriptural exposition. In the allegories some of his greatest imaginative successes are due to the development of the dreamlike, introspective style with its subtle personal music; but it is the workaday vigour and concreteness of the prose technique practised in the sermons which provide a firm stylistic background to these imaginative flights. The popular sermon manner is colloquial with the common proverbial voice of folk tradition, whereas the colloquialism of *Grace Abounding* is the spontaneous outburst of a man in agony. In contrast to the acute class consciousness of some contemporary "mechanick preachers" Bunyan is completely natural in his use of common life and the culture of the countryside; in expounding the Gospel he can echo the very tones of the parables because he has grown up close to the soil in an agricultural community.

In one sermon, for instance, he compares the small number of the elect to the gleanings in harvest:

> What are the gleanings to the whole crop? and yet you here see, to the gleanings are the saved compared . . . You know it is often the cry of the poor in harvest, Poor gleaning, poor gleaning.

His comparisons always elucidate his moral message; they appeal to common experience, and bring the preacher and his audience nearer together in contexts where any suggestion of a literary flourish would draw them apart:

> Poor coming soul, thou art like a man that would ride full gallop, whose horse will hardly trot! Now the desire of his mind is not to be judged by the slow pace of the dull jade he rides, but by the hitching and kicking and spurring as he sits on his back.

When Bunyan later came to describe in his allegory the different types of hypocrite and backslider he was able to combine the rustic reality of the proverbial manner with skilful moralizing:

> His house is as empty of Religion as the white of an egg is of savour . . . a saint abroad and a devil at home.

But by this time, in his fiction, the popular strength which he uses from time to time in the livelier sermons is diffused throughout the narrative in phrases like "all on a dung sweat," "loses his sheep for a halfpenny-worth of tar," "make hay while the sun shines" and "she all-to-be-fooled me."

The Pilgrim's Progress.—At the time when he wrote his autobiography (before 1666) Bunyan was still too near to his terrors and therefore too respectful of every detail of his religious experience to mold it creatively. In a few years, in *The Pilgrim's Progress,* probably composed later, in his first imprisonment, he was able to treat with more detachment both his conversion and the endurance of persecution which tested its reality. The process toward personification, already implicit in the language describing his fears, his doubts and the particular verses of the Bible which haunted him, is now completed. For instance, in *Grace Abounding* he saw the plight of his exclusion from the little band of Nonconformists at Bedford in the form of a vision; its geography has the vagueness proper to a dweller in a flat, nondescript region:

> About this time the state and happiness of these poor people at Bedford was thus in a dream or vision presented to me. I saw, as if they were set on the sunny side of some high mountain, there refreshing themselves with the pleasant beams of the sun, while I was shivering and shrinking in the cold, afflicted with frost, snow, and dark clouds. Methought also, betwixt me and them, I saw a wall that did compass about this mountain . . . At last I saw, as it were, a narrow gap like a little doorway in the wall, through which I attempted to pass, the passage being very strait and narrow . . . At last with great striving methought I at first did get in my head, and after that, by a sideling striving, my shoulders and my whole body.

In *The Pilgrim's Progress* the little door in the wall reappears as the Wicket Gate, the entrance on the way to salvation. It is the symbol of Christ, who opens the door to Christian, weighed down by his burden. The vision of his conversion period has become a formal part of the allegory; the image, like so many in Bunyan, is based on a text: "Strive to enter in at the strait gate"; indeed the biblical influence is stronger on the form of the episodes in the allegory than on its language.

Because it recapitulates in symbolic form the inner story of Bunyan's conversion, there is an intense, life-or-death quality about Christian's pilgrimage to the Heavenly City in the first part of *The Pilgrim's Progress.* The sense of urgency is established in the first scene as Christian in the City of Destruction reads in his book (the Bible) and breaks out with his lamentable cry, "What shall I do?" It is maintained by the combats with giants and monsters along the road; for although there is something of the hair-raising folk tale adventure dear to the childish imagination about these episodes, Apollyon and Giant Despair embody spiritual terrors. The voices and demons of the Valley of the Shadow of Death are a direct transcription of Bunyan's compulsive and neurotic fears during his conversion. Episodes of stirring action like these alternate with more stationary passages: in the Interpreter's House Christian is shown a series of emblematic pictures, some traditional, some invented by Bunyan for the occasion, and there are various conversations between the pilgrims and those they encounter on the road, some pious, some providing light relief when hypocrites like Talkative and Ignorance are exposed. The halts at places of refreshment like the Delectable Mountains or the meadow by the River of Life evoke in the simplest descriptive terms (the green pastures of the Psalms "beautified with lilies") an unearthly spiritual beauty.

The narrative may seem episodic but Calvinist theology provides a firm, underlying ground plan. Only Christ, the Wicket Gate, admits Christian into the right road, and before he can reach it he has to be shown his error in being impressed by the pompous snob Worldly Wiseman, who stands for mere negative conformity to moral and social codes. Quite early in his journey Christian loses his burden of sin at the Cross, where it rolls from his shoulders into the sepulchre; he receives white garments, a mark is set in his forehead, and he is presented with a roll with a seal upon it which he is to hand in at the Celestial Gate. Christian now knows that he has received the free pardon of Christ and is numbered among the elect. It might seem that all the crises of the pilgrimage were past, yet this initiation of grace in the soul is not the end of the drama but the beginning. Christian, and the companions who join him, Faithful and Hopeful, are fixed in the path of salvation, so that it is the horrors of the temptations they have to undergo, not the possibility that they may waver, which engage our attention. Likewise, when the pilgrims are plunged into the worldliness of Vanity Fair, Bunyan is illustrating the persecution the saints of God must endure. The most grievous temptations come when the bright hope of assured salvation is dimmed, and Christian and Hopeful are cast into the dungeon of Despair until the key called Promise (representing the assurances to the saints given by the Bible) unlocks the door.

Christian's agonized striving holds our attention because we look through his eyes and share his uncertainty about the outcome, even though on a longer view of the divine purpose there is no uncertainty. However, the narrative, so conscientiously symbolic throughout, does not lose the savour of common life. In the character sketches and humorous passages scattered through the book Bunyan's genius for realistic observation is exercised in a manner which prevents the conversion allegory from becoming too inward and obsessed. Faithful and Hopeful are not dimensional characters, but the charitable courtesies of their intercourse with Christian are touching and truthful, as when both Christian and Hopeful try to take the blame for going aside into By-Path Meadow. In the pictures of the reprobate and the account of the ups and downs of the way there is a sharp eye for behaviour and a sardonic humour. A group of moral types is endowed with all the liveliness of individuals by a deft etching in of a few dominant features and gestures. The "very brisk lad" Ignorance, and Talkative, "a tall man, and something more comely at a distance than at hand," have the likeness of individual heretics while presenting their examples of typical heresies in the same way as the *exempla* of the medieval sermon; so has the shifty By-Ends.

The Pilgrim's Progress is the culmination of the old allegory tradition, but whereas medieval allegory has different levels of meaning and suggestiveness, Bunyan sees only one thing at a time, or rather, in order to visualize a moral quality, he has to circumscribe it within the narrow but powerful outline of a type. His people could provide minor characters for a Restoration play or an 18th-century novel; even the heroic figure of Christian can appear later in a "character-part" as the seasoned spiritual campaigner who "snibbeth his fellow," the young Hopeful, and puts him in his place. For after all Christian himself is a transcript from life; Bunyan, the physician of souls with a shrewd eye for backsliders, had faithfully observed his own spiritual growth.

A spurious Second Part of *The Pilgrim's Progress,* purporting to correct its frivolities, appeared in 1682. Bunyan returned to his dream and published his own continuation of the allegory in 1684. The atmosphere has changed: for the lonely, personal drama we have mellow reflection of personal experience; the emphasis is on the bustling life of the church and the social virtues of friendship and family responsibility. Women play a large part, as they had come to do in the Bedford congregation; and a special tenderness is shown to those with scruples of conscience which prevent them from entering into full communion with Nonconformist bodies. On the whole Bunyan has turned from high drama to comedy, and from poetry to efficient propaganda for open-communion principles. The story tells how Christian's wife, Christiana, sets out to follow him to the Celestial City, accompanied by her children and her friend Mercy. It is affection for Christiana rather than grace which sets Mercy on her way and gains for her admittance to the Wicket Gate. The progress is leisurely: the children grow up and marry and a bourgeois novel unfolds with charming, moralized pictures of courtship and domestic manners. But Bunyan can pull out the diapason and rise to the splendour of the final scene when the pilgrims cross the River of Death, chanting their formal, scriptural ejaculations of trust in God's mercy.

The Life and Death of Mr. Badman.—Bunyan had already been prompted by the success of the first part of *The Pilgrim's Progress* to follow it with a study of the life of the reprobate, *The Life and Death of Mr. Badman* (1680). The tale is cautionary, related by an older Puritan to a younger one; it is not allegorical, but a primitive approach to the domestic middle-class novel as it was later to be developed by Defoe and Richardson. Though it lacks the emotional heights and depths of *The Pilgrim's Progress* it contains much hard, dry observation of manners intermingled with pious comment.

Badman is a highly unrealistic compendium of all the vices; he has not the imaginative potentiality of Christian, who is Everyman. Realism enters into the admirable account of his commercial, middle-class background. He begins young with lying, swearing, stealing and sabbathbreaking. He runs away from a good master to serve one of like mind with himself; finally he persuades his father to set him up in a shop of his own where he can give free rein to his lusts, and allows his loose companions to make him the "jack-pay-for-all." He retrieves his losses by marrying a rich orphan of godly upbringing. His courtship is a consummate piece of play-acting and provides a criticism of the evils of mixed marriages, for if *The Pilgrim's Progress* is the testament of the heroic spirit of earlier Puritanism, *Badman* reflects the problems encountered by Nonconformists as the tide of persecution withdrew and they began to find their place in the national life.

Thus the sins chiefly denounced in *Badman* are those such as commercial dishonesty which were likely to bring the holy community into public contempt within the larger society. Bunyan's congregation contained many tradesmen of varying degrees of affluence, but his sympathy still lies with the poor countryman dependent on the unscrupulous middleman in the town who can force up prices at a time of scarcity. He cherishes a medieval notion of the just price ("let the poor have a pennyworth, and sell thy Corn to those in necessity") while at the same time struggling to work out ethical standards suitable for the new competitive market. Sometimes the stress is laid on Badman's disorderly conduct of his affairs, sometimes his wealth is seen as a token of his inability to go through the eye of the needle.

Some of the best writing in the book is to be found in the additional anecdotes told by the narrator Wiseman to illustrate particular sins. These robust scarifying stories, in the tradition of the popular judgment books, speak with the voice of folk experience, reiterating a view of naturalistic restraint and common sense that is older than religious Puritanism.

The Holy War.—Bunyan's second allegory, *The Holy War* (1682), is a deeply meditated and carefully written work but it remains a splendid failure. Like many second novels by later writers it lacks the creative gusto which first impelled its author into fiction, and it suffers from an overambitious plan. The traditional metaphor of the Christian journey is true to the variety and unexpectedness of human life, while the metaphor of a military campaign is not. The perpetual tension, the strict division of characters into "friends" and "foes," which result from the choice of allegorical setting, reflect also the Calvinist insistence on the total depravity of human nature; ordinary human beings are swallowed up by warring concepts. The city of Mansoul is besieged and taken by the devil, Diabolus, and his armies, and liberated by the prince Emanuel; later there is a second siege and a further rescue by Emanuel. The allegory is complex: the conversion and relapse of the individual soul, the grand theme of *Grace Abounding* and *The Pilgrim's Progress,* is treated once again; at another level there is the story of the Fall, the Redemption and the subsequent history of the church. There is also a more limited historical allegory in which Bunyan refers to the treatment of the godly in Charles II's reign; and a fourth theme concerns the millenarian hopes of the saints. There are noble echoes of Bunyan's earliest inspiration in the account of the marching and countermarching troops of Emanuel, and a certain top-heavy dignity in the whole grandiose plan of a work which comprehends the actions of *Paradise Lost* and *Paradise Regained* as only part of its material.

Bunyan's Reputation.—Until the decline of religious faith and the great increase in books of popular instruction in the 19th century, Bunyan, like the Bible, was to be found in every English home and was known to every ordinary reader. In literary estimation, however, he remained beyond the pale of polite literature during the 18th century, though his greatness was acknowledged by Swift and Johnson. After the romantic movement he was recognized as a type of the natural genius and placed alongside Home and Burns.

Southey's introduction to the 1830 edition of *The Pilgrim's Progress* and Macaulay's essay (1843) were influential. Twentieth-century scholarship has made it possible to see how much he owed to the tradition of homiletic prose and to Puritan literary genres already developed when he began to write. But the sublime tinker remains sublime, if less isolated from his fellows than was formerly thought; the genius of *The Pilgrim's Progress* remains valid, not only in the sturdy and simple English in which it is written, but when it is translated into other languages and dialects across the whole world. Nothing illustrates better the profound symbolic truth of the work than its continuing ability to evoke responses in readers belonging to widely separated cultura traditions.

See also references under "Bunyan, John" in the Index.

Bibliography.—*Editions:* the first collected edition of Bunyan's works was *The Works of that Eminent Servant of Christ, Mr. John Bunyan,* ed. by Charles Doe, 1 vol. only (1692); 2nd ed., 2 vol. (1736). The standard edition is still that by George Offor, 3 vol. (Glasgow 1853; Edinburgh and London, 1862). Editions of single works include *Grace Abounding* and *The Life and Death of Mr. Badman,* ed. by

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Biography and Criticism: Lord Macaulay in *Critical and Historical Essays*, i (1843); John Brown, *John Bunyan, his Life, Times and Work* (1885; rev. by F. M. Harrison, 1928); W. Y. Tindall, *John Bunyan, Mechanick Preacher* (1934); H. Talon, *John Bunyan, the Man and his Works* (1948; Eng. trans. 1951); F. R. Leavis in *The Common Pursuit* (1952); R. Sharrock, *John Bunyan* (1954). (R. Sk.)

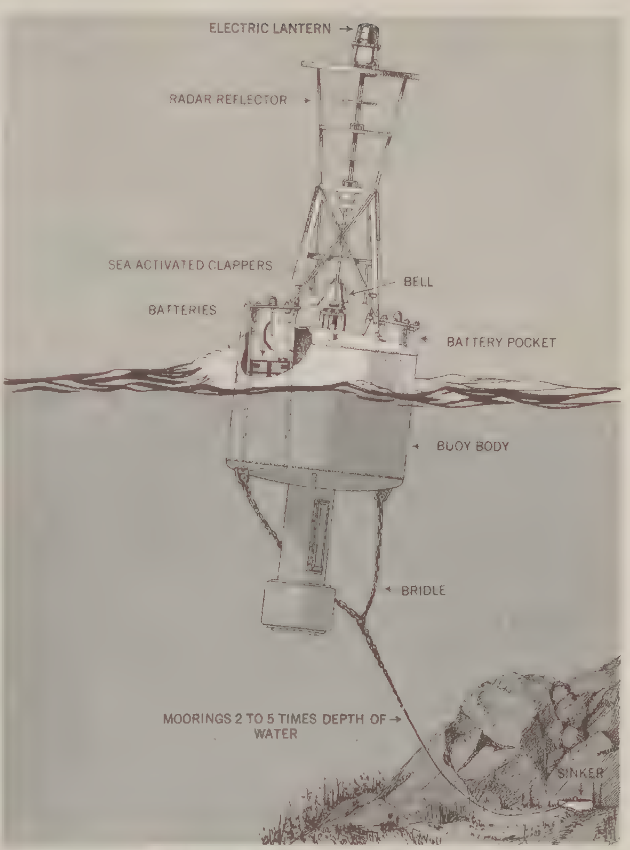
BUNYAN, PAUL, a mythical hero of the American lumber camps, for whom there is no known prototype. Meagre traces of Bunyan in oral folklore suggest that he was known to lumbermen in places as widely scattered as Pennsylvania, Wisconsin and the northwest before 1910, when the first Bunyan stories were published. In "The Round River Drive" by James MacGillivray (*Detroit News-Tribune*, July 24, 1910), Paul's camp is the scene of a dozen traditional frontier and logging jests. Within 15 years the obscure lumberjack had become a hero of popular culture, the subject of two widely read books both titled *Paul Bunyan* (by Esther Shephard and James Stevens, 1924, 1925). His companions—Babe the Great Blue Ox, Hels Helsen, Johnny Inkslinger—were almost as famous as the huge logger himself. It is said that he created Puget sound and the Grand Canyon, and for hotcakes used a griddle so large that men greased it by skating on it with sides of bacon for skates.

This transformation of an occupational folk figure into a national "legend" was largely due to effective popularization by professional writers. W. B. Laughead, a Minnesota advertising man, used Bunyan in a series of pamphlets (1914–44) to publicize products of the Red River Lumber company and first introduced the hero to a general audience. Esther Shephard combined northwest lumbermen's folk tales with suggestions from Laughead's booklets, while Stevens, also a lumber publicist, elaborated on traditional yarns and wrote fictional accounts of his own invention. In folk tradition Bunyan was a lumberman who could skillfully or cleverly overcome such occupational hazards as the log jam; fashioning lakes or rivers at will, he was undismayed by adverse geography. In Stevens' stories the lumberman became a giant industrialist; the humour, no longer dependent on knowledge of lumbering techniques, devolved on the incongruities of Bunyan's giganticism and the stupidity of some of his men. Stevens was the most successful early popularizer in restyling Bunyan for a wide audience and many later redactions were based on his work. For his claim that Bunyan originally was a soldier in the Papineau rebellion in Quebec, 1837, there is no evidence; Bunyan is unknown in French-Canadian history or folklore.

Bunyan's name became proverbial for size or strength and is frequently invoked in advertising varied products, as the subject of civic festivals, and in many children's books which further elaborated the alleged folk tales. In the fine arts Paul Bunyan is the subject of poems by Frost, Sandburg and Richard Wilbur; of an operetta by W. H. Auden and Benjamin Britten; of a ballet suite by William Bergsma; and of many paintings and statues.

The traditions are studied in Daniel G. Hoffman, *Paul Bunyan: Last of the Frontier Demigods* (1952); *see* also Richard M. Dorson, "Paul Bunyan in the News," *Western Folklore*, vol. 15, pp. 26–39, 179–193, 247–261 (1956). (D. G. Hn.)

BUOY, a floating object anchored at a definite location to guide or warn mariners, to mark position of submerged objects, to moor vessels in lieu of anchoring, or to record or transmit meteorological or oceanographic data by radio. When used without a descriptive adjective the term generally denotes a mark for mariners. (*See* Lighthouses and Other Aids to Navigation: *Signaling Systems: Buoys and Beacons.*) Special purpose buoys are designed for a variety of uses, such as cable buoy, anchor buoy or race buoy. A mooring buoy differs from other types in not being an aid to navigation but a point to which vessels may be tied up. Secured to a permanent group of anchors by a heavy chain, such a buoy serves as a connecting link between the vessel and the anchors. Mooring buoys conserve space in crowded harbours because a moored vessel requires less room to swing with the wind and tide than does a vessel at anchor. They are frequently used to secure warships because a vessel can be released from a mooring buoy much more rapidly than it can get underway from a dock or hoist its own anchor. Meteorological and oceanographic buoys are usually placed in areas not frequented by ships, and in depths of water up to 12,000 ft. They periodically transmit barometric pressure, temperature (air and water), wind force, wave height, and other physical data according to the particular design. Meteorological buoys may be combined with buoys used for aids to navigation, but usually carry a low-powered flashing light to warn ships and to assist in locating the buoy for servicing. (R. T. Al.)



LIGHTED BELL BUOY USED BY U.S. COAST GUARD

BURAYDAH (Buraida), capital town of Al Qasim province, in the Najd, Saudi Arabia. Pop. (1959 est.) 30,000. It has extensive palm groves and cornfields. Like its rival 'Unayzah (25,000), south of the Wadi Rima, its merchant princes have always been in the forefront of Arabian commercial activity, and have branches in the Hejaz, Iraq and Syria, and as far afield as Karachi and Bombay. In former times Buraydah and 'Unayzah controlled the export of Arab horses to India and elsewhere; and the overland trade of Arabia, by camel, was largely a monopoly of their 'Aqail caravans. (H. St. J. B. P.)

BURBAGE, RICHARD (*c.* 1567–1619), English actor, first player of a number of Shakespeare's heroes, has been called both the Roscius (in reference to the Roman actor Quintus Roscius Gallus; *q.v.*) and the Garrick (in reference to the great 18th-century actor David Garrick; *q.v.*) of the Elizabethan stage. He was famous and popular as an actor by the time he was 20. A member of the earl of Leicester's players, he remained with this group throughout its evolution into "the King's men" (1603). Shakespeare was closely associated with Burbage during his career in London, and in his will left the actor a token remembrance. It was Burbage, excelling in tragedy, who first played the roles of Richard III, Romeo, Henry V, Hamlet, Macbeth, Othello and Lear. Although short and stout, Burbage seems to have been a most impressive figure; the many praises of him in prose and verse by his contemporaries attest his powers as an actor, and numerous playwrights of the time sought his services. As the company of which he was a major sharer at the Globe and Blackfriars prospered, so did Burbage, who died, on March 13 (or 9), 1619, a man of substance.

Burbage was a painter as well as an actor; the painting of a woman at Dulwich college, London, is undoubtedly by him, and the Chandos portrait of Shakespeare has sometimes been attributed to him.

Richard Burbage's father, JAMES BURBAGE (*c.* 1531–97), was a carpenter turned actor and was one of Leicester's players when the queen gave them their licence in 1574. In 1576, as a private speculator, he leased land at Shoreditch and there built the first public playhouse in London, called the Theatre. In 1577 he had some interest in a second theatre nearby, called the Curtain. Later, against great opposition, he started the "private" Blackfriars theatre as a winter playhouse in the precincts of the old Dominican priory. In 1597 the land lease of the Theatre property expired, and litigation developed between the landowner and the owners of the theatre structure. After James Burbage's death in that year, his sons Richard and Cuthbert inherited the suit. During the absence of the landlord, the heirs tore down the Theatre and conveyed the timbers across the river to the Bankside, where they were used in building the famous Globe theatre of 1599. (FK. C. B.)

BURBANK, LUTHER (1849–1926), U.S. plant breeder who by hybridization produced over 800 new strains and varieties of plants, was born at Lancaster, Mass., on March 7, 1849. He attended public schools until he was 15 years old, and then spent four winters at Lancaster academy. Outside school he learned much about plant life on a farm. In the Lancaster library he found a copy of Darwin's *Variation of Animals and Plants Under Domestication,* and under the stimulus of this work he obtained and read other books by Darwin, as well as a number of other scientific books.

At the age of 21 he began his life work of plant breeding on a 17-ac. tract near Lunenberg, Mass., remaining there until 1875, when he moved to California. In Santa Rosa he established a nursery garden with greenhouse, which was to become famous the world over and in which, with additional acreage a few miles away, he was to carry on his experimental and creative work for 50 years. There he developed the long series of "new creations," as he called them, of fruits, flowers, vegetables, grains and grasses that are associated with his name.

Burbank performed hybridization or selection experiments with thousands of kinds of plants representing nearly 200 genera. His work with plums and prunes, which extended over 40 years, resulted in the introduction of 113 varieties; of these, about 20 continue to be of importance, particularly in California and South Africa. Among other fruits, Burbank produced notable varieties of apples, blackberries, cherries, peaches and quinces. Of his 90 varieties of vegetables, the best known is the Burbank potato, which he discovered in 1873 and which is still widely planted.

Several hundred varieties of ornamental plants were introduced by Burbank, the Shasta daisy being the most famous; also notable are his amaryllids, cannas, dahlias, gladioli, lilies, poppies and verbenas. Among his best-known experiments were those concerned with the breeding of cacti for fruit and forage. His spineless cacti for forage, in spite of enthusiastic claims made for them, were but little used.

Burbank's work, which involved the rearing of hundreds of thousands of individual plants, was not conducted to prove or test scientific theories or to make scientific discoveries but had as its sole aim the production of more and better varieties of cultivated plants. In addition to these tangible attainments, however, his efforts gave great impetus to the development of plant breeding. From the viewpoint of science, this stimulus was perhaps the most important result of his work. He died at Santa Rosa on April 11, 1926.

Burbank's published works include *Luther Burbank, His Methods and Discoveries,* 12 vol. (1914–15); *How Plants Are Trained to Work for Man,* 8 vol. (1921); and *New Creations* (1893–1901), a series of descriptive catalogues of his new varieties of plants. *Harvest of the Years* (1927), written by Burbank with Wilbur Hall, is an informative autobiography.

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BURBANK, an industrial and residential city of California, U.S., 12 mi. N of the Los Angeles Civic Centre in Los Angeles County. Burbank has long been known as the home of the first major airport in the Los Angeles area. In addition to aircraft, Burbank industry includes several motion-picture and television studios. A land grant including the site of Burbank was made to José Maria Verdugo by the Spanish government in 1797. The Verdugo family held the ranch until the early 1860s. After several changes of ownership, the tract comprising the city was sold to David Burbank, a Los Angeles dentist, who operated his holdings as a large sheep ranch until 1886. He then sold his farm to the Providencia Land, Water, and Development Company for subdivision. The townsite was surveyed and a village bearing Burbank's name came into being May 1, 1887. Burbank was incorporated July 8, 1911, with a population of 400. A council-manager form of government was established in 1927. Pop. (1960) 90,155, (1970) 88,871. For comparative population figures *see* table in CALIFORNIA: *Population.* (J. M. WO.)

BURCKHARDT, JACOB CHRISTOPH (1818–1897), a Swiss historian and writer on the Italian Renaissance and the philosophy of history, was described by the Dutch historian Johan Huizinga as the "wisest man of the 19th century" and by Nietzsche as "our greatest sage." He was born at Basel on May 25, 1818, the son of a pastor. He began his studies at the city's *Gymnasium* and later at its university, studying theology history and philology. From 1839 to 1843 he continued his studies at the University of Berlin. His teachers in Berlin were J. G. Droysen, Franz Kugler and L. von Ranke.

Burckhardt obtained his Ph.D. degree at Basel in 1843, spent four months in Paris and became the editor of the conservative *Basler Zeitung.* He left this newspaper two years later, visited Italy in 1846 and returned there in 1847–48, 1853–54 and many other times later.

Burckhardt began his university teaching career at Basel in 1844. In 1855 he was appointed to the chair of art history at the Polytechnical school at Zürich and in 1858 to the chair of history at the University of Basel. He retired in 1893 and died at Base on Aug. 8, 1897.

Burckhardt's visits to Italy in the 1840s marked the beginning of his extensive scholarly work and his numerous publications At the same time the romantic ideas of his youth lost their attraction for him, and he turned to classicism. Yet he was interested in the middle ages, and in his first important work, *Die Zeit Konstantins des Grossen* (1853; Eng. trans., *The Age of Constantine the Great,* 1949), Burckhardt presented the dawning of this period as a necessary transition from the ancient world to Christianity, the foundation of a new civilization.

Burckhardt's next book was *Der Cicerone* (1855), a comprehensive study of the works of art in Italy. This guide won wid acclaim and served many generations of travelers to Italy. O Burckhardt's later works *Die Kultur der Renaissance in Italie* (1860; Eng. trans., *The Civilization of the Renaissance in Italy* 3rd ed., 1951) was the most important because it attempted th first synthesis of the period. This masterpiece became the starting point for further critical study. *Die Geschichte der Renaissance in Italien,* devoted mainly to architecture, appeared in 186 During 1868–73 Burckhardt prepared *Die Weltgeschichtlich Betrachtungen* (1905; Eng. trans., *Reflections on History,* 1943) in which he presented his philosophy of history.

Another work, *Die Griechische Kulturgeschichte,* on the histor of the Greek civilization, was begun in 1864, left unfinished a his death and published in four volumes (1898–1902) by h nephew Jacob Oeri; the little book *Erinnerungen aus Rubens* ar three important essays on art called *Beiträge zur Kunstgeschich von Italien* were published in 1898.

His *Gesamtausgabe* was published in 14 volumes (1929–34), with critical texts and introductions; his *Briefe* were edited by Max Burckhardt in 10 vol., of which 3 vol. appeared 1949–55.

See also Werner Kaegi, *Jacob Burckhardt*, 3 vol. (1947–56). (W. Ki.)

BURCKHARDT, JOHANN LUDWIG (1784–1817), Swiss orientalist, was, next to Mungo Park, the most notable traveler employed by the African Association during the pioneer age of African exploration between 1788 and 1830. Burckhardt was born in Lausanne on Nov. 24, 1784; he was educated in Germany and went to England in 1806 with an introduction from the naturalist J. F. Blumenbach to Sir Joseph Banks, president of the Royal Society and founder of the African Association. Burckhardt studied for three years at London and Cambridge and in 1809 received instructions from the association to go first to Syria to perfect his Arabic and accustom himself to life among Muslims, and then to make his way to the regions south of the Sahara by the northerly route to Fezzan.

When Burckhardt arrived in Cairo in 1812 there seemed no immediate prospect of a reliable caravan to Fezzan, so he traveled instead up the Nile, eastward from Shendi to Suakin, and thence made the pilgrimage to Mecca, returning by way of Medina and Suez to Cairo in June 1815. He visited Mt. Sinai in the spring of 1816, and eventually died in Cairo on Oct. 17, 1817, still waiting for a chance to cross the Sahara on his promised journey.

Burckhardt was an accomplished orientalist; under the name of Shaikh Ibrahim ibn Abdullah and wearing Muslim dress, he achieved a profound knowledge of Muslim law and customs, and a deep sympathy for Islam. He left his large collection of Arabic manuscripts to Cambridge University.

His works were published by the London African Association: *Travels in Nubia,* with biographical memoir (1819); *Travels in Syria and the Holy Land* (1822); *Travels in Arabia* (1829); *Arabic Proverbs or the Manners and Customs of the Modern Egyptians* (1830); *Notes on the Bedouins and Wahabys* (1831).

See also: *Scheik Ibrahim (Johann Ludwig Burckhardt), Briefe an Eltern und Geschwister,* ed. by C. Burckhardt-Sarasin and H. Schwabe-Burckhardt (1956). (D. Mn.)

BURDETT, SIR FRANCIS (1770–1844), English radical who was a zealous advocate of reform, was born on Jan. 25, 1770. His political opinions were greatly influenced by a visit to Paris in the early days of the French Revolution. Returning to England in 1793, he married Sophia, the enormously rich daughter of Thomas Coutts the banker. He became (by purchase) member of parliament for Boroughbridge in 1796, and succeeded his father as 5th baronet in 1797. In parliament he denounced the war with France and William Pitt's suspension of the Habeas Corpus act. Burdett was elected member of parliament for the "popular" constituency of Middlesex in 1802, but his return was disputed and after a second election he was unseated in 1806. He had spent nearly £100,000 on the constituency. He was elected member for Westminster in 1807, a memorable victory in the history of English radicalism. Burdett held the seat without interruption for the next 30 years.

Burdett made his parliamentary reputation in 1810 when he came into sharp collision with the house of commons over an issue of privilege. A radical named John Gale Jones had been committed to prison by the house. Burdett denounced the proceeding and questioned the power of the house to take this step. A revised edition of his speech on this occasion was published by William Cobbett, a friend of Burdett, in the *Weekly Register*. The house voted this action a breach of privilege and a warrant was issued for Burdett's arrest. Burdett at first resisted the authorities, and for a time he was confined to the Tower of London. Actions which he subsequently brought against the speaker and the sergeant at arms were dismissed. In parliament Burdett denounced corporal punishment in the army, supported all attempts to check corruption, and introduced motions for parliamentary reform. In 1811 he became chairman of the first Hampden club, organized by his fellow radical John Cartwright (*q.v.*). Later he was a zealous advocate of Catholic emancipation. In 1820 Burdett severely censured the government's action at Peterloo (*q.v.*); he was prosecuted at the Leicester assizes, fined £1,000 and committed to prison for three months. Long before the passing of the Reform bill (1832) Burdett's zeal for reform and his enthusiasm for extirpating abuses had diminished. He separated himself from the reformers and lost the confidence of his former colleagues. He left Westminster in 1837, and was elected member for North Wiltshire. Thereafter he voted and worked with the Conservatives in parliament until his death on Jan. 23, 1844. (A. Bri.)

BURDETT-COUTTS, ANGELA GEORGINA BURDETT-COUTTS, Baroness (1814–1906), English philanthropist, remembered for her generous use of her large fortune, and as a friend of Charles Dickens (*q.v.*). The youngest daughter of Sir Francis Burdett (*q.v.*), she was born in London on April 21, 1814. She took the name Coutts in 1837 when she inherited a fortune from the duchess of St. Albans, formerly Harriot Mellon, the actress, and second wife of the banker Thomas Coutts, Angela's grandfather. She soon became increasingly interested in philanthropy, and won the friendship of many eminent men of her time, from the duke of Wellington to Gen. George Gordon, and including especially Sir James Brooke (*q.v.*) and Dickens. It was Dickens who helped to guide and inspire many of her charitable activities during the main period of their friendship (1841–58), particularly those concerned with education and the housing of the poor. The number and breadth of her enterprises were great; many were far-reaching, though not all were successful; but all were marked by fundamental good sense and generosity. A keen churchwoman, she founded churches and church schools, and endowed the bishoprics of Cape Town and Adelaide (1847) and British Columbia (1857). In 1871 she was made a peeress in her own right. Her reputation was at its height. She then chose to marry a young American, Ashmead Bartlett, aged 27, a member of her secretariat. As a result, by the terms of her grandfather's will, she had to surrender more than half her fortune to other members of the family. The marriage was not happy, and her philanthropic activities were much curtailed. She died in London on Dec. 30, 1906, and was buried in Westminster Abbey.

See Clara Burdett-Patterson, *Angela Burdett-Coutts and the Victorians* (1953); *Letters from Charles Dickens to Angela Burdett-Coutts 1841–1865*, ed. by Edgar Johnson (1953). (K. J. F.)

BURDUR, the chief town of the *il* (province) of the same name in the southwest of inner Anatolia, Turkey, lies near the eastern shore of Lake Burdur. Pop. (1965) 29,268. It is surrounded by market gardens and has the appearance of an oasis town; its size and economy expanded after World War II. It stands on the north-south main road Antalya-Dinar-Afyonkarahisar.

The *il* had a population in 1965 of 194,950 and an area of 2,657 sq.mi. It lies between the Mediterranean and central Anatolian regions, and its southern part is occupied by the Taurus mountains. The main occupation is agriculture, including both irrigation and dry farming. Wheat and barley are the main crops in the dry areas, and vegetables, fruit and vineyards are produced on the irrigated land. On the plateaus and mountains stock raising is the chief occupation of both the sedentary population and the nomad Yörüks. (N. Tu.; S. Er.; E. Tu.)

BURDWAN, a town, district and revenue division of West Bengal, India. The town (area 9 sq.mi. with rural enclaves; pop. [1961] 108,224) lies astride the Banka river, 73 mi. N.W. of Calcutta, on the main Eastern railway. Places of interest are the Rajbari (Maharaja's palace), Gulab bagh, and two large tanks (earthen embanked reservoirs), Rani sagar and Sham sagar. The Rajbari houses the University of Burdwan, constituted in 1960.

Burdwan District covers 2,716 sq.mi. and had a population of 3,082,846 in 1961. The eastern part is a low alluvial plain containing loamy soils, innumerable tanks, rice fields and a dense population; on the west occurs a highly industrialized zone on Gondwana rocks bearing rich coal seams and fire-clay deposits, while in the middle stretches older alluvium covered with red lateritic soils and patches of sal jungle. The Bhagirathi, Damodar and Ajay are the chief rivers. The economy of the district is mainly based on coal, which is mined in the west. The Durgapur barrage scheme of the Damodar Valley corporation provides irrigation water (*see* DAMODAR). Asansol (*q.v.*) (pop. 103,400) is the largest industrial and trade centre of the district. Raniganj (30,113) has many coal mines in its neighbourhood and a paper mill and pottery works within the town. Burnpur (21,024) has one of the largest iron and steel works in India. Two new townships have sprung up at Chittaranjan (28,973) and at Durgapur (pop. 41,699), the former manufacturing locomotive engines and the latter coke, iron and steel. The only three major towns in the eastern agricultural plains are Kalna (pop. 22,603), Katwa (20,568) and Dainhat (10,519), all situated on the right bank of the Bhagirathi.

BURDWAN DIVISION comprises the seven districts of Howrah, Hooghly, Midnapur, Bankura, Burdwan, Birbhum and Purulia. It covers an area of 16,528 sq.mi. and had a population in 1961 of 16,165,283. (S. P. C.)

BUREAUCRACY in common parlance and in general literature is a word employed in so great a variety of ways that one must be wary in what context it is being used. In the English-speaking world, the term bureaucracy usually carries an invidious overtone. Generally it refers to the shortcomings of a permanent civil service organized into a hierarchy and enjoying certain rights of tenure. But it is often applied to all officeholders, temporary as well as permanent. It is loosely and interchangeably applied to groups of officials, to their methods of work, or even to their policies. As contrasted with the special meaning of bureaucracy in the social sciences, it has not been accepted in ordinary usage as a neutral designation of a respectable occupation or of an accepted type of social-administrative structure.

The words "bureaucrat" and "bureaucratic" have an even more negative connotation. The designation of an official as a bureaucrat is almost invariably derogatory, whether in Hansard's *Parliamentary Debates*, the *Congressional Record*, or in the British and American press. The word "bureaucrat" is seldom used to designate a wise or progressive official, and the word "bureaucratic" is not employed to describe fair, considerate, and efficient administrative behaviour. This situation makes it unlikely that the term "bureaucracy" will receive general acceptance as a generic designation, carrying no critical connotation, for the increasing number of institutions employing great numbers of people compelled by an era of high technology and subdivision of labour to earn their living and to perform the world's work in large organizational units.

The word "bureaucracy" stems from the French *bureau*, which has come to mean a department or a subdivision of a department, usually of government. The French word, in turn, was derived from the word for writing desk or table with drawers, so called because originally covered with a cloth known as *burel*. Just as the word "office" was formerly identified only with public office, so the word "bureau" was at first applied only to public business, and the baize-covered table remains to this day the symbol of official conferences. Literally then, bureaucracy would mean bureau rule, much as autocracy means the rule of the despot, and democracy the rule of the people.

Bureaucracy and the Social Sciences.—A less pejorative use of the word appears increasingly in the literature of the social sciences. It designates a social institution recognized to be of growing importance and a subject of serious and objective study, there being no other term quite so convenient. More and more publications are emerging as a result of social science research on the structure of organizations, the origins and attitudes of the people comprising them, their behaviour, their communications, their relationships, and their productivity. The research has been greatly influenced by the pioneering work of the German scholar Max Weber (1864–1920), who first projected a model of "ideal bureaucracy" to designate the social institution of a permanent professional corps of officialdom organized in a hierarchy and applying impersonal, uniform norms to the handling of individual cases under a rule of law. Since his time, social scientists have studied bureaucracy as a human institution in much the same way that they have observed other human institutions such as the family, the tribe, and the community. They often contrast bureaucracy with less centralized and impersonal systems which prevail in patrimonial and feudal societies.

All the social sciences have made contributions to these researches including political science, sociology, anthropology, and social psychology. Nor have these researches been confined to the structure and behaviour of public agencies. Many of them have been concerned with institutional studies in the realm of business corporations, educational organizations, voluntary associations, and even religious bodies. The most recent studies have examined not only specific organizations but the effects of large-scale organization on a society and on the individuals that comprise it. Such studies have been concerned with the effect on the people of the tendency of "bureaucratization" in an entire nation.

Bureaucracy in Despotic States.—In ancient despotic societies where final decision over the destiny of the country and its citizens rested in a dynasty or in the hands of small hereditary or self-perpetuating elite, the absolute power of the monarch was often manipulated by a bureaucracy. In times of almost universal illiteracy the monarch was particularly dependent on the scribes and clerks he was compelled to employ who alone could read and write. Karl A. Wittfogel in *Oriental Despotism* (1957) gives vivid examples of the absolute power of officials in the states of antiquity. The classic case of entrenched officialdom is the civil service of China, in which an elaborate system of examinations for entrance and promotion, within an elite literate corps, dates back to before the Christian era. (*See* SUNG: *Sung Civilization.*) Wittfogel makes an interesting contrast between a serving, a controlled, and a ruling bureaucracy.

In the 20th century, with the decline of kings and emperors exercising absolute rule, new forms of despotism arose in communist and fascist regimes, with no ultimate control over the acts of the officials who achieved power by seizing domination of the political machinery and command of the military and police forces and the apparatus of terror. In the weaker democracies one frequently sees the temporary seizure of power by military juntas or careerist groups.

But even in advanced democratic states, as writers such as James Burnham have shown in his *The Managerial Revolution* (1941), a new oligarchy of industrial and governmental managers has arisen, whose inside knowledge put them in a position of power over the ordinary citizens. Although Burnham's fears may have been exaggerated, the growth of large organizations, both in government and business, in which small groups of insiders wield great authority, continues to be a subject both of scientific research and of public concern.

Civil Services and Democracy.—In modern democracies the official is considered to be the servant and not the master of the people. The acts of the civil servant are restricted by many checks and balances. He is subject to the rule of law and judicial review and is accountable to the freely elected representatives of the people in Parliament or Congress. The constitutional rights of the citizens of freedom of speech, assembly, and of the press, the secret ballot, and the duty of the official to make public disclosure of his acts as well as to respond to the policies of the governmen of the day make up the democratic guarantees. There are crimina penalties for corruption and in the case of inefficiency and for acts exceeding his powers the penalties include suspension and discharge from the service.

The higher civil services of the Western world until quite recently had certain undemocratic aspects. The earliest one wa the German school of cameralists which flourished in the 18th century. Special chairs were established in the universities designed to train young men for the management of the exchequer of the king or ruling prince, and the candidates were selected from the sons of the aristocracy. The members of the administrativ class of the British civil service, beginning in 1855, were chosen by competitive examinations from graduates of Oxford and Cambridge universities, which in the 19th century were open mainl to young men of the upper classes. The *grands corps* of the Frenc civil service, beginning in the time of Napoleon I, were largel chosen until World War II from aristocratic or upper middle class candidates. There has been a great broadening in the access t university education in Britain and France in the 20th centur by granting of scholarships and fellowships. As universities be come more democratic, so has the entrance to these European elite services. Greater opportunity is offered today than ever before to gifted men of humble origin to enter the top grades of the national services still predominantly through university channels, but also by promotion from the ranks. The strong emphasis on intelligence and education has continued to influence the severe system of competitive examinations for entrance to the administrative ranks of the European public services.

The American tradition on the other hand has been not only anti-aristocratic but, until recently, anti-intellectual. During the administrations of the first six presidents of the United States there was a tendency to retain in office the sons of the propertied and educated families of the Eastern seaboard. But a drastic change occurred under Pres. Andrew Jackson, with whose administration one associates the slogan "To the victor belong the spoils." Rotation in appointive as well as in elective office (except for the federal judiciary) became identified with the upsurge of democracy in the young republic. Jackson asserted that official duties could be made "so plain and simple that men of intelligence may readily qualify themselves for their performance." This view resulted not only from the admission of the new states as the Western frontier advanced beyond the seaboard but from the rise of political parties which related government jobs to services to the party in power. The sordid spectacle of a poorly paid and chosen public service, changing with every incoming administration, and replaced by other patronage appointees of no greater competence and of less experience in their tasks, ensued for most of the 19th century. And these jobholders tended to be loyal to the political boss who nominated them rather than to the department that paid them.

Emergence of the American Merit System.—Two parallel forces finally prevailed and brought about the gradual emergence of the contemporary U.S. merit system. One was the persistent campaign of the civil service reformers such as Carl Schurz to counteract the wave of corruption and scandals that took place after the Civil War. But a less known and equally potent force was the early entry of the government into scientific and technological fields and the growth of technical education through the land-grant colleges. The professional groups in these fields insisted on the appointment of administrators of qualification and merit. (*See* Don K. Price, *Government and Science*, 1954.) But not until the assassination of President Garfield by a disappointed office seeker was the competitive civil service system finally authorized by the passage of the Pendleton Act of 1883.

Every president since that time has extended the merit system. The Personnel Classification Act was not passed until 1923, however, and the Foreign Service career system was not established until the passage of the Rogers Act in 1924. Many state and local authorities adopted civil service systems, though there still are large excepted areas at those levels. It is estimated that today more than 99% of the 2,500,000 civilians in the federal service are in the merit system and continue in their posts when a new administration takes office in Washington.

At the federal level the earlier anti-intellectual tradition has virtually disappeared in the face of the complex demands of modern administration since the time in the 1920s when even members of the top ranks of the administrative services were known as "clerks." The great increase in the number of college graduates in the government service was a striking fact reported in the study by W. Lloyd Warner and associates, *The American Federal Executive* (1963), which also pointed to the marked growth in the number of federal executives holding graduate degrees.

The prestige and dignity of holding a government post in the career services of the federal government have advanced with the advent of merit principles. Salaries, pensions, and fringe benefits have been greatly improved. Training plans have been introduced and there is a greater amount of lateral mobility as well as promotion from within the service, thus making the public service more attractive as a career for able people. But there are still many improvements to be made in perfecting the career services, particularly at the top administrative and scientific levels as indicated in the Report of the President's Committee on Administrative Management (1937) and in the reports of the First and Second Hoover Commissions (1949 and 1955).

The U.S. system is less of a "closed civil service" than its foreign counterparts and has a greater degree of lateral mobility to and from the government of personnel from industry, from the universities, and from the professions. The length of time it has taken the advanced nations to bring their civil services to the point where they offer the possibility of a self-respecting and worthwhile career, on a democratic basis, should induce a more tolerant attitude toward the slow progress of the public services in the newly independent and underdeveloped countries.

Bureaucracy as an Organizational Disease.—The most useful concept of bureaucracy in a popular sense is one that avoids the extreme poles of approbation and opprobrium and that does not depend on the social bias of its user. This concept is that bureaucracy is the pathology of large organizational units. Just as every biological organism is susceptible to disease and deterioration, so every social organism is subject to certain illnesses. The factors that make for a healthy organization and of the signs of morbidity in a sick one are becoming better understood. Public administration and business management are becoming more precise in diagnosis and cure, and agencies themselves are making greater use of experts in new techniques to prevent and correct bureaucratic tendencies.

Bureaucracy as an illness, as many authorities have pointed out, is not confined to governmental agencies and can be found in all kinds of large organizational units. But in a democracy there is a continuing need to prevent bureaucratic tendencies in the government because of its powers over private rights and because it lacks the correctives of the market place.

Types of Bureaucratic Illness.—The two illnesses to which large organizations are prone are the polar tendencies of aggressiveness and recessiveness. The aggressive or imperialistic type of agency is preoccupied with the extension of its jurisdiction, size, and power. The recessive type of unit, on the other hand, suffers from a kind of inferiority complex. It shrinks from innovation, hesitates to assert itself, and tends to avoid responsibility and to shift it to others. A given agency may fluctuate between these two opposing tendencies, but as a rule it will be prone to persist in one or the other. When an agency becomes overaggressive or overrecessive, a form of bureaucracy is at work. The respective influences of the permanent career staff and of the temporary policy staff are out of balance. The cure consists in restoring a balance between these conflicting forces of continuity and flexibility.

One of the phenomena observed in large organizations is the elevation of status over function as an objective. Officials in such organizations tend to give greater weight to the importance of their rights and prerogatives than to their duties. While a growing spirit of professionalism has often greatly benefited the competence of public services, an excessive preoccupation with questions of status and rights of officials, as in the case of the medieval guilds, becomes a brake on flexibility and innovation.

Responsiveness, Innovation, and Productivity.—The questions most frequently raised about civil service systems in which the incumbents enjoy tenure rights, relate to their responsiveness to new policies as reflected by the election of a new administration, to their open-mindedness in regard to new methods and innovation, and to their industry and productivity. Many studies indicate that the widely held stereotype that all civil servants resist change, cannot innovate, and are lazy and unproductive is exaggerated. Agencies differ in their behaviour just as people do and there is much evidence that these traits are by no means universal and are to be found in large private organizations as well. With the improvement that has come about in the quality of top administrators, it will generally be found that the degree of rigidity of attitudes of the staffs of large organizations tends to be inversely proportional to their rank and status.

In the U.S. federal government, the chiefs of the large operating agencies or bureaus are predominantly career men and exercise considerable power in their alliances with congressional committees and supporting interest groups in defiance of the policies of the department head. Partly as a check on this tendency, the U.S.

practice is to interpose political assistant secretaries between the bureau heads and the head of the department, a system which does not prevail in Britain, where the permanent secretary reports directly to the minister. The *cabinet* of the minister in France is composed of a team of "seconded" civil servants and of political careerists, which under French conditions seems to have definite advantages. The modernization of its high services has been one of the remarkable accomplishments of France since 1945. The U.S. system of recruitment by technical specialization has certain advantages, but it has differed from the European and has no exact counterpart of the generalist administrative class in the United Kingdom, nor of the mobile *grand corps* in France. Harold J. Laski, in *Democracy in Crisis* (1933), was wide of the mark in his predictions that the British civil service would sabotage a Labour government, as was shown by its spirited support of the government headed by Clement Attlee which came into power in July 1945.

Secrecy.—After World War II, a very old problem of bureaucracy reasserted itself in acute new forms, the problem of governmental secrecy. The cold war which has kept the great powers in a continued state of military preparedness with huge and increasing military budgets and the accelerating rate of technological progress applied to weapons such as missiles and the atomic bomb have brought great areas of governmental information into the secret or "classified" category. Civil servants continue to be examined not only for competence and integrity, but for "loyalty and security," and have been frequently discharged or rejected on very slender evidence. The temptation in such times for officials to extend justifiable governmental secrecy to unrelated matters is a great one, and may be used to cover up errors and to lessen the accountability of public servants to the citizens. A prophetic depiction of the effect of secrecy on democratic institutions, in what he called "the garrison state," was given by Harold D. Lasswell in *National Security and Individual Freedom* (1950).

This problem will continue to be persistent in the thermonuclear age. In spite of legislation in the United States requiring public disclosure, it may find no satisfactory solution until effective international control of the ultimate weapons is established and until a more peaceful international atmosphere prevails.

Criteria of Health.—In democratic societies the simple virtues still tend to be accepted as criteria of organizational health in the public mind. Such characteristics as integrity, impartiality, responsiveness, progressiveness, efficiency, and courtesy are all signs of organizational health and freedom from bureaucracy. Bureaucracy obtains when an agency lacks these elements to any marked degree. Thus, graft and corruption, favouritism, waste, backwardness, insensitivity to public needs, and idleness are all evidences of organizational disease. Simple as these symptoms sound, they are not easy to overcome in a large, complex organization.

Prevention and Cure.—The democratic process is the best protection against bureaucratic disease. The right to question and to criticize is the most potent anti-bureaucratic hygiene. But new methods of internal evaluation and improvement in the many techniques used by public administration are increasingly being adopted by government agencies themselves. Applied psychology has contributed better methods of personnel administration and of appraising, stimulating, and rewarding good work and productivity. Social sciences have contributed useful techniques in the art of supervision and in regard to group behaviour. Administrative research and in-service training have been fostered. The concepts of modern economics such as measures of "input" and "output" are beginning to be applied to innovations in program and performance budgeting (*see* NATIONAL INCOME ACCOUNTING). Government has been a pioneer in the adoption of the electronic digital computer, and many agencies, performing great masses of transactions, have upgraded the efficiency of their services to the public and have eliminated red tape and excessive paper work. The statistical sciences, aided by the computer, have improved the quality and quantity of factual data available as a basis for decision making on public policies and have made possible the use of operations research. Great progress has been made in the archival disciplines, which preserve and index documents of permanent value and dispose of unnecessary papers. (*See* further INFORMATION PROCESSING.) Government accounting and auditing systems have been perfected. Many agencies are taking pains to humanize their services to the citizen and to issue forms and instructions in clearer and more understandable terms. Advances have been made in improving the organizational structure of departments. In the enormous acceleration of programs of scientific research and technical development the government has used the device of contracting-out major projects to private industry and to universities. In fact a healthy bureau is one in which activities such as those enumerated are continuously pursued.

Of even greater importance is the fact that many governments are introducing new methods aimed to prevent and to remedy abuses arising from the arbitrary use of administrative authority. A significant innovation in this field is the Scandinavian creation of the post of ombudsman (*q.v.*), an official who is authorized to receive and deal with citizen grievances against departments and agencies, and a number of countries are beginning to emulate this example. There is a growing practice of consultation by officials with citizen and employee groups. The war against the sicknesses of bureaucracy in the modern world, with its growing structures of complex organizations, is an incessant one and eternal vigilance is the price not only of liberty, but of the rendering of impartial and effective public services which free men demand of their governments in the modern democratic service state.

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(H. E.)

BURFORD, a Cotswold town of Oxfordshire, Eng., near th Gloucestershire border, 18½ mi. W. of Oxford. Population (1961 Burford and Upton and Signet civil parish was 1,453. The hand some High street, built of local oölite, rises steeply from the Win rush. The battle of Beorford (752) was not, as generally state at Burford, which was acquired in 1088 by Robert Fitz Hamon wh gave it a market and the earliest datable guild merchant (*se* GUILD). Alderman Simon Wisdom helped found the gramma school in 1571. Sir Lawrence Tanfield, whose memorial tom dates from 1628 bought the town and manor (1617) and success fully challenged Burford's privileges (1621). He also built th priory on the site of an Augustinian hospital (13th century This was sold by Lord Falkland to William Lenthall, speaker the Long parliament (1637), and is now a convent. It was at Bu ford that Oliver Cromwell crushed the Levellers in 1649. St. Joh the Baptist's church, with massive Norman spire, was reco structed (14th–15th century) with a delicate spire and a separat 13th-century chapel of St. Mary. (W. O. H.)

BURG, a town of Germany, is situated about 31 km. (19 mi. N.E. of Magdeburg on the Berlin-Magdeburg railway line. Po (1964) 29,843. A little stream, the Ihle, flows along the eas ern edge of the town and on the western edge is the Ihle cana a part of the Elbe-Havel canal. Burg originally belonged to t diocese of Querfurt which was joined to the archdiocese of Magd burg in 1496. In 1635, together with other parts of the arc bishopric, it was ceded to Saxony and in 1687 to Brandenbur After the dissolution of Saxony-Anhalt in 1952, Burg became regional capital in the district of Magdeburg, German Democrat

Republic. The town has a rolling plant for sheet metal, and cloth, shoes, machines and crispbread are manufactured.

BURGAS, the medieval Pyrgos, a port and capital of Burgas district, southeast Bulgaria, lies on an inlet of the Black sea, on a low foreland between two lagoons. Pop. (1961 est.) 93,405. It faces open sea on the east and its own harbour on the south. At mid-19th century it was a fishing village of about 3,000 inhabitants, but it rose rapidly in importance after Bulgaria's liberation (1878), mainly by reason of the railway to Sofia (1890) and the building of a new harbour (1904). It now rivals Varna as the chief port of Bulgaria, surpassing it in the grain trade; about 40% of the country's Black sea trade passes through the port, including tobacco, fruit, fertilizers, cement and ore concentrates. In and near the town are flour mills, a sugar factory, soap factories, fish canneries and engineering works, and an oil refinery was constructed after 1960. Some copper is mined in the vicinity, and lignite at Rudnik; salt is produced at Pomorie.

Burgas, with the small neighbouring port of Sozopol, also handles about three-quarters of the Bulgarian fish catch. It is a cultural centre and a seaside resort. Sunny Beach, near Nesebur, also shares in the resort trade with Pomorie, noted for its mud-baths and its vineyards, and Sozopol, with fine stretches of sandy beach. (AN. BE.; S. H. BR.)

BURGENLAND, a *Bundesland* (federal state) of Austria. Area 3,965 sq.km. (1,531 sq.mi.); pop. (1961) 271,001. Forming the boundary area toward Hungary, it was derived from parts of the former four West Hungarian *comitats* (counties), Pressburg (Bratislava), Wieselburg (Moson), Ödenburg (Sopron) and Eisenburg (Vasvar). It became a political unit of its own in 1921.

Physical Geography.—Its surface consists largely of marine and fluviatile deposits of more recent periods, containing brown coal in a number of places, although here and there outliers of the Central Alps, consisting of crystalline base rock, appear as horsts above the level of these later strata. There also exist a few basalt mountains, the necks of Tertiary volcanoes. Antimony ores occur in the Bernstein mountains. There are a large number of mineral and thermal springs and still occasional micro or small earthquakes. The most striking feature of the northern Burgenland is the Neusiedler lake (*q.v.*). Structurally, geologically and geographically the low-lying parts of the northern Burgenland beong to the Hungarian plain which is linked with the southern Vienna basin by two gateways situated north and south of the Leitha mountains. The latter, a horst of crystalline rock, rise to 1,585 ft. The Rust hills (rising to 928 ft.), on the western shore of the Neusiedler lake, are a similar formation.

The crystalline Rosalia mountains are no longer an isolated range but are linked with the Alps. The Rosalia mountains rise to a plateau surface of about 2,000 ft. In the southern branch they are crossed by the Sieggraben pass. East of the Sieggraben the crystalline rocks are covered by Miocene gravel.

The middle Burgenland is the most mountainous part decreasing eastward to the Hungarian plain and rising to the Landsee and Bernstein mountains in the west and the Güns mountains in the outh (Geschriebenstein, 2,897 ft.).

The southern Burgenland is of pronounced relief, with hills rising to over 1,500 ft. Streams drain the region from northwest to southeast and are accompanied by systems of terraces.

Climatically the Burgenland is more favoured than the rest of Austria. It has the longest growing season, with 235 to 252 days per year, experiences an early spring, has most sunshine and a ainfall of about 24 in. The north shows the strongest continental characteristics and has the warmest summers of the country. Proected by the mountains from northwesterly winds and regulated by the influence of the lake, the earliest fruit and vegetables in Austria can be grown there and conditions are suitable for viticulure.

Alpine flora is absent and mixed forests and spruce covers only he Landsee and Bernstein mountains, while the vegetation of the est of the middle and southern part of the country is characterized by beech, pine and mixed forest of beech and spruce. Characteristic of the easternmost parts of middle and southern Burgenland are pubescent oak, hornbeam and black pine. Northern Burgenland has steppe and continental saline heath vegetation. The Seewinkel with its saline steppe lakes and the Neusiedler lake forms the habitat of a multitude of water birds. The entire Neusiedler lake area is protected, and 165 hectares (408 ac.) in the Seewinkel are nature preserves supervised by a biological research station at Neusiedl.

History.—Human occupance has beyond doubt been continuous since the Paleolithic period. In the late Iron Age the southwestern part belonged to the Celtic kingdom of Noricum (*q.v.*). During the time of the Roman occupation, from 15 to about 375 A.D., it was part of Pannonia (*q.v.*). Subsequently occupied in turn by Teutonic tribes, Avars and Slavs, the first German settlers came during the 8th century. Although part of Hungary, it became an area of predominantly German settlement under a largely Magyar ruling class. The history of the Burgenland is initially part of the history of Hungary and from 1529 onward part of that of the Habsburg empire. After World War I, the claims of the Austrian Republic to the predominantly German parts of western Hungary were granted nearly in full, but when in July 1921 Austria attempted to establish its administration, the Austrian *Gendarmerie* was attacked by Hungarian irregulars and had to withdraw. As a result of Italian mediation Hungary handed over the present Burgenland but retained control of Sopron (Ödenburg) after a plebiscite.

The loss of the Sopron area robbed the Burgenland of its natural capital and severed all communication lines from north to south. Eisenstadt was chosen as capital in 1925. Following the *Anschluss* (union with Germany), Burgenland was abolished as a political unit on Oct. 1, 1938, its northern part being incorporated in the *Reichsgau* Niederdonau and its southern part in the *Reichsgau* Steiermark (Styria) of Greater Germany. It was re-established as a *Bundesland* on Oct. 1, 1945.

Population and Administration.—The population at the 1961 census was 271,001, a decrease since 1934; the density was 177.0 to the sq.mi. Because of its predominantly agricultural economy and poverty, emigration from this area is of long standing, both to other parts of Austria and also to Germany and overseas (U.S., Canada, Argentina, Brazil). The absence of a sizeable industry and prevalence of small farms with extreme fragmentation of holdings give rise to a low standard of living, underemployment and seasonal migration.

Although ethnically predominantly German and speaking a dialect of the Bavarian group, the Burgenland has the highest proportion (*c.* 15%) of non-German minorities, Croat and Magyar. More than 85% of the people are Roman Catholics; the Burgenland became a diocese in its own right in 1960. There are few towns and only Eisenstadt has a population of more than 5,000. Rural settlement is characterized by a preponderance of villages of the regular colonial types. The characteristic house is the single file farmstead and forms developed from it.

The *Land* government consists of the governor and five other members elected by and responsible to the provincial diet (*Landtag*), which has 32 members elected by popular vote. The *Landtag* is a legislative body but the acts it passes must be approved by the federal government. In the *Bundesrat* (federal upper house) the Burgenland has 3 votes. Administratively it is divided into 7 districts and 2 "district-free" cities (Eisenstadt and Rust). Local government is in the hands of elected burgomasters and town and commune councils.

The Economy.—The Burgenland, 47% arable and 25% forested, produces a large surplus of grain, including maize (corn), and root crops. In the northern part, crops which include vines and also some tobacco, hemp and, experimentally (on the lake shores at Weiden), rice are grown. Livestock is partly stall fed, partly grazed on common pastures. Because of smallness of holdings which necessitates the use of cows as draft animals, milk yields are the lowest of Austria.

Total timber production in 1960 was 279,000 cu.m. Unique in Austria are the vast areas of reed along the shores of the Neusiedler lake. The annual production of reed for industrial use of about 700,000 cu.m. is capable of considerable increase. Some processing is done locally but more than half is exported raw to Germany. The lake also produces quantities of fish (mainly carp)—approximately 200,000 kg. annually.

There is quarrying for Leitha limestone, an excellent building stone which was used for most of the important public buildings in Vienna, and for basalt for use as road metal. China clay is produced near Stoob and there are a number of clay pits for brickworks. The chalk from Müllendorf near Eisenstadt is used both for writing and in industry. The veins of precious serpentine near Bernstein are used for making jewelry and vases. Antimony ore is produced near Schlaining. Fuel resources consist of brown coal. Industries are limited to small plants and include sugar refining and canning, sawmills and furniture industry, and the making of pencils. The large jute factory at Neufeld an der Leitha employs more than 1,000 persons.

The siting of the railways was determined by the Burgenland's former location within Hungary. The three main lines by which the Hungarian railway system was linked with Austria merely cross the Burgenland in the north, centre and south. North-south traffic was maintained by branch lines but since all the railway junctions came to lie within Hungary there is no line linking the north of the Burgenland with the south. A peculiarity resulting from this is that one may travel by rail without any passport or customs control through Hungarian territory (Sopron). A modern north-south road of 230 km. (143 mi.) length from Kittsee to Jennersdorf and leading on to Graz has since been built. Although much has been done to improve road conditions, considerable improvement is necessary to provide for increased motor traffic.

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BÜRGER, GOTTFRIED AUGUST (1747–1794), German poet of the period of *Sturm und Drang*, best remembered for his lyrical ballads, was born at Molmerswende, near Halberstadt, on Dec. 31, 1747, the son of a pastor. He studied theology at Halle and law at Göttingen, continually in difficulties because of his irregular life. He became friendly with the young poets of the literary group known as the *Göttinger Hain* and his first poems appeared in their *Musenalmanach*. In 1772 he became a magistrate at Altengleichen, where in 1773 he wrote his vivid and dramatic ballad "Lenore." In 1774 he married Dorette Leonhardt, but soon fell in love with her sister, the "Molly" of his poems. Bürger's first collection of poems was published in 1778 and in the same year he became editor of the *Musenalmanach*. After his wife's death in 1784 he lectured on the theory of style, aesthetics, poetry and philosophy at Göttingen. In 1785 he married "Molly," who died in childbirth the following year. This event profoundly moved him, as is shown in his letters and in the sonnets to her. In 1789 he was appointed extraordinary professor at Göttingen, though without a stipend, and in the same year paid a visit to Goethe and Schiller at Weimar. His third marriage in 1790 was a disaster and was dissolved in 1792. This, together with Schiller's unjust criticism of the second edition of his poems, hurt him deeply. He became ill with tuberculosis and died in poverty at Göttingen on June 8, 1794.

Bürger began writing verse in the conventional rococo manner, but gradually developed a style based on folksong and the language of the people, characterized by naïvety, simplicity and homely realism. With his popular ballads such as "Lenore," "Das Lied vom braven Mann," "Die Kuh" and "Der wilde Jäger" he created a new lyrical poetry in Germany. His sonnets, which show the influence of Petrarch, became famous and he was admired and imitated by such poets as A. W. Schlegel and Novalis. Most of his translations (Homer, Ossian) were fragments. Bürger's love of English poetry is expressed in his translation of Thomas Percy's ballads and his prose version of *Macbeth*. His German adaptation of the stories of Baron Münchhausen (1786) from the English original by R. E. Raspe enjoyed lasting success.

Bürger's complete writings were edited by E. Grisebach, 5th ed. (1894) and by W. von Wurzbach, four volumes (1902–04). His poems were edited by E. Consentius, two volumes (1920); his letters were edited by A. Strodtmann, four volumes (1874).

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BURGERS, THOMAS FRANÇOIS (1834–1881), South African statesman and theologian, who was president of the Transvaal republic from 1872, remained a controversial figure, because of his unresisting surrender of the republic to the British government in 1877 and because of his religious unorthodoxy. He was born in Cape Colony on April 15, 1834, and educated at Utrecht, Neth., where he graduated as doctor of theology and was ordained a minister of the Dutch Reformed Church. He was called to Hanover, Cape Colony, as minister in 1859 but a synodal commission declared him a heretic in 1864 for holding modernist views, and he was suspended. He appealed successfully to the Cape supreme court, whose judgment was subsequently confirmed by the privy council in London (Feb. 1867). In 1871 the Transvaal *volksraad* (parliament), dissatisfied with their western boundary as defined under the Keate award (1871), decided to seek a president of greater diplomatic talent than M. W. Pretorius, and persuaded Burgers to stand for election. He was elected and took office on July 1, 1872. Burgers carried an important education law, encouraged the new gold-mining industry, and attempted to straighten out the government's confused finances. He visited Europe in 1875 to negotiate a railway loan, but his scheme was ill-conceived and it failed disastrously. In 1876, Burgers' government was further embarrassed by conflict with Sekukuni, chief of the Bapedi in the northeastern Transvaal, part of whose territory was needed for the railway. This war was very unpopular, and peace had barely been made when, early in 1877, Sir Theophilus Shepstone entered the Transvaal under a special commission from the British government, with authority to annex the nearly bankrupt republic. Burgers surrendered his state without resistance and retired to Cape Colony. He died there on Dec. 9, 1881. *See* Transvaal: *History*.

See S. P. Engelbrecht, *Thomas François Burgers* (1946). (T. R. H. D.)

BURGH (Bourke, Burke), the name of a historic Irish family which has been associated with Connaught for more than sever centuries. It was founded by William de Burgh (d. 1206), the brother of Hubert de Burgh (*q.v.*). William accompanied Prince John to Ireland in 1185, and was rewarded by grants of land. Remaining in Ireland, he was given a further grant of most of Connaught in Richard I's reign, but although he spent much time trying to establish his rule there, he was not successful. However, his son Richard (d. 1243) was again granted Connaught in 1227, through the influence of Hubert de Burgh. Richard was appointed justiciar in 1228, and used his combined public and private influence permanently to establish his lordship in Connaught He lost his office of justiciar in 1232, but by siding with the crown in the revolt of Richard Marshal, earl of Pembroke, in Ireland (1234) he managed further to extend his influence and territory after its suppression. After his death in 1243 he was succeeded in turn by his sons Richard (d. 1248) and Walter (*c.* 1230–71) Walter continued to fight the native chieftains, and added greatly to his vast domains by obtaining a grant of the county of Ulste from Prince Edward (afterward Edward I), in consequence o which he was styled earl of Ulster. Walter was succeeded by his son Richard (*c.* 1259–1326), 2nd earl. In 1286 Richar ravaged and subdued Connaught and deposed Brian O'Neill a chief native king, substituting a nominee of his own. He also attacked the native king of Connaught in favour of that branch of the O'Conors whom his own family supported. He led hi forces from Ireland to support Edward I in his Scottish campaigns, and on Edward Bruce's invasion of Ulster in 1315 Richar marched against him, although he had given his daughter Elizabet in marriage to Robert Bruce, afterward king of Scotland, abou 1304. Occasionally summoned to English parliaments, he spen most of his 40 years of activity in Ireland, where he was th greatest noble of his day, usually fighting the natives or his Angl

Norman rivals, the Geraldines. The patent roll of 1290 shows that in addition to his lands in Ulster, Connaught and Munster he had held the Isle of Man, but had surrendered it to the king.

Richard's grandson and successor, WILLIAM (1312–33), 3rd earl, was the son of John de Burgh by Elizabeth, lady of Clare, sister and coheir of the last Clare earl of Hertford (d. 1314). William married a daughter of Henry, earl of Lancaster, and was appointed lieutenant of Ireland in 1331, but he was murdered in 1333, leaving a daughter, the sole heiress not only of the Burgh possessions but also of vast Clare estates. She was married in childhood to Lionel, son of Edward III, who was recognized in her right as earl of Ulster, and their descendant, the duke of York, ascended the throne in 1461 as Edward IV; since that time the earldom of Ulster has been held by members of the royal family only. On the murder of the 3rd earl in 1333, however, his male kinsmen succeeded in holding the bulk of the Burgh territories, and, adopting Irish names, became virtually native chieftains. Their two main branches were those of "MacWilliam Lochtar" in southern Connaught, later given the title of earls of Clanricarde (1543); and "MacWilliam Uachtar" who from 1603 held their territory as the viscountcy of Mayo.

See CLANRICARDE, EARLS OF.

BURGH, HUBERT DE (d. 1243), professional administrator and chief justiciar of England (1215–32) under King John and Henry III, the last great holder of that office, was a member of a knightly family of moderate estates in East Anglia. He served in John's household before he came to the throne and was his chamberlain by 1198. After John's accession (1199) he became sheriff of five counties, custodian of several castles and warden of the Welsh Marches (1201) and of the Cinque Ports (1202). In Normandy, he had charge of Falaise castle (1202) and, for a time, of Arthur I, duke of Brittany, whom he is said to have preserved from the mutilation ordered by the king. He became constable of Chinon (1203) and was captured there when the castle fell to the French in 1205. After two years' captivity in France he became sheriff of Lincolnshire (1208), but his harsh administration was unpopular and the king removed him and his deputy in 1213, when he became one of the seneschals of Poitou. He was with the king when Magna Carta was sealed at Runnymede in June 1215 and was there made chief justiciar. Although appointed partly because he was more acceptable to the barons than his predecessor, Peter des Roches, bishop of Winchester, Hubert remained loyal to John and Henry III during the war with the barons. He led a successful defense of Dover castle (1216 and 1217) against Prince Louis of France, who had come over to oppose King John, and was one of the leaders in the naval victory at Sandwich in Aug. 1217 which finally destroyed Louis' hopes of obtaining the English crown.

After the end of the war (1217), Hubert was one of the most influential men in a government consisting of an increasingly uneasy coalition of men held together initially by the regent, William Marshal, earl of Pembroke (d. 1219), and by the presence of papal legates up to 1221. Thereafter a struggle developed between Hubert, supported by Stephen Langton, archbishop of Canterbury, and Peter des Roches, the king's tutor, who headed a group of alien administrators and soldiers and who was occasionally supported by various English barons. Hubert managed in 1223–24 to recover many castles from the rival party and to deprive most of the aliens of office. He was now predominant and seemed secure when Henry III declared his majority in 1227 and Peter des Roches ceased to be the king's tutor. He enjoyed enormous territorial power, partly as a result of royal favour, and partly as a result of his three marriages, in 1209, 1217 and 1221, with Beatrice de Warenne, an heiress from East Anglia, with Isabella, countess of Gloucester, who had been divorced by King John in 1199 and was the widow of Geoffrey de Mandeville, 5th earl of Essex, and with Margaret, sister of Alexander II of Scotland. He was made earl of Kent in Feb. 1227 and chief justiciar for life in April 1228.

Hubert was a typical member of the administrative class created by Henry II and his sons. His revival in the 1220s of some administrative policies condemned in the 1215 version of Magna Carta contributed to the renewed struggle for the charters from 1225 onward and provided excuses for attacks upon him. His love of power, wealth and title also made enemies, especially in Wales and the Welsh Marches where, by 1231, he held the castles of Skenfrith, Grosmont and Llantilio, and the castles and lordships of Montgomery, Cardigan and Carmarthen, the honour of Gower, and the wardship of the honours of Gloucester and of Brecon and Radnor. This threatened the interests of the earls of Pembroke and Chester and other Marcher lords, and provoked unsuccessful wars with Llewelyn of Wales in 1228 and 1231. The first sign of his fall came in 1229 when Hubert was violently blamed by the king for the breakdown of an expedition to France. Peter des Roches, who had been abroad since 1227, returned in 1231 to intrigue against him. Scattered attacks on alien clergy in England, for which Hubert was held responsible, were used as an excuse to try him in 1232 on trumped-up charges and to deprive him of the justiciarship and of his offices and custodies. He was humiliated and later imprisoned at Devizes, but not deprived of his private lands and earldom. Released by the baronial opponents of Peter des Roches's party (1233), he was admitted to the king's peace with them (1234), but was subjected to another inconclusive trial (1239). He died at Banstead, Surrey, on May 12, 1243, and his lands, but not his title, descended to his son, John de Burgh.

Hubert was the last of the great chief justiciars and was not replaced in office. While earlier justiciars owed their prominence to long royal absences abroad, Hubert owed his to the minority of Henry III. After the loss of England's continental possessions in 1204 and 1214, and following the increasing specialization of fiscal administration, the office had outlived its most obvious and useful functions.

See Clarence Ellis, *Hubert de Burgh* (1952). (J. C. Ho.)

BURGH: *see* BOROUGH.

BURGHERSH, HENRY (1292–1340), English bishop and chancellor, several times changed his political allegiance during the disturbed reign of Edward II and survived to become a trusted emissary of Edward III. At the urgent request of Edward II he was appointed bishop of Lincoln (1320) by Pope John XXII, despite the fact that the chapter had already made an election. After his uncle and patron, Bartholomew, Lord Badlesmere, had fought against the king at the battle of Boroughbridge, Burghersh's lands were seized by the king in 1322, and were restored to him only in 1326. Burghersh took part in the movement which led to the deposition and murder of King Edward II, and became chancellor of England (May 1328) through the influence of Queen Isabella, mother of the young Edward III. On her disgrace (Nov. 1330) he lost his position and favour for a time, but was treasurer from 1334 to 1337 and was entrusted with many important diplomatic commissions by the king. He died at Ghent on Dec. 4, 1340. (J. R. L. H.)

BURGHLEY, WILLIAM CECIL, BARON (1520–1598), English statesman, who was the chief minister of Queen Elizabeth I, was born at Bourne in Lincolnshire on Sept. 18, 1520. He was descended from a family of minor gentry living on the Welsh border in Herefordshire. His grandfather, David (d. 1537), yeoman of the guard of Henry VII and yeoman of the chamber to Henry VIII, began the Cecil connection with Lincolnshire. His father, Richard (d. 1553), rose to be yeoman of the wardrobe under Henry VIII and Edward VI. William Cecil, after attending the grammar schools at Grantham and Stamford, went to St. John's college, Cambridge, in 1535. He was in Cambridge for six years and closely associated with some of the most distinguished scholars of his time, notably with John Cheke who was his tutor. Cecil fell in love with Cheke's sister Mary, and in spite of parental opposition married her in Aug. 1541, shortly after leaving Cambridge. They had one son, Thomas, who was later to become earl of Exeter. Mary died two years later, and in 1545 Cecil was married again, this time to Mildred, daughter of Sir Anthony Cooke and one of the most learned ladies of her time. Her father belongs with the pioneers of Protestantism, and her sisters all married men prominent in the English Reformation movement. Cecil's connection both with the Chekes and with the Cookes was an important factor in determining his own Protestant leanings.

From Cambridge Cecil went to Gray's Inn. His first public office was as member of parliament in 1543. He sat again in 1547, and thereafter served either as a commoner or a peer in virtually every succeeding parliament as long as he lived. During the first decade of Elizabeth's reign he was her chief spokesman in the house of commons and after that in the lords. He was generally recognized as a fluent and effective speaker.

His career at court began in 1547 in the service of the duke of Somerset, lord protector of the young King Edward VI. In matters religious he supported Somerset's program of moderate reform, of which Thomas Cranmer was the chief exponent, as opposed to the radical reformers led by Bishop John Hooper. Cecil also supported Somerset's spirited attack upon the enclosure movement to make common land private property. He recognized however that the English gentry, the power behind the throne, had a vested interest in enclosures, and thought it unwise to antagonize them. In fact, Somerset's identification with the so-called commonwealth men led to his downfall. Cecil fell with him and followed him to the Tower. Like Somerset he was released after a brief imprisonment, though the power of the crown passed to the duke of Northumberland. When Somerset conspired to recover his old position Cecil declined to follow him and came to terms with Northumberland, who appointed him principal secretary in Sept. 1550 and elevated him to a knighthood the following year.

Under Northumberland Cecil was a competent, hard-working public servant. He seems to have had little to do with the formulation of policy, either foreign or domestic. With Northumberland's religious policy Cecil was evidently not in sympathy. He befriended Cranmer against Northumberland's attacks, but was careful not to antagonize the virtual ruler of England. Moreover, although, with the rest of Edward's council, Cecil gave his reluctant approval to the change in succession contrived by Northumberland and, in fact, continued as principal secretary during the nine days' reign of Lady Jane Grey, he was opposed to the change and conspired actively with those who soon achieved Northumberland's downfall.

Cecil was therefore in a position to make a strong claim for indulgence when Mary came to the throne, and he was among the first to receive her pardon. There was some talk of his continuance in office, but it came to nothing. When, under Mary, England returned to the Roman Catholic communion, Cecil returned also. He was in fact one of those who went to the Low Countries to escort Cardinal Pole to England when he came to authenticate the return to Rome. English Protestants, particularly those in exile, regarded Cecil as a renegade. The opinion that he was active in support of them is ill founded, though he got in some trouble with the government by his defense in the house of commons of their property rights.

When Elizabeth succeeded Mary in 1558 she appointed Cecil her principal secretary. He had been in her service and in her pay as manager of her real estate (surveyor) since 1550. In 1561 she made him master of the court of wards, one of the most lucrative offices in the gift of the crown, upon the proceeds of which Cecil grew rich. For 14 years he remained her principal secretary, virtually the administrative head of her government. During that period he engineered the establishment of the Anglican Church and protected it from Catholic assaults on the right and Puritan assaults on the left. His personal sympathies inclined him toward the Puritans, but Elizabeth's rooted antipathy to them convinced him that their belligerent attitude toward the Establishment might well drive the queen back to the old church. He therefore did his best to curb their reforming zeal. But his chief fear was of the Catholics, who were numerically strong in England, particularly among the old nobility, and were constantly encouraged by both the Spanish and French crowns. Their menace was accentuated by the fact that the heiress presumptive to the English throne was the young and charming Catholic queen of Scots, Mary Stuart. For that reason Cecil did his best to persuade Elizabeth to marry and perpetuate the Tudor line. He supported in turn an Austrian and a French match, but he was resolutely opposed to her marriage to Robert Dudley, earl of Leicester, who was, and remained during the whole course of his life, her chief favourite. Indeed, Cecil's policy antagonized the favourite, the old nobility and the Roman Catholics. The outcome revealed itself in an attempt in 1568 to drive him from office, and in 1569 to destroy the English Protestant government by an uprising in the north. Both efforts failed.

Meanwhile Cecil had been instrumental in weakening the position of Mary Stuart in Scotland by building up the strength of the Scottish Protestant party. Mary herself facilitated his efforts by her ill-advised marriages, first to Lord Darnley and afterward to the earl of Bothwell. The outcome was that she was forced to flee from Scotland into England in 1568, where for the residue of her life she remained a prisoner and the focal point of Catholic disaffection.

In foreign affairs during Cecil's term of service as secretary he leaned on the whole to Spain rather than France, his Spanish proclivities being accentuated by the fact that Spain held the Low Countries, which were England's principal foreign market. But here religious considerations intervened, and the active part which the Spanish ambassador played in stimulating Roman Catholic revolt led Cecil in the other direction. In the so-called Ridolfi plot of 1571—to which the captive Scottish queen, the old English nobility led by the duke of Norfolk, and the Spanish ambassador were all parties—Cecil unraveled the designs of conspirators, brought Norfolk to the block and secured the expulsion of the Spanish ambassador and the more rigorous confinement of Mary Stuart. After this his position was secure. In 1571 Elizabeth raised him to the peerage as Baron Burghley and in the following year appointed him lord treasurer.

He was relieved of the day-by-day burden of administration, but he remained until the end of his life Elizabeth's chief counselor. Together they formed one of the most remarkable partnerships in English history, in which his wide knowledge and worldly wisdom tempered her feminine impulses, and her versatility forced him to cast off the shackles of precedent. But she was always the mistress and he always the loyal servant. What they both wanted was a strong and secure England; all other considerations, religious as well as secular, were subordinated to that end.

Throughout his life as Lord Burghley, the same major problems confronted him as had confronted him during the first critical decade of Elizabeth's reign. On the religious issue Burghley remained in the *via media*. The papal excommunication of Elizabeth in 1570 and the Jesuit missionary efforts in the 1570s and '80s increased or seemed to increase the menace from the Catholics. Burghley continued to oppose them and the captive Mary Stuart to whom they looked for relief. Probably he was the one who took the last decisive step which led to her death at the block. His one considerable contribution to controversial literature was his *Execution of Justice in England*, in which he vindicated the increasing severity of the government toward the Catholics on the grounds not of their faith but of their treasonable purposes.

The Puritans steadily increased in numbers and in influence They virtually controlled the house of commons and developed considerable strength in the privy council. Indeed, the privy council after 1573 was split between a moderate group led by Burghley and a Puritan group led by Sir Francis Walsingham and Leicester. The Puritan faction regarded the religious issue as the dominant one in determining Elizabeth's policy toward Scotland, Spain and France. They wished Elizabeth to set herself at the head of a Protestant league and to give active support to the Dutch rebels against Spain in the Low Countries, to militant enterprise against Spain in the new world and to Huguenot rebels in France Burghley and his royal mistress would have preferred to build fires in their neighbours' houses by measures short of war. It wa a war party against a peace party. In 1585 the war party won the day, and from that time on until the end of Elizabeth's reign, England was at war. By a strange perversity of fate, since Leiceste died in 1588 and Walsingham in 1590, Burghley himself, during the last eight years of his life, when he was past 70, had to conduct that war. He died in London on Aug. 4, 1598.

Burghley led an exemplary private life. He was a good husband a careful father and a considerate master. By his second wife h had three children who survived infancy, a son Robert and two daughters, Ann and Elizabeth. Robert succeeded him as principal adviser to the aging queen; Ann and Elizabeth both married wel though Ann's marriage to Edward de Vere, 17th earl of Oxford, was an unhappy one.

In matters economic, Burghley was an orthodox mercantilist. He was a good scholar in the classical tradition and he loved the company of scholars. He showed little or no interest in the development of English literature and had a Puritan distaste of the drama. He was a great builder. His house at Theobalds was one of the show places of England. It is gone. Gone also is his London house in Covent garden. The one monument to his building which remains is Burghley house at Stamford Baron, still occupied by the descendants of his first-born son. Theobalds was inherited by his son Robert, who later exchanged it for the royal palace of Hatfield. There Robert built, adjacent to the old palace, the present Hatfield house, still occupied by his descendants.

Bibliography.—Conyers Read, *Mr. Secretary Cecil and Queen Elizabeth* (1955), *Lord Burghley and Queen Elizabeth* (1960); J. E. Neale, *Elizabeth I and Her Parliaments 1559–1581* (1953), *Elizabeth I and Her Parliaments 1584–1601* (1957); J. Hurstfield, *The Queen's Wards* (1958). (C. Rd.)

BURGKMAIR, HANS (1473–*c.* 1531), German painter and wood engraver whose works are among the earliest in German art to show influences of the Italian Renaissance, was born at Augsburg. He studied under his father, Thoman Burgkmair, and under Martin Schongauer, and was a member of the painters' guild in Strasbourg in 1490 and in Augsburg in 1498. About 700 woodcuts have been ascribed to him, most of them distinguished by that spirit and freedom which were admired in the works of Albrecht Dürer. His principal work is the series of 135 prints representing the triumphs of the emperor Maximilian I. His works include some of the first chiaroscuro woodcuts. In his *Turnierbuch* of 52 illustrations he had the assistance of his son Hans Burgkmair (*c.* 1500–59). Burgkmair was also an excellent painter in fresco, specimens of which are in the galleries of Munich and Vienna.

BURGLARY, at common law, is the offense of breaking and entering the dwelling house of another in the nighttime with intent to commit a felony. The term "dwelling house" has been defined to include other buildings located within the curtilage or common enclosure. Breaking consists not only in the breaking of some external portion of the building but also in the opening of a closed door or window. Any entry, however slight, is sufficient, including thrusting the hand or even an instrument into the building. Only an intent to commit a felony, not its actual consummation, is required.

Most Anglo-American jurisdictions have expanded the scope of burglary by statute. The nighttime requirement has often been abolished. Structures in addition to the dwelling house and those within the curtilage are usually given the protection of these statutes. A few states in the U.S. have wholly eliminated the breaking requirement and have substituted the element of trespassory entry. Many jurisdictions, following the English common law, have created the distinct offense of housebreaking, consisting of some, but not all, of the elements of burglary. Thus in England housebreaking is defined to include all the elements of burglary except the nighttime requirement. Precedents drawn from the common law of burglary, however, are commonly applied in the interpretation of these statutes. Possession of burglary tools with intent to commit burglary is a common statutory offense.

See also Criminal Law: *Crimes Against Property*. (F. A. A.)

BURGLARY INSURANCE: *see* Casualty Insurance.

BURGOS, the capital formerly of Old Castile, has been since 1833 capital of the Spanish province of Burgos. Pop. (1960) 82,177 (mun.). Burgos occupies a strategic site about 800 m. (2,625 ft.) above sea level, commanding both the natural route from the Ebro to the plateau of Old Castile by the Pancorbo defile, now followed by the main road and railway from France, and also the road from Pamplona, formerly part of the Pilgrims' Way leading to Santiago, which runs closer to the foothills of the Sierra de la Demanda (40 km., or 25 mi. E.). The town stands on the lower slopes of a castle-crowned hill, overlooking narrows of the Arlanzón river, 241 km. (150 mi.) N. of Madrid by road.

The oldest quarter of the town stands on the eastern slope of the Castle hill, the great mass of the cathedral dominating the entire town. The rest of the old town lies southward, its life centred in the arcaded Plaza Mayor, the Plaza de Santo Domingo de Guzmán, a busy market place, and the Plaza de Calvo Sotelo, with the late 15th-century Casa del Cordón. Beyond these, along the road to France, and on the eastern outskirts, are the military headquarters and barracks. The Casa de Miranda, a building representative of the best domestic architecture of 16th-century Spain, and now a museum with archaeological exhibits, carvings and paintings, lies across the river. The most important of the six bridges, the Puente de Santa María, leads to the Arco de Santa María, the finest of the four surviving gates, with sculptures illustrating the history of Burgos.

Burgos is the see of an archbishop, whose province comprises the dioceses of León, Santo Domingo and Santander. The cathedral, founded in 1221 by Ferdinand III of Castile and the English bishop Maurice of Burgos, is a fine example of florid Gothic, built of white limestone, not completed until 1567. Its cruciform design is almost hidden by the 15 chapels added at all angles to the aisles and transepts, by the beautiful 14th-century cloister on the northwest and the archiepiscopal palace on the southwest. Over the three central doorways of the main or western façade rise two lofty and graceful towers. The bones of the 11th-century hero, the Cid (*q.v.*), have rested in the cathedral since 1919. The chapel of Corpus Christi contains the chest which the Cid is said to have filled with sand and subsequently pawned for a large sum to the credulous Jews of Burgos. The legend adds that he redeemed his pledge. In the cloister is a famous Gobelin tapestry. There are also the Cid's wedding contract, a polyglot Bible (Latin, Hebrew and Arabic), vestments worn by the archbishop at the Council of Trent and a collection of ivory, gold and silver objects. In the aisleless Gothic church of Santa Agueda, or Santa Gadea, tradition relates that the Cid compelled Alfonso VI of León, before his accession to the throne of Castile in 1072, to swear that he was innocent of the murder of Sancho, his brother and predecessor on the throne. The Gothic churches of San Esteban (1280–1350) and San Nicolás (1505) have fine sculptured doorways. The surviving convents lie chiefly outside the city. At the end of the Paseo de la Isla stands the nunnery of Santa María la Real de las Huelgas, originally a summer palace (*huelga,* "pleasure-ground") of the kings of Castile. In 1187 it was transformed into a Cistercian convent by Alfonso VIII, who invested the abbess with almost royal prerogatives. Alfonso and his wife Eleanor, daughter of Henry II of England, are buried there. The Cartuja de Miraflores, a Carthusian convent, founded by John II of Castile (1406–54), lies 3 km. (2 mi.) S.E. of Burgos. Its church contains a monument of exceptional beauty, carved by Gil de Siloë in the 15th century, for the tomb of John and his second wife, Isabella of Portugal. There are also fine carved stalls and the painting "La Asunción" by Jusepe de Ribera. The rosaries made by the monks from thousands of rose petals keep their perfume for years. The convent of San Pedro de Cardeña, 11 km. (7 mi.) S.E. of Burgos, was the original burial place of the Cid, in 1099, and of Jimena, in 1104. About 80 km. (50 mi.) from the city is the abbey of Silos, which appears to have been founded under the Visigothic kings as early as the 6th century. It was restored in 919 by Fernán González, and in the 11th century became celebrated throughout Europe, under the rule of St. Dominic. It was reoccupied in 1880 by French Benedictine monks.

Burgos is on the main railway line from France and Vitoria to Valladolid. It is an agricultural centre, and manufactures woolen and leather goods, chemical manures, chocolate and paper. It has a large tourist industry, one of the first camping grounds to have been established in Spain and an extensive sports centre.

After its foundation in 884 as an outpost in the east of the Asturian kingdom, Burgos became the capital of the countship and, later, of the kingdom of Castile, declared independent in 1035. As the recognized "head of Castile," Burgos enjoyed the prestige of a capital city until the reign of Philip II. Like its rivals it sank to political insignificance after 1560, when Madrid was declared the *única corte*. There remained to Burgos, however, the commercial supremacy in Castile which resulted from the powers with which its merchant guild was invested by the Catholic sovereigns in 1494. In that year all foreign trade of Castile, particularly that in fine wool, and the charge of ships sailing from ports of the north coast were put under the jurisdiction of the Burgos guild, whose shipping department became the model for the famous Casa de Contratación at Seville. With the decline of Castilian trade, Burgos languished until its revival in the 18th century under Charles III. In the Peninsular War the French in 1808 defeated the Spaniards at Burgos. The French in turn were unsuccessfully besieged in the city by General Wellington in 1812; it fell to the British in the following year.

In July 1936 conservative Burgos became the official seat of Gen. Francisco Franco's government and was a base for campaigns toward Madrid and the Basque states.

Burgos province includes the enclave of Treviño in the province of Álava. Pop. (1960) 380,791; area 5,509 sq.mi. The province extends from the main Cantabrian watershed, beyond the Ebro, in the north, to south of the Douro river. In the east it marches with Logroño and Soria in the heart of the Demanda and Urbión massifs which separate Old Castile from the middle Ebro. From these massifs it descends westward and southward to the wide stretches of flat ground occupying the centre of the northern part of the central plateau. The Pancorbo gorge, cut across the Montes Obarenes in the northeast, gives a line of communication between the basin of Miranda de Ebro and the rest of the province, and at the same time between Álava and Old Castile. The Ebro runs eastward through the northern half of the province, but is not navigable. The Douro, or Duero, crosses the southern half, running west-northwest; it also is unnavigable in its upper valley. The other important streams are the Pisuerga, flowing south toward Palencia and Valladolid, and the Arlanzón, which flows through Burgos for more than 120 km. (75 mi.).

Burgos is one of the great forest provinces of Spain, with more than 300,000 ac. of pine, oak, beech and other species under state management, while vast ranges of almost uninhabited upland serve as pasture for the flocks, which in most years exceed 1,000,000 head of sheep. Lambs are exported to Bilbao and Madrid. Goats, horned cattle, horses, mules and swine are numerous. Cereal cultivation—with wheat ordinarily occupying about two-fifths of the cultivated area—is the basis of the agriculture of this province, of which the centre and south form part of the best cereal zone of Spain. The Douro and Arlanza valleys produce good wine and are agriculturally important for their more equable climate, their good communications and their irrigation works, actual and projected. Soft coal (used for briquettes), mica, china-clay and salt are obtained in small quantities, and oil-bearing lands north of the capital have been under investigation. The industries of the province are on a small scale, the ancient woolen, linen and hemp manufactures surviving in small factories and as cottage industries. Hydroelectric power and light are available throughout the province. The northern railways from Madrid to the French frontier cross the province in the central districts: the Valladolid-Bilbao line in the north; and the Valladolid-Saragossa line in the south. The Burgos-Soria-Calatayud railway provides direct communication with the Mediterranean at Sagunto and Valencia. The only important town in the province is Burgos, but modern developments have expanded Miranda de Ebro and Aranda de Duero as overflow towns for Madrid. The country towns and villages are inhabited by a notably intelligent and independent peasantry—petty farmers, shepherds and foresters—whose physical type is northern rather than Mediterranean; and Burgos stands fourth or fifth in Spain in respect of elementary education, above the richer provinces of Biscay and Barcelona. (L. G. Mi.)

BURGOYNE, JOHN (1722–1792), English general and dramatist, is chiefly remembered for his controversial part in the American Revolution (*q.v.*). He bought his first commission in 1740 and made a runaway marriage in 1743 with a daughter of the 11th earl of Derby, whose protégé he subsequently became. During the Seven Years' War he took part in two raids on the French coast (1758 and 1759). He then raised a light cavalry regiment, in command of which he went to Portugal, distinguishing himself at the action of Villa Velha in 1762. After the war he was elected to parliament and became a leader of fashion in London; and in 1774 he wrote his first play, "The Maid of the Oaks."

On the outbreak of the American Revolution, Burgoyne was posted first to Boston (1775), and then to Canada (1776) as second-in-command to Lord Carleton, whose feeble attempts to invade the New England colonies he strongly criticized. He then drew up and secured the adoption of a plan for an offensive with 12,000 men by the Crown Point-Ticonderoga route to unite with a force under Gen. William Howe sent northward from New York, and another under Col. Barry St. Leger from the west to cut off the New England colonies from the middle and southern colonies. But he was given less than 8,000 men for the expedition and though it secured Crown Point and Ticonderoga (1777) after a slow and toilsome march, much harassed by hostile irregulars and Indians, it was brought to a halt by 16,000 troops in position. There was no news of the co-operating forces from the south and west, and after exhausting his stocks of food and ammunition, Burgoyne was compelled to capitulate at Saratoga, in Oct. 1777. His conduct of the campaign was much criticized, but the main causes of its failure were the insufficiency of his means and the lack of co-ordination of the concentric offensive, of which his force formed only one part. (*See* also SARATOGA, BATTLES OF.)

Burgoyne was for a short time (1782–83) commander in chief in Ireland, but he thereafter retired increasingly to private life. His wife had died in 1776 and between 1782 and 1788 he had four children (of whom the eldest became Field Marshal Sir John Fox Burgoyne; *q.v.*) by his mistress, the singer Susan Caulfield. He wrote a series of plays, culminating in *The Heiress,* the most successful of them, which appeared in 1786. Burgoyne died in London on Aug. 4, 1792.

See E. B. Fonblanque, *Political and Military Episodes . . . from the Life and Correspondence of Right. Hon. J. Burgoyne* (1876); F. J. Hudleston, *Gentleman Johnny Burgoyne* (1927). (E. W. Sh.)

BURGOYNE, SIR JOHN FOX, Bart. (1782–1871), English field marshal, best remembered for the part he played in the Crimean War, was born on July 24, 1782, an illegitimate son of Gen. John Burgoyne. Educated at Eton college and the Royal Military academy, Woolwich, he was commissioned in the royal engineers in 1798 and saw service in the Mediterranean until 1807. Subsequently he went to Sweden and Portugal on the staff of Sir John Moore. He served in all the campaigns of the Peninsular War from Corunna to Toulouse, playing a prominent part in the sieges of Ciudad Rodrigo, Badajoz, San Sebastian and Bayonne. In 1814 he was commanding engineer to Maj. Gen. Sir Edward Pakenham's disastrous expedition to New Orleans, but was not present at Waterloo. In the years of peace after 1815, Burgoyne held various military and civil appointments, serving as chairman of the board of public works, chief famine commissioner in Ireland and inspector general of fortifications in the United Kingdom. He was promoted lieutenant general in 1851. During the Crimean War he was chief engineer on Lord Raglan's staff, and it was on his advice that the allies, instead of advancing directly on Sebastopol after their victory at the Alma, marched round to invest the fortress from the south—a strategy much criticized at the time and since. He was recalled in Feb. 1855, but was made a baronet in 1856. After the war he became constable of the Tower of London and was made field marshal in 1868. The last year of his life was saddened by the death of his only son, Capt. Hugh Burgoyne, V.C., who was in command of the experimental H.M.S. "Captain," sunk in 1870 in the Bay of Biscay. Sir John Burgoyne died in London on Oct. 7, 1871.

See Lt. Col. Hon. G. Wrottesley, *Life and Correspondence of F.M. Sir John Burgoyne* (1873). (E. W. Sh.)

BURGUNDY (Fr. Bourgogne), a name limited in modern times to the region of France lying between the Saône, the Loire and the upper Seine, that is, to the former duchy of Burgundy (*see* below), but applied also in the middle ages to the last Burgundian kingdom, later called the kingdom of Arles, and to the countship of Burgundy, later known as the Franche-Comté.

First Burgundian Kingdoms.—The original Burgundians were a Scandinavian people who established themselves first on the southern shores of the Baltic (the island of Bornholm was called Burgundarholm), then in the valley of the Vistula. Unable to defend themselves there against the Gepidae, they migrated westward to the valley of the Main. There they founded a powerful kingdom, which by A.D. 406 extended to the Rhine. Their king Gundahar (Gundicar or Gunther), however, who seems to have had his capital at Worms, became involved in hostilities with the Romans and with the Huns, who together destroyed the kingdom (435–437). The massacre of the Burgundian royal family by the Huns is reflected in the story of the *Nibelungenlied* (*q.v.*). The Romans transferred the surviving Burgundians to Savoy in 443.

As the influence of the Romans declined in the second half of the 5th century, the Burgundians gradually began to assume control over areas north and west of Savoy, occupying not only Besançon and then, west of the Saône, Langres, Dijon and Autun, but also the lower Saône valley, Lyons and the valley of the Rhône down to Vienne and the Viennois. They also tried to expand southward into Provence. Their king Gundobad (d. 516) promulgated their first code of laws, later known as the *loi Gombette*. Gundobad's son Sigismund was converted from Arianism to Roman Catholicism and founded the monastery of Saint Maurice d'Agaune (in the Valais). Attacked by the Franks, Sigismund was killed by Clodomir, son of Clovis, in 524, but Burgundy remained independent under his brother Gundomar till 534, when the Franks annexed it.

After the death of Clotaire I in 561, however, when the Merovingian kingdom was partitioned, one of his sons, Guntram, secured the *regnum Burgundiae* or kingdom of Burgundy. This *regnum* eventually included not only the former Burgundian lands but also the diocese of Arles in Provence, the Val d'Aosta east of the Alps and even the country of Orléans, Chartres and Sens in north central France. It remained a separate Merovingian kingdom until Charles Martel subjugated it to Austrasia in the second decade of the 8th century.

Kingdom of Burgundy, or Provence.—The Carolingians made several partitions of Burgundy before Boso, ruler of the Viennois, had himself proclaimed king of all Burgundy from Autun to the Mediterranean in 879. Though the French Carolingians recovered the country west of the Saône and north of Lyons (Autun, Chalon and Mâcon) from him and the German Carolingians reclaimed Jurane Burgundy (*i.e.*, Transjurane Burgundy, or the country between the Jura and the Alps, together with Cisjurane Burgundy properly so called, namely the Franche-Comté), Boso and his successors were able to maintain themselves in the kingdom of Provence (*q.v.*) or Lower Burgundy—sometimes also, rather misleadingly, called Cisjurane Burgundy—till about 933.

Last Kingdom of Burgundy.—In 888 Rudolf I (d. 911 or 912), son of Conrad count of Auxerre, of the family of Welf, was ecognized as king of Jurane Burgundy, his territory comprising he Transjurane dioceses of Lausanne, Geneva and Sion and the diocese of Besançon, to which Basel was subsequently added. His son and successor Rudolf II (d. 937) was able to conclude a treaty in 934 with Hugh of Arles, king of Italy and master of Provence since the death of Boso's son Louis the Blind (the emperor Louis III), whereby Hugh ceded Provence to Rudolf in return for Rudolf's renunciation of his claims to the kingdom of Italy.

Rudolf II thus came to rule over the whole *regnum Burgundiae* xcept the areas west of the Saône, but his successors Conrad the Peaceful (937–993) and Rudolf III (993–1032) were unable to xercise their authority over their vassal lords—especially the ounts of Burgundy (*see* Franche-Comté) and of Savoy—or over he bishops and had to rely on the protection of the German kings. When Rudolf III died without legitimate heirs in 1032, he left his kingdom to the emperor Conrad II. For its later history *see* Arles, Kingdom of.

THE DUCHY OF BURGUNDY

The duchy of Burgundy was that part of the *regnum Burgundiae* west of the Saône which was recovered from Boso by the French Carolingians and remained a part of the kingdom of France. In re-Roman times this territory had been occupied by Gallic tribes, the Aedui, the Senones and the Lingones. Under the Romans it was divided between the *civitates* of Autun, Auxerre, Nevers, Sens, Troyes, Langres (which included Dijon), Chalon and Mâcon. When Norman invaders were devastating Burgundy (888–898), Boso's brother Richard, called le Justicier, count of Autun since 880, was invested with a great command against them. Having driven them out, he then subjected the greater part of the territory to his own authority. His son Rudolph (Raoul), who succeeded him in 921, was elected king of France in 923.

First Capetian Dukes.—On Rudolph's death in 936 the Carolingian Louis IV d'Outremer and Hugh the Great, duke of the Franks, detached Sens, Troyes and Langres from Burgundy, and Hugh secured the succession to the duchy for his two sons. The younger of these, Henry I (Eudes-Henry), who died without children in 1002, had adopted his stepson Otto William, but the king of France, Robert II, who was Henry's nephew, refused to acknowledge Otto William as heir to Burgundy and conquered the duchy (1003–06). Robert made his son Henry duke of Burgundy, to which Dijon (separated from the duchy with Langres) was restored in 1016, though the countships of Nevers and Auxerre were detached from it. In 1032, after Henry's accession to the crown of France, his brother became duke as Robert I (d. 1075).

The duchy constituted in 1016, although smaller than its 10th-century predecessor, was stronger. It remained in the Capetian family until 1361. In their foreign policy the Capetian dukes adhered loyally to their cousins the kings of France. They took part in the crusades and in expeditions against the Muslims in Spain, and a grandson of Duke Robert I became count of Portugal and the ancestor of its first royal house. In internal affairs the dukes built up a considerable domain and enforced obedience from their vassals. They also annexed Chalon (where the counts had been making themselves independent of the duchy) and Auxois. Burgundy thus came to be recognized as the premier peerage of the French kingdom. Hugh III (d. 1192) commanded the French forces in the Holy Land after the return of King Philip II Augustus to France during the third crusade and became involved in disputes with Richard I of England. Eudes III (duke from 1192 to 1218) took part in the Albigensian wars and supported Philip Augustus against John of England. Hugh IV (duke from 1218 to 1272) was prominent in the reign of Saint Louis. Robert II (duke from 1272 to 1306) and Eudes IV (duke from 1315 to 1349) were the most powerful barons of their time in France, being allied by marriage with the royal house and often directing royal policy. (In an attempt to secure for himself his wife's inheritance, which comprised both Artois and the Franche-Comté, Eudes IV compelled Philip VI of France to break with Robert of Artois, who was thus driven to ally himself with England.) Philip of Rouvre, Eudes IV's grandson, was also heir to the Boulonnais and Auvergne through his mother, but on his death in 1361 the inheritance was divided. Charles II of Navarre claimed Burgundy, but the French king, John II, took it for himself.

Although in the last decades of the dynasty the country had been devastated by the plague of 1348 and by mercenary armies in the Hundred Years' War, Burgundy had on the whole prospered under the dukes of the first Capetian line. The nobles were subjected to the jurisdiction of *grands jours* (ducal assizes), held at Beaune. The towns grew: Dijon, around which a wall was built in 1137, became an important market; a fair was held at Chalon-sur-Saône, where merchants from the south of France met northern traders; and Italian merchants came to Burgundy to buy its wool, which rivaled that of England. Pilgrims flocked to Vézelay and Autun (where in 1146 a magnificent church was built round the tomb of St. Lazare). Finally the Burgundian monasteries were famous: Cluny (founded 910) became the centre of an order extending from England to Spain; Guillaume, abbot of Saint Bénigne de Dijon, reformed many houses in Burgundy and Normandy (*c.* 1000); and in 1098 the monastery of Cîteaux was founded and with it a new religious order, the Cistercian.

Valois Dukes.—A new period in Burgundian history opens under King John II, who in 1363 decided to grant the duchy to his fourth son, Philip (*q.v.*) the Bold. Philip had to struggle against the mercenary companies, but in 1369 Charles V of France arranged his marriage to Margaret of Flanders, who brought with her the inheritance of Nevers, Franche-Comté (the ancient countship of Burgundy), Rethel, Artois and Flanders. In 1384, the duke of Burgundy inherited all these territories. Thus the duchy was reunited to Franche-Comté, and the two Burgundies formed the southern part of a state the northern possessions of which extended over the Netherlands, the valley of the Meuse and the Ardennes. In the north expansion was to continue (Hainaut, 1428; Brabant, 1430; Luxembourg, 1443), but the south, from which Nevers was again detached in 1404 (for the benefit of junior branches of the house), became less and less important. Brussels instead of Dijon was eventually made the duke's usual residence. Philip the Bold, however, who lived in Burgundy when he was not in Paris, built the Chartreuse de Champmol at Dijon to house the family vault. It was he also who bought the Charolais (*q.v.*) in 1390.

John (*q.v.*) the Fearless, who succeeded Philip in 1404, devoted all his energies to his struggle with Louis, duc d'Orléans and with the Armagnac faction which took up the policy of Louis and devastated the border territories of Burgundy to the south and west between 1412 and 1435. After John had been assassinated (1419), his son Philip (*q.v.*) the Good recognized Henry VI of England as his suzerain and continued the struggle against the Armagnacs. The treaty of Arras (1435), which established peace between Burgundy and Charles VII of France, conceded to Philip the countships of Auxerre and of Mâcon, the *châtellenie* of Bar-sur-Seine and the *élections* which reunited the enclaves of royal domain within the frontiers of the duchy. Even so, the mercenary Écorcheurs continued their depredations in Burgundy till 1445. Thereafter Burgundy enjoyed peace till Philip's death (1467).

The next duke, Charles (*q.v.*) the Bold, was constantly in conflict with Louis XI of France. His aim was to acquire those territories which divided his southern from his northern possessions, most particularly Lorraine. In this he was unsuccessful. Louis XI moreover persistently opposed him, conducting several campaigns against him and subjecting Burgundy to economic blockade.

On the death of Charles (1477), Louis XI invaded the duchy under the pretext of defending the rights of the heiress, Mary (*q.v.*), but Mary married, not the dauphin Charles, but the archduke Maximilian of Austria. Louis then attempted to annex the two Burgundies as royal domain lands granted in appanage and not able to pass to a woman. The Burgundians revolted but were defeated. By the treaty of Arras (1482) the duchy and the Franche-Comté were confirmed to the French king as the dowry of Mary's daughter, Margaret of Austria, who was to marry the dauphin Charles. When Charles instead married Anne of Brittany, the Franche-Comté and the Charolais were restored to the Habsburg heirs of the house of Burgundy. The duchy, however, was retained by France.

The Valois dukes (1363–1477) had brought new institutions to the duchy. The *chambre des comptes* of Dijon was organized in 1386, a ducal council functioned at Dijon, and the *grands jours* were transformed by Charles the Bold into a parlement which met alternately at Beaune and at Dole. Flemish artists and the Dutch sculptor Claus Sluter were brought to Dijon to decorate the Chartreuse de Champmol and to carve the tomb of the dukes. The splendours of the Burgundian court were admired throughout Europe, and in 1432 Philip the Good made the Sainte-Chapelle at Dijon the seat of the Order of the Golden Fleece. The Burgundian towns found a new prosperity, and Burgundians made brilliant careers in the service of their dukes.

Later History.—The "reunion" of 1477 brought back insecurity. While the duchy was annexed to the French crown, the Franche-Comté and the northern possessions of the former dukes were organized by the Habsburgs as the Circle of Burgundy (Kreis Burgund). Moreover the Habsburg princes maintained their pretensions to the duchy. The emperor Charles V, when Francis I of France was his prisoner, in fact compelled him to renounce Burgundy to Austria (treaty of Madrid, 1526), but Francis eluded the obligation. The hostility between France and the Habsburgs compromised the close relations that had been developed between the two Burgundies under the Valois dukes, though a treaty of neutrality signed in 1522 achieved a precarious peace along the Saône as frontier. The French wars of religion devastated the duchy. The towns had to be fortified, and mercenaries roamed over the country. As Catholic supporters of the Holy League, the towns did not recognize Henry IV as king until 1595. Then the duchy was again ravaged in the Franco-Spanish wars from 1636 onward (and also during the Fronde, when the great Condé, as governor, drew Burgundy into his faction). Not until the French conquest of the Franche-Comté in 1678 were peace and security restored.

During the 16th, 17th and 18th centuries Burgundy constituted a military *gouvernement* (to which Bresse was attached in 1601). From 1631 to 1789 the princes de Condé were governors. The parlement, whose seat had been fixed by Louis XI at Dijon, assumed the functions of the ducal council and had jurisdiction over the duchy and over Bresse and its dependencies (Bugey, Valromey and the Pays de Gex); but Mâcon, Auxerre and Bar-sur-Seine continued to depend on the parlement of Paris. In the 17th century an intendant was appointed at Dijon, but Bresse and its dependencies were the only parts of the généralité of Dijon in which he had full authority. The rest of Burgundy was administered by the estates of Burgundy, whose privileges dated from the 14th century. The estates, under the presidency of the bishop of Autun, met every three years, voted taxes and decided how revenue should be employed in provincial administration. They also defended the privileges of the province, which was less heavily taxed than any other in France. The classes to benefit most from such tax reliefs were the members of the parlement, of the *chambre des comptes* and of the judiciary, who transformed the towns with new building and bought up the lands of the often bankrupt nobility. But the estates also strove to provide the province with a good communications system and began the network of canals which now links the Loire, the Seine and the Saône. These improvements encouraged the development of the wine trade (Beaune wines had been famous throughout medieval Europe, and Paris also bought much wine from Auxerre), which in the 18th century was expanded to become one of the principal assets of the province (*see* further WINE). In the 18th century also literature and science were pursued as well as commerce, intellectual life being particularly vigorous in Dijon.

The province of Burgundy disappeared with the Revolution when it was divided into the *départements* of Côte-d'Or, Saône-et-Loire and Yonne.

See also references under "Burgundy" in the Index volume.

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BURGUNDY CANAL (CANAL DE BOURGOGNE), a canal in France connecting the Seine and Saône waterways across the watershed in the Langres plateau. From St. Jean-de-Losne on the Saône river it passes by Dijon along the valley of the Ouche to negotiate the crossing into the Armançon basin by a tunnel two miles long. By the Armançon it connects with the Yonne at Laroche and so with the Seine at Montereau. The canal, built in 1832, was important for a short period for supplying Paris with timber, building stone and wine from the south, but declined once railway connections were provided. It is difficult to navigate because of its numerous locks and tunnel, the frequent shortage of water at the summit and the capricious regime of the Yonne. Building materials now constitute the main traffic and the only considerable port along the canal is Dijon. (AR. E. S.)

BURHANPUR, a town in the East Nimar district, Madhya Pradesh, India, is on the Central railway and the north bank of the Tapti river, 275 mi. N.E. of Bombay. It was founded in A.D. 1400 by a Muslim prince of the Farukhi dynasty of Khandesh. His successors held it for 200 years, until it was annexed by the Mogul emperor Akbar in 1599. It formed the chief seat of the government of the Deccan provinces of the Mogul empire till Shah Jahan moved the capital to Aurangabad in 1636. Burhanpur became for 100 years the centre of many conflicts between th Marathas and Moguls. In 1803 it was captured by Maj. Gen. Arthur Wellesley, afterward duke of Wellington, but it was restored by treaty to the Maratha successor-state of Sindhia in 1805. It was finally ceded to the British in 1861.

In its old buildings and tombs, Burhanpur resembles the Mogul capitals of the north. The ruined citadel and palace (*c.* 1400), the Mosque of the Lady (*c.* 1585) and the Jamma Masjid or Great mosque (1588) are of the Farukhi period. Like all Mogul cities, it was famous for luxury articles; *i.e.*, brocades, flowered silks and gold and silver embroideries. It is now an ancient walled city which, after many years of decay from its old-time status and the decline almost to the vanishing point of the old industries, has shown an upward tendency under more modern conditions. There are a few families who traditionally produce gold and silver thread and brocades, and there is a large group of weavers of silk bordered cloths. The establishment of a cotton mill, ginning factories and presses has restored some of its lost prosperity. A Mogul water supply, which has been modernized, still functions.

Burhanpur's population, after many fluctuations, rose to 82,090 at the 1961 census.

BURIAL, the depositing of human remains in a grave, crypt, tomb or other similar shelter. *See* CEMETERY; DEATH (LEGAL ASPECTS); FUNERARY RITES AND CUSTOMS.

BURIDAN, JEAN (JOANNES BURIDANUS) (*c.* 1295–? after 1366), French philosopher, born probably at Béthune, was rector of the University of Paris in 1328 and in 1340. A moderate nominalist, he contributed to the condemnation of extreme Occamism in 1340; his own works were prohibited from 1474 to 1481. He opposed Nicolas of Autrecourt's atomism and defended the principle of causality.

His moral determinism—men must will what presents itself as the greater good—is qualified by the doctrine that the will is free to delay the reason's judgment by suggesting a more thorough inquiry into the value of motives. Buridan treated economic values as subjective values and allowed no place for a supreme political ruler, or *praesidens* among rulers, of mankind. He paved the way to modern cinematics by developing suggestions found in Philoponus', Olivi's and Francis of Marchia's works: Aristotle's doctrine that a thing is kept moving by the surrounding air is replaced by the theory of impetus; the mover imparts to the moved a power, proportional to the speed and mass, which keeps the thing going; resistance of the air progressively reduces the impetus; weight adds to or reduces the speed. In logic Buridan expounds and comments upon doctrines handed down in Aristotle's, Peter of Spain's and Occam's works and supplements them with the more modern chapters (*Obligationes*, etc.).

The phrase *pons asinorum* (rules for the discovery of syllogistic middle terms) has not been found in his works. The example of a dog, not an ass, dying of hunger between two equal amounts of food occurs in his commentary on Aristotle's *De caelo*. Exploded legends made him the founder of the Vienna university and the lover of a queen of France (perhaps Joan of Navarre or Margaret of Burgundy).

Most of Buridan's commentaries on Aristotle's *Organon*, *Physics*, *De Anima*, *Metaphysics*, *Economics*, etc. are still unpublished. His published works include: *Summulae de dialectica* (1487 *et eq.*); *Consequentiae* (1493 *et seq.*); *Quaestiones* on Aristotle's *Physics* (1500 *et seq.*), *De anima* and *Parva naturalia* (1516 *et eq.*), *Metaphysics* (1480 *et seq.*), *Ethics* and *Politics* (1489 *et eq.*), and *De caelo* (1942).

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(L. M.-Po.)

BURIRAM, a province of northeast Thailand, area 4,159 sq.mi., which extends from the Mun river in the north to the mountains on the Cambodian border. The population, including many of Cambodian stock, was 570,228 (1960). Natural vegetation is predominantly savanna and dry monsoon forest. Cattle and timber are important products. Irregular rainfall causes violent fluctuation in the yield of rice, the major crop. The province has a number of rice mills and sawmills.

Major towns are Buriram (pop. [1957 est.] 11,629), the capital, and Lamplaimat, a commercial centre 50 mi. E. of Khorat. Both are on the Khorat-Ubon railroad, the chief communication link with the rest of Thailand. (G. W. SK.)

BURKE, EDMUND (1729–1797), British statesman, parliamentary orator and political thinker, played a prominent part in all major political issues for about 30 years after 1765, and remains an important figure in the history of political theory.

Burke was Irish, born in Dublin probably on Jan. 12, 1729 (new style; Jan. 1, old style). His father, a solicitor, was Protestant, his mother Roman Catholic. He encountered a third religious tradition at his boarding school, run by a Yorkshire Quaker. He entered Trinity college, Dublin, in 1744, and came to London in 1750 to begin keeping terms at the Middle Temple. There follows an obscure period in which Burke lost interest in his legal studies, was alienated from his father and spent some time wandering about England and France. In 1756, however, he published anonymously and in the style of Viscount Bolingbroke *A Vindication of Natural Society . . . in a Letter to Lord * * *, by a Late Noble Writer*, a satire aimed at both the destructive criticism of revealed religion and the contemporary vogue of "return to Nature." A contribution to new trends in aesthetic theory, *A Philosophical Enquiry Into the Origin of Our Ideas of the Sublime and Beautiful*, which appeared in 1757, gave him some reputation in England and was noticed abroad by Diderot, Kant and G. E. Lessing, among others. In agreement with the publisher Robert Dodsley, he initiated *The Annual Register* as a yearly survey of world affairs; the first volume appeared in 1759 under Burke's (unacknowledged) editorship, and he retained his connection with it for about 30 years.

In 1757 Burke married Jane Nugent, the daughter of an Irish Catholic doctor. From this period also date his numerous literary and artistic friendships, including those with Dr. Johnson, Oliver Goldsmith, Sir Joshua Reynolds and David Garrick.

POLITICAL CAREER

After a first unsuccessful venture into politics, Burke was appointed secretary, in 1765, to the marquess of Rockingham, leader of one of the Whig groups in parliament, and entered the house of commons. Burke remained Rockingham's secretary until the latter's death in 1782, exercising great influence on his upright and disinterested, if not very forceful, patron. He worked with some success to inspire with a sense of unity and common principle the group that cohered round Rockingham. Mostly in opposition, it was the vehicle of Burke's parliamentary career.

Attack on the Influence of The Crown.—Burke soon took an active part in the domestic constitutional controversy of George III's reign. The revolution settlement after 1688, while placing specific limitations on the royal prerogative, left many aspects of constitutional practice undefined. The main problem during the 18th century was the respective control of king and parliament over the executive. George III was seeking to reassert a more active role for the crown, which had lost some influence in the reigns of the first two Georges, without infringing the revolution settlement. Burke's chief comment on this issue is his pamphlet *Thoughts on the Cause of the Present Discontents* (1770). He argued that George's actions were against not the letter but the spirit of the constitution. Choice of ministers purely on personal grounds was favouritism; they should be chosen on a public ground—the approbation of parliament and people. The community and its accredited representatives must be presumed capable of rational choice, provided that the independence of the house of commons was maintained. But changed circumstances of government meant that a restoration of the past, such as a return to triennial parliaments, was no remedy; what was needed was a more active intervention of the electorate in defense of its powers. The pamphlet includes Burke's famous, and new, justification of party, defined as a body of men united on public principle, which could act as a constitutional link between king and parliament, providing consistency and strength in administration, or principled criticism in opposition.

In 1774 Burke was elected a member of parliament for Bristol, then the second city of the kingdom and an open constituency. He held this seat for six years but failed to retain the confidence of his constituents. For the rest of his parliamentary career he was member for Malton, a pocket borough of Lord Rockingham's. It was at Bristol that he made the well-known statement on the role of the member of parliament. He should be representative, not delegate. The electors are capable of judging his integrity, and he should attend to their interest; but he must address himself to the general good of the whole community, acting according to his own judgment and conscience, unfettered by mandates or prior instructions from those he represents. Burke had only qualified support for the movements for parliamentary reform, his main concern was curtailment of the crown's powers. However, he accepted the possibility of widening political participation, provided that there was evidence of rationality, restraint of aggressive partiality and dedication to the common good; he rejected any doctrine of mere rule of numbers. Apart from general principles, Burke made a practical attempt to reduce the influence of the crown as one of the leaders of the movement for economical reform, which pressed for parliamentary control of royal patronage and expenditure. When the Rockinghams took office in 1782 bills were passed reducing pensions and emoluments of offices, including his own. Burke was specifically connected with an act regulating the civil list.

Colonial Policy.—*America.*—A second great issue which confronted Burke in 1765 was the quarrel with the American colonies. Their prodigious development in the 18th century had produced strains in the system of imperial political and economic regulation which came to a head after the Seven Years' War. The imposition of a stamp duty by George Grenville in 1765, and other measures, provoked unrest and opposition, which soon swelled into disobedience, conflict and secession. English policy was vacillating; determination to maintain imperial control ended in coercion, repression and unsuccessful war. The Rockingham group opposed coercion, basing their American policy on their actions in their short administration of 1765 when they repealed the Stamp act, while asserting the imperial right to impose taxation by the Declaratory act.

Burke's best-known statements on this issue are the two parliamentary speeches, *On American Taxation* (1774) and *On Moving His Resolutions for Conciliation With America* (1775), and *A Letter . . . to the Sheriffs of Bristol* (1777). British policy, he argued, had been both imprudent and inconsistent, but above all legalist and intransigent in the assertion of imperial rights. Authority must be exercised with respect for the temper of those subject to it, if there was not to be a collision of power and opinion. This truth was being ignored in the imperial quarrel; it was absurd to treat universal disobedience as criminal: the revolt of a whole people argued serious misgovernment. Burke made a wide historical survey of the growth of the colonies, the special traditions and circumstances which had formed their character, the revolutionary changes in the recent past, their economic problems. In place of narrow legalism he called for "legislative reason," an imaginative reinterpretation of the values enshrined in the imperial relation in the light of these new factors. The claims of circumstance, utility and moral principle should be considered, as well as precedent. And as a prerequisite of reconciliation, a conciliatory temper must be shown by the imperial parliament with readiness to meet American complaints and measures to restore colonial confidence. His proposal was an extension of the forms of the British constitution to the imperial relation, so far as circumstances allowed it.

In view of the magnitude of the problem the adequacy of Burke's specific remedies is questionable, but the principles on which he was basing his argument were the same as those underlying the *Present Discontents:* government should ideally be a co-operative, mutually restraining relation of rulers and subjects; there must be attachment to tradition and the ways of the past, wherever possible, as familiar and tested, but equally, recognition of the fact of change and the need for a comprehensive and discriminatin response to it, reaffirming the values embodied in tradition in ne circumstances.

Ireland.—Ireland was a special problem in imperial relation It was in strict political dependency on England and internall subject to the ascendancy of an Anglo-Irish Protestant minorit owning the bulk of the land. Roman Catholics were excluded by penal code from political participation and public office. To thes oppressions were added widespread rural poverty and a backwar economic life aggravated by commercial restrictions resultin from English commercial jealousy. Burke was always concerne to ease the burdens of his native country. He consistently ad vocated relaxation of the economic and penal regulations, and step toward legislative independence, at the cost of alienating h Bristol constituents, and of incurring suspicions of Catholicis and charges of partiality.

India.—The remaining imperial issue, to which he devoted man years, and which he ranked as the most worthy of his labours, wa that of India. The commercial activities of a chartered tradin concern, the British East India company, had created an extensiv empire. Burke in the 1760s and 1770s opposed interference by th English government in the company's affairs as a violation o chartered rights. However, he learned a great deal about the stat of the company's government as the most active member of th select committee which was appointed in 1781 to investigate th administration of justice in India, but which soon widened its fiel to that of a general inquiry. Burke concluded that the corrup state of Indian government could be remedied only if the vas patronage it was bound to dispose of was in the hands neither of company nor of the crown. He was the author of Fox's East Indi bill (1783) which proposed that India should be governed by board of independent commissioners in London. Two of Burke best-known speeches were on Indian affairs, *On Mr. Fox's Eas India Bill* (1783) and *On the Nabob of Arcot's Debts* (1785 After the defeat of the bill, Burke's indignation came to centre o Warren Hastings, governor general of India (1773–85). It was a Burke's instigation that Hastings was impeached in 1787 an he challenged Hastings' claim that it was impossible to appl western standards of authority and legality to government in th east. He appealed to the concept of the Law of Nature, the mora principles rooted in the universal order of things, to which al conditions and races of men were subject. The impeachmen dragged on for eight years and ended with Hastings' acquittal o all charges. It resulted in an authoritive statement of the principle of responsible rule in imperial affairs; but it is generally regarded as an act of injustice to Hastings, who had been, despit questionable methods, a disinterested servant of the company an the British name in India.

Burke's Character.—The impeachment is the most conspicuous illustration of the failings to which Burke was liable throughout his public life, including his brief periods in office as paymaste general of the forces in 1782 and 1783. His political positions wer sometimes marred by gross distortions and errors of judgment His Indian speeches fall at times into a violence of emotion an abuse, lacking restraint and proportion. His reliance on the opinions of Philip Francis, an enemy of Hastings, illustrates his liability to form false judgments of personality, both favourable an unfavourable. His parliamentary activities were at times irresponsible or factious. Nor did he escape the charge, in Indian affairs, of personal interest. Throughout his career he was associated financially and politically with his brother Richard and a putative kinsman William Burke, both doubtful characters known to be unsuccessfully speculating in East India stock. The Burkes's joint finances were indeed always in a precarious state and as Edmund was ever eager to forward his kinsmen's political fortunes it is understandable that he appeared in some hostile eyes as hardly more than one of a clan of Irish adventurers.

Of these failings it can plausibly be argued that they were the defects of Burke's virtues rather than an impurity in those virtues themselves. It has not been shown that Edmund himself was a speculator in company stock; it seems rather that he was rendered blind or oblivious to the nature of his kinsmen's proceedings by family partiality. Nor do his political lapses, even at their worst, appear to spring from self-interest or unworthy motives, but from his failure to control and balance his unusually sensitive and powerful emotional nature. Burke's weaknesses therefore lie close to what is best in his character and career: his capacity to illuminate practical politics by general principles, in a synthesis at once intellectual and emotive, the intensity of his dedication and industry in public affairs, the constancy of his humanitarian struggle against injustice and suffering, the readiness and generosity of his help in need (of which the poet George Crabbe and painter James Barry are the best known recipients), the distinction of his numerous literary and political friendships, and the happiness of his family life and kinship ties.

Attitude Toward the French Revolution.—The outbreak of the French Revolution in 1789 was initially greeted in England with much enthusiasm. Burke, after a brief suspension of judgment, was both hostile to and alarmed by this favourable English reaction. He was provoked into writing his *Reflections on the Revolution in France* (1790) by a sermon of the Protestant dissenter Richard Price welcoming the Revolution. Burke's deeply felt antagonism to the new movement propelled him to the plane of general political thought; it provoked a host of English replies, of which the best known is Thomas Paine's *Rights of Man* (1791–92).

In the first instance Burke discussed the actual course of the Revolution, examining the personalities, motives and policies of its leaders. More profoundly, he attempted to analyze the fundamental ideas animating the movement and, fastening on the Revolutionary concepts of "the rights of man" and popular sovereignty, emphasized the dangers of democracy in the abstract and the mere rule of numbers when unrestrained and unguided by the responsible leadership of an hereditary aristocracy. And, further, he challenged the whole rationalist and idealist temper of the movement. It was not merely that the old social order was being thrown down. He argued that the moral fervour of the Revolution, and its vast speculative schemes of political reconstruction, were causing a devaluation of tradition and inherited values, and a thoughtless destruction of the painfully acquired material and spiritual resources of society. Against all this, he appealed to the example and the virtues of the English constitution: its concern for continuity and unorganized growth, its respect for traditional wisdom and usage rather than speculative innovation, for prescriptive, rather than abstract, rights, its acceptance of a hierarchy of rank and property, its religious consecration of secular authority and recognition of the radical imperfection of all human contrivances.

As an analysis and prediction of the course of the movement, Burke's French writings, though frequently intemperate and uncontrolled, were in some ways strikingly acute; but his lack of sympathy with its positive ideals concealed from him its more fruitful and permanent potentialities. It is for the criticism and affirmation of fundamental political attitudes that the *Reflections* and the *Appeal from the New to the Old Whigs* (1791) retain their freshness, relevance and force.

Burke opposed the French Revolution to the end of his life, demanding war against the new state, and gaining a European reputation and influence. But his hostility to the Revolution went beyond that of most of his party, and in particular was challenged by Charles James Fox. Burke's long friendship with Fox came to a dramatic end in a parliamentary debate (May 1791). Ultimately the majority of the party passed with Burke into support of William Pitt's government. In 1794, at the conclusion of Hastings' impeachment, Burke retired from parliament. His last years were clouded by the death of his only son, on whom his political ambitions had come to centre. He continued to write, defending himself from his critics, deploring the condition of Ireland and opposing any recognition of the French government (notably in *Letters on a Regicide Peace* [1796–97]). Burke died at Beaconsfield, Buckinghamshire, on July 9, 1797.

POLITICAL THEORY

Burke's writings on France, though the most profound of his works, cannot be read as a complete statement of his views on politics. Burke never gave a systematic exposition of his fundamental beliefs but appealed to them always in relation to specific issues. His consistency during his political career has therefore been debated, both in his lifetime and since. He himself repudiated charges of inconsistency, and it is possible to regard his writings as an integrated whole, in terms of constant principles underlying his practical positions.

Those principles are, in essence, an exploration of the concept of "Nature." Burke conceives the life of feeling and the spiritual life of man as a harmony within the larger order of the universe. Natural impulse, that is, contains within itself self-restraint and self-criticism; the moral and spiritual life is continuous with it, generated from it and essentially sympathetic to it. Instinct is ideally rational in the sense of objective and impartial, sustaining self-interest but recognizing its finite place in larger wholes. It follows that society and state make possible the full realization of human potentiality, embody a common good and represent a tacit or explicit agreement on norms and ends. The political community acts ideally as a unity. Its constitutional organization and activities should be designed to elicit, maintain and expand the inherent rationality of its parts and members. Political participation will naturally differ from one part of society to another, and from period to period, but the constant principle is that it should be arranged to exclude aggressive self-interest and to allow expression of rational conciliatory self-interest compatible with the good of the whole. Burke therefore does not reject the concept of natural right, but he does not give it any simple or direct political implication. It refers to the whole potentiality of human nature and comprises an acceptance of both the rightness and wisdom of the life of feeling, the reality of moral obligation and the need for inner or outer restraint on mere appetite.

This interpretation of nature and the natural order implies deep respect for the historical process, and the usages and social achievement built up in time. Negatively, this is an insistence on the safety of the tried and enduring; positively, it is a sense of the principle of growth and perfection immanent in a tradition and stable complex of feeling. Therefore it does not entail an inflexible or uncritical adherence to the inherited order. Social change is not merely possible but inevitable and desirable. But the scope and the role of thought operating as a reforming instrument on society as a whole is limited. It should act under the promptings of specific tensions or specific possibilities, in close union with the detailed process of change, rather than in large speculative schemes involving extensive interference with the stable, habitual life of society. Also, it ought not to place excessive emphasis on some ends at the expense of others; in particular, it should not give rein to a moral idealism which sets itself in radical opposition to the existing order. Such attempts cut across the natural processes of social development, initiating uncontrollable forces or provoking a dialectical reaction of excluded factors. The natural development is a unitary evolution of social potentialities, a progressive embodiment of its immanent values: individual diversity and common rationality, widening political participation, extension and refinement of the spiritual and cultural life. This evolution will be conditioned and particularized within different communities by a multitude of special factors, which must be respected. The hope is not a realization of particular ends, such as the "liberty" and "equality" of the French Revolution, but an intensification and reconciliation of the multifarious elements of the good life which community exists to forward. At each level and stage of the human order, the natural harmony is frangible. Its violation creates a disorder; but such disorder is not the primordial or essential relation of the elements of human experience; it is the disharmony of the parts of an integrated whole.

This system is a theodicy. Burke is not a Christian political thinker in the sense that the tenets of Christian faith, or unity of Christian worship, are integral elements in his political thought, as is the case with Richard Hooker. But of all earlier English political thinkers, his closest affiliations, in historical situation, in tone, and in many details of thought, are with Hooker; and both consciously belong to the tradition of political thought whose greatest figures are St. Thomas Aquinas and Aristotle.

In his own day, Burke's writings on France were an important inspiration to German and French counterrevolutionary thought. His influence in England has been more diffuse, more balanced and more durable. He stands as the original exponent of long-lived constitutional conventions, the idea of party and the role of the member of parliament as free representative, not delegate. More generally, his remains the most persuasive statement of certain inarticulate political and social principles long and widely held in England: the validity of status and hierarchy, the limited role and scope of politics in the life of society, the confinement of political principle within the sanctions of custom, natural feeling and morality. As for the contemporary relevance and ultimate validity of his thought, this would seem to reduce to the question how far his particular conception of "nature" can still be found consonant with subsequent social experience and self-analysis.

See also references under "Burke, Edmund" in the Index volume.

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BURKE, SIR JOHN BERNARD (1814–1892), British genealogist, the second editor of Burke's *Peerage,* who in 1847 introduced the annual revised editions, was born in London on Jan. 5, 1814, and was educated in London and France and called to the bar at the Middle Temple in 1839. He was the most voluminous genealogical and heraldic writer of the 19th century, and the most celebrated member of a family of genealogists. His father, John Burke (1787–1848), began Burke's *Peerage* (1826), *Landed Gentry* (1836), *Extinct Peerage* (1831) and *Extinct Baronetcies* (1838). Sir Bernard, early associated with his father's works, greatly increased their range, and also wrote many other books, among them the *General Armory* (1842); *The Roll of Battle Abbey* (1848); and *The Romance of the Aristocracy* (1855); *Vicissitudes of Families* (3 ser., 1859–63); and *The Genealogical and Heraldic History of the Colonial Gentry* (1891).

Sir Bernard combined this work with a busy professional career. He was Ulster king-of-arms from 1853 until his death; registrar and knight-attendant on the Order of St. Patrick; keeper of the state papers of Ireland; and a governor and trustee of the National Gallery of Ireland. He was knighted in 1854 and made commander of the Bath in 1868. Of his seven sons four were notable as heralds or genealogists. Burke died in Dublin on Dec. 12, 1892. His work can easily be criticized, but it may fairly be claimed that there is no aspect of heraldry, genealogy or peerage law in which the inquirer cannot learn from him. (L. G. PE.)

BURKE, ROBERT O'HARA (1820–1861), Irish-Australian explorer, was the leader of the first expedition to cross Australia from south to north. This expedition, known as the "Great Northern exploration" or "Burke and Wills" expedition, was promoted by the Royal Society of Victoria. Burke was born at St. Cleram, County Galway, Ire., in 1820. He served in the Austrian army and, later, in the Irish constabulary. In 1853 he emigrated to Australia where he became an inspector of police in Victoria.

He was a brave impetuous man, but no bushman; although the expedition reached its objective, it ended in disaster. Expensively equipped and enthusiastically sponsored, it left Melbourne in Aug. 1860 with 18 men and ample transport, including camels from India. Burke, his second in command W. J. Wills, C. Gray and John King reached the Gulf of Carpentaria in Feb. 1861, having left a rear guard at Cooper's Creek in Queensland. The depot was not properly maintained nor was any reliable system of communication agreed on; only King survived the return journey and was rescued by A. B. Howitt's search party in Sept. 1861. Burke died of starvation on June 28, 1861. A statue to Burk and Wills was erected in Melbourne.

The only first-hand account of the venture is in Wills's journal found with his body. (D. MN.)

BURKE, WILLIAM (1792–1829), a criminal notorious for a series of murders committed in Scotland in association with William Hare, was born in County Tyrone, Ire., in 1792 and went to Scotland about 1818. In 1827 he was living in a lodging house in Edinburgh kept by another Irishman, William Hare. At that time in Scotland the growing need of doctors and students for corpses for dissection could not legally be filled, and body snatching and resurrectionism were rife. So when one of Hare's lodgers died, he and Burke sold the body to Robert Knox, a leading anatomist, for £7 10*s.* It was fatally simple. Helped by Mrs Hare and Helen McDougal, the two men lured travelers into one of their houses, made them drunk and suffocated them. In nine months they disposed of the bodies of 15 victims at prices ranging from £8 to £14, but the disappearance of the 16th victim was noticed, the police traced the body to Knox's cellar and the four were arrested. Hare turned king's evidence, making Burke's conviction possible. He was hanged in Edinburgh on Jan. 28, 1829 Hare was safe from prosecution, but public hatred drove him from Scotland.

The verb "to burke," meaning to suffocate or kill in order to sell the body, or, figuratively, to suppress or hush up, came from Burke's career.

See William Roughead (ed.), *Burke and Hare,* with complete trial of Burke and McDougal, 3rd ed. (1948).

BURLAMAQUI, JEAN JACQUES (1694–1748), Swiss publicist, was born at Geneva on June 24, 1694, where he was honorary professor of ethics and the law of nature for 15 years As a member of the council of state, he gained a high reputation for his practical sagacity. His *Principes du droit naturel* (1747 and *Principes du droit politique* (1751) passed through many editions and were extensively used as textbooks. His fundamental principle may be described as rational utilitarianism, and in many ways it resembled that of the English philosopher Richard Cumberland (*q.v.;* 1631–1718). Burlamaqui died at Geneva on April 3, 1748.

BURLAP, a plain woven jute fabric also sometimes called hessian. The name burlap is a contraction of the Anglo-Saxon *burrel,* meaning "coarse cloth," and *lappen,* "to lap" or "wrap."

Burlap weights generally range from 5 oz. to 14 oz. a yard; fabric widths usually range from 36 to 100 in. Burlap is the standard jute fabric construction; other constructions are jute canvas, a very fine weave of highest quality "white" fibre, and sacking, a heavier and more coarsely woven fabric. The major use for burlap is as bags for packaging, but it is also widely used as carpet backing, cement curing covers during construction, lining for clothing upholstery interiors, backing for plastic upholstery fabrics and decorative wall coverings.

Centre of the world jute manufacturing industry is Calcutta, India. Burlap is exported in bales of 2,000 yd.; the fabric is converted to end uses by domestic manufacturers.

See JUTE. (Q. L. H.)

BURLEIGH, HARRY THACKER (1866–1949), U.S. Negro baritone and composer known for his transcriptions of Negro spirituals, was born at Erie, Pa., Dec. 2, 1866. He studied from 1892 to 1896 at the National Conservatory of Music, New York city, where he was encouraged by the mother of composer Edward MacDowell and also by Dvořàk. He was a soloist in New York city, at St. George's church (1894–1946) and at the synagogue Temple Emanuel (1900–25). He composed more than 200 songs and became widely known for his arrangements of Negro spirituals, notably "Deep River." In 1917 he won the Spingarn medal for the highest achievement by an American Negro. He died at Stamford, Conn., Sept. 12, 1949.

BURLESQUE, a comic imitation of a serious literary work, in which heroes behave like clowns and gods like the lowest of men. It is closely related to parody (*q.v.*), in which the language and style of an author, poem or other work is mimicked; burlesque relies more on an extravagant incongruity between a subject and its treatment, and its effects are in general broader and coarser. Homer was burlesqued in *Batrachomyomachia* (*The Battle of the Frogs and Mice*) and the long-winded medieval romance in Chaucer's *Tale of Sir Thopas*. The mock-epic *Morgante* by Luigi Pulci (*q.v.*) ridicules the Charlemagne story and the whole theme of chivalry in high-sounding *ottava rima*. In 15th-century Italy urlesque expressed a commonsensical middle-class attack on a ying aristocratic culture and in that form also it proved the initial inspiration of Cervantes' *Don Quixote*. In the France of Louis XIV it was used by the "Moderns" in the "Battle of the Books," the *Virgile Travesti* of Paul Scarron (*q.v.*) being the best nown of many burlesque or antiheroic epics on classical or even acred themes. These were somewhat influenced by the Spanish drama of Lope de Vega, in which the clown or *gracioso* parodies he actions and sentiments of the heroic lover. English burlesque is chiefly dramatic (a notable exception being the burlesque poem *Hudibras* by Samuel Butler; *q.v.*). George Villiers' (2nd duke of Buckingham) *The Rehearsal* (1671), which mocks the Restoration drama of Dryden and Thomas Otway, Fielding's *Tom Thumb* 1730), Sheridan's *The Critic* (1779), which takes a side glance at the amateur actor and Henry Carey's "most tragical tragedy" *Chrononhotonthologos* (1734) are the outstanding survivals from n age when burlesque was cruelly satirical and often defamatory. The heroic Bombardinion's lines in Carey's fragment provide a bridge-passage to the more kindly, punning Victorian burlesque:

> Go call a coach, and let a coach be called;
> And let the man who calls it be the caller;
> And in his calling, let him nothing call,
> But coach! coach! coach! Oh! for a coach, ye gods!

Authors of Victorian burlesque—light entertainment with music, the plots of which were frivolously modeled on those of history, literature or classical mythology—included H. J. Byron, J. R. Planché and W. S. Gilbert (*q.v.*), before his partnership with Sullivan. Before the end of the 19th century burlesque yielded in popular favour to musical comedy, leaving some traces on the antomime (*q.v.*). (Jo. M. C.)

Burlesque in the U.S. Theatre.—A very different kind of entertainment, also known as burlesque, was taken to the United States in 1868 by Lydia Thompson's troup of "British Blondes," which included a chorus line of girls in tights. In the U.S., it evolved into a type of show designed for male patronage, compounded of slapstick sketches, earthy jokes, chorus numbers and solo dances usually billed as "daring" or "sensational." In the early 20th century, two national circuits of burlesque shows, as well as resident companies in New York, were thriving. W. C. Fields, Al Jolson, Leon Errol and Fannie Brice were among the comedians who served their apprenticeship in this rugged school.

The addition of "strip tease" dancing to the burlesque repertoire in the early 1920s brought censorship that closed many burlesque theatres. By the early 1960s few burlesque houses remained and these usually provided no more than strip-tease performers, a motion picture and a comic who told his jokes with an air of defeatism o an audience waiting for the next display of feminine anatomy.

BURLEY (Burleigh), **WALTER** (*c.* 1275–*c.* 1345), English scholastic philosopher, honorifically designated as *doctor planus et perspicuus* ("the plain, clear-sighted teacher"), is known o have taught at Oxford, at Paris (*c.* 1324) and also at Toulouse. A voluminous writer, he produced many treatises on Aristotle, but his chief work was *Liber de vita et moribus philosophorum et poetarum* (modern ed. by H. Knust, 1886), a kind of history of philosophy. A realist on the question of universals, Burley held a theory of knowledge resembling that of St. Thomas Aquinas. In his commentary on Aristotle's *Physics*, he asserted that he did not agree with the argument for an unmoved first mover. (S. J. C.)

BURLINGAME, ANSON (1820–1870), U.S. congressman and diplomat, was born in New Berlin, N.Y., on Nov. 14, 1820. In 1823 his parents moved to Ohio and in 1833 to Michigan. In 1841 he was graduated from the Detroit branch of the University of Michigan and in 1846 from the Harvard law school. He soon entered Massachusetts politics and in 1853–54 served in the state senate. From 1855 to 1861 he was a member of the national house of representatives, being elected for his first term on the Know-Nothing ticket and thereafter for the Republican party, of which he was one of the founders in Massachusetts. Burlingame's speech (June 21, 1856) of sharp reproof to Preston S. Brooks for attacking Sen. Charles Sumner (*q.v.*) led Brooks to challenge Burlingame to a duel, but the duel never took place. In 1860 Burlingame was defeated for re-election and in 1861 Pres. Abraham Lincoln named him minister to Vienna. The Austrian government found him unacceptable because of his pro-Kossuth speeches and he was then appointed minister to China. Burlingame found China in a critical situation. The T'ai P'ing rebellion had not yet been suppressed; the "unequal treaties" had infringed China's sovereignty; the central government was weak; antiforeign feeling was strong; and the foreign mercantile community desired vigorous treaty enforcement and more treaty rights. Burlingame quickly became the leader of the diplomatic corps in a policy of co-operation among the western powers and China to secure settlement of disputes by diplomacy rather than force and to further the modernization of China. Burlingame's charm, good counsel and sympathy for China so impressed the Chinese government that in Nov. 1867, upon his resignation as U.S. minister to China, he was named imperial envoy charged with the conduct of China's international relations. In Feb. 1868, with two Chinese colleagues and a suite of 30, Burlingame began a tour of western capitals. The mission made a triumphal progress across the United States, in the course of which Burlingame, a brilliant orator, conveyed an optimistic idea of China's receptivity to western influence. In Washington, Burlingame negotiated with Secretary of State William Seward the so-called "Burlingame treaty," consisting of eight articles supplementary to the Reed treaty of 1858. While several of the articles were simply amplifications of rights secured in 1858, the first two put on record the traditional American policy of respect for China's territorial integrity and the fifth provided for reciprocal immigration. In London, Burlingame secured a declaration that China was entitled to the forbearance of foreign nations. On the European continent the mission was less successful. Burlingame died of pneumonia in St. Petersburg, Russia, on Feb. 23, 1870. (M. E. C.)

BURLINGAME, a city of San Mateo County, Calif., U.S., 19 mi. S of San Francisco on the west side of San Francisco Bay and a part of the San Francisco-Oakland standard metropolitan statistical area (*see* San Francisco). Its name honours Anson Burlingame (*q.v.*), who visited and bought land in the area in 1866. Refugees from the San Francisco earthquake of 1906 incorporated the city in 1908. Between 1920 and 1930 it grew rapidly into an upper-class residential community, and after 1945 its population spurted again. In 1970 the population was 27,320 (for comparative population figures *see* table in California: *Population*). Ready access to San Francisco, a mild climate, and wooded homesites attracted residents. By its 50th anniversary it had high-ranking public schools, a general hospital, libraries, theatre and musical groups, parks, and a triweekly newspaper. Commercial and industrial development involved over 50 firms in the manufacture of electrical and pharmaceutical products, and in administrative and distributive enterprises. (J. H. St.)

BURLINGTON, RICHARD BOYLE, 3rd Earl of (1694–1753), English architect and originator of the Neo-Palladian style of the 18th century, was born on April 25, 1694. In 1703 he succeeded to the title and inherited a large fortune and estates in Yorkshire and Ireland as well as Burlington House in Piccadilly, London, and a house and garden at Chiswick, Middlesex.

He began studying architecture in 1717. Fascinated by Colen Campbell's propagation of Inigo Jones's (*q.v.*) and A. Palladio's (*q.v.*) classicism and by Giacomo Leoni's great English edition of Palladio's treatise, he traveled to Vicenza, Italy, for firsthand experience of Palladio. Back in London in 1719, he started to practise architecture and to advocate a revival of the Palladian and Jonesian interpretation of classical tenets. He assembled the largest collection of Palladio and Jones drawings ever brought together (presently in the Royal Institute of British Architects, London). Most of Burlington's buildings derived from these drawings.

In 1721 he emerged as an architect of importance with the design for the dormitory of Westminster School, London (gutted in 1940, but reconstructed in 1947). In 1723 he built General Wade's house in Great Burlington Street, London (demolished in 1935), following exactly one of Palladio's drawings. Burlington's own villa at Chiswick (restored 1952) resulted from a mosaic of judicious borrowings. It was the most influential Neo-Palladian building in England. The Assembly Rooms at York with the so-called Egyptian Hall (1731–32), based on Palladio's interpretation of a Vitruvian passage, represent the apogee of Burlington's style. They were the most dogmatically severe classical structure in Europe at that time. Few of his other buildings survive (almshouses at Sevenoaks, Kent, 1727; east front and hall of Northwick Park, Worcestershire, 1727–30), but in his day he was the acknowledged oracle of good taste and men of his class hardly dared to build without consulting him.

During his last two decades, Burlington retired more and more from public life and architectural practice. He had trained a new generation of architects—Henry Flitcroft (1697–1769), Isaac Ware (d. 1766), and, above all, William Kent (*c.* 1686–1748). Having firmly established these men, he regarded his life's work complete. He died on Dec. 3, 1753.

As a young man, under Lord Shaftesbury's influence, Burlington dreamed of bringing about a great national style, a rebirth of all the arts in the spirit of classical antiquity. Always an ardent partisan of Italian opera, he also tried to foster a renaissance in sculpture and painting, but without success. For two decades he had a pervading influence on the character of architectural publications. Through cheap, pocket-sized books, Neo-Palladianism reached all strata of society in England. An imported style—learned, doctrinaire, sophisticated, and seemingly exclusive—thus was turned into a truly national idiom. Neo-Palladianism—simple, uniform, and rational—lent itself as an expressive symbol for political Whiggism and Protestant ideology. The style dominated the English scene from the early 1720s onward for a generation.

See also NEOCLASSICAL ART AND ARCHITECTURE: *Neoclassical Architecture*.

See H. M. Colvin, *A Biographical Dictionary of English Architects, 1660–1840* (1954), with further bibliography. (Rf. W.)

BURLINGTON, a city on the Mississippi River bluffs in southeastern Iowa, U.S., is the seat of Des Moines County. After 1808 traders used this point intermittently until the Sauk and Fox Indians relinquished title to the region in 1832. Settlers arrived in 1833. The town, originally called Flint Hills, a translation of the Indian name for the place, was named after Burlington, Vt. It was incorporated and surveyed in 1836, adjacent to the only adequate steamboat landing on the western river shore for about 80 mi. Burlington served as a land office and port of entry for Iowa settlers and for a brief period it was also the territorial capital. It prospered from the river trade and also as an early railroad centre. Between 1860 and 1880 the population rose from 6,706 to 19,450. Growth was slow thereafter until World War II. Ohio and the Middle Atlantic and Southern states provided many early settlers. German, Swedish, and Irish immigrants increased after 1850 and by 1900, 55% of the county population was foreign born or of foreign parentage. During the 20th century there was a steady growth in population. Pop. (1970) 32,366. (For comparative population figures *see* table in IOWA: *Population.*)

Major industries produce explosives, electrical, electronic, and automotive equipment, crawler tractors, turbines, boilers, biscuits, and desks; local agriculture emphasizes corn production and the feeding of livestock. Southeastern Iowa College serves several neighbouring counties. Geode State Park lies in western Des Moines County. (A. G. Bo.)

BURLINGTON, a city of New Jersey, U.S., is situated on the Delaware River 18 mi. NE of Philadelphia. It was settled by Quakers in 1677, four years before the founding of Philadelphia. It was first called New Beverly, then Bridlington (for a village in Yorkshire), and later Burlington. In 1681 the town became the capital of the province of West Jersey, alternating in 1702 with Perth Amboy as the capital of West and East Jersey. This continued until 1790 when Trenton became the state capital.

Burlington was given temporary steamboat service as early as 1788 when John Fitch's 60-ft. boat sailed upstream from Philadelphia, nearly 20 years before Fulton's boat moved up the Hudson. The railroad brought the town a new outlet for trade in 1834. In fact, the new facility was so welcome that the company was allowed to construct its tracks down Broad Street and build its station at the main intersection in town. This remained a problem until the latter 1950s when the station was removed.

Factories were established in the latter 19th century. By the second half of the 20th century production included cast-iron pipe plastics, gypsum, dresses, machines, and carbon paper. Among the points of interest are St. Mary's Church; the house of James Lawrence (*q.v.*), who said, "Don't give up the ship"; and the house where James Fenimore Cooper was born, which later became the library and museum of the Burlington County Historical Society. Pop. (1970) 11,991. For comparative population figures *see* table in NEW JERSEY: *Population.* (H. F. Wi.)

BURLINGTON, an industrial city of Alamance County in central North Carolina, U.S., is a centre for the manufacture of textiles, hosiery, electronic equipment, metal goods, furniture dairy products, and chemicals and drugs. A coffin factory established in 1884, one of the first in the south, is the oldest industry A large producer of man-made fibres originated in Burlington in 1923. Shops of the North Carolina railroad were erected on the site of the city in 1855 and the town of Company Shops was incorporated in 1866; a new charter was issued in 1887 when the name was changed to Burlington. The nearby site of the Battle of Alamance (1771), a pre-Revolutionary War encounter between colonists and the royal governor (*see* NORTH CAROLINA: *History*) is now a state park. Elon College, a coeducational institution of the Congregational Christian Church chartered in 1889, is nearby Pop. (1970) 35,930. For comparative population figures *see* table in NORTH CAROLINA: *Population.* (W. S. P.)

BURLINGTON, largest city of Vermont, U.S., the seat of Chittenden County, is on Lake Champlain, 100 mi. SE of Montreal, Que.; it is a port of entry and site of the northeastern regional office of the U.S. Immigration and Naturalization Service. Pop (1970) 38,633. Much of the city is built on a hillside overlooking 12 mi. of lake to the Adirondacks in the west, with the Green Mountains 20 mi. to the east. Lumber previously was imported from Canada but the commerce of the harbour in modern times i devoted largely to oil and gasoline; large oil terminals line the harbour, along with launching and docking facilities for small craft The lake ferry company (1816), operating between Burlington and New York state, is the oldest steamship company in the U.S. Battery Park, famous for sunset views, was fortified in 1812. Nearby is the Unitarian Church (1816), at the head of the main business street. Industries include the manufacture of electronic materials structural steel, can openers, ovens, syrup, cereal, furniture, ceramics, and woodenware. The city is a wholesale centre. The *Free Press* is Vermont's oldest daily newspaper.

The University of Vermont occupies the hilltop. The origina constitution of the republic of Vermont (1777) provided for a university, which was chartered in 1791 by the first General Assembly held after the state joined the Union. The state agricultural college was incorporated with it in 1865. Notable buildings include the Ira Allen Chapel (named for the founder), Billings Library, the Old Mill (cornerstone laid by the marquis de la Fayette in 1825), and Grassmount (1804). Its college of medicine, one of the nation's oldest, serves with the Mary Fletcher and De Goesbriand Memorial hospitals and the state health department as a state and regional medical centre. Trinity College (1925), for women (men are admitted to summer and evening courses), is also in the city, and St. Michael's College (1903), for men, is 4 mi. E both are Roman Catholic. Seven miles south is the Shelburne Museum of restored early New England buildings and the lake steamer "Ticonderoga," brought overland from Lake Champlain

Burlington was chartered by Gov. Benning Wentworth of New Hampshire in 1763 and named for the Burling family, pioneer landowners. Settlement began in 1773 and the city was incorporated in 1865 with a population of 8,000. It was the home of Ethan Allen from 1787 until his death in 1789 and is the site of his grave

For comparative population figures *see* table in VERMONT: *Population.* (R. N. B. H.)

BURMA (UNION OF BURMA; MYANMA), an independent republic of southeast Asia, consisting of Burma proper and five states, formerly a kingdom and then a territory of the British empire. Reference is often made to two broad divisions: Lower Burma, corresponding to the areas acquired by the British Indian government in 1826 and 1852; and Upper Burma, acquired in 1886. This is Burma proper; the states consist of large peripheral mountain and plateau areas inhabited mainly by non-Burmans. The whole territory stretches from latitude 10° N. to about 28° 30′ N.; but of the total length of about 1,300 mi. (2,100 km.), nearly 500 mi. (800 km.) are included in the long projection of Tenasserim, which extends to within 250 mi. (400 km.) of Malaya. The broadest part of the country, in about 21° N., is 575 mi. (925 km.) from east to west. Total area is 261,789 sq.mi. (678,034 sq.km.).

Roughly half of Burma lies outside the tropics, but the configuration of the country is such that the whole may be regarded as tropical. In the north the disputed boundary between Burma and China was not precisely determined until the implementation of the border treaty, signed by U Nu and Chou En-lai Oct. 1, 1960, and ratified Jan. 9, 1961. The northwestern frontier touches India (Assam, Manipur and the Lushai hills) and there is a short section of frontier with Pakistan (Chittagong). On the west the boundary is formed by the Bay of Bengal, in the southwest by the Gulf of Martaban and Andaman sea. On the east the frontier touches the Chinese province of Yünnan, and Laos, and for a long distance runs southward with Thailand.

This article is divided into the following sections and subsections:

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I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—Burma falls naturally into three great geomorphological units: (1) The Arakan Yoma, a great series of fold ranges of Alpine age, forms the barrier between Burma and India. The foothills of the Arakan Yoma stretch as far as the shores of the Bay of Bengal. (2) The Shan plateau massif, occupying the whole of the east of the country and extending southward into Tenasserim, forms part of what has been called the Indo-Malayan mountain system and has existed as a geomorphological unit since the close of the Mesozoic. (3) The central basin lies between the Arakan Yoma and the Shan plateau. Formerly a gulf of the early Tertiary sea, open to the south, it is now occupied by a great spread of Tertiary rocks.

The mountain range of the Arakan Yoma and its continuation northward has a core of old crystalline rocks. On either side are hard, tightly folded sedimentary rocks, mainly Tertiary in age. Rocks of Jurassic and Cretaceous age are also known to occur, but the geology of the ranges is still very imperfectly known. Extensive strike faulting occurs along the eastern flanks of the Arakan Yoma and large serpentine intrusions, probably of Cretaceous age, are associated with the faults. Chromite and other useful minerals are known to occur, especially in association with the serpentine, but are not at present exploited. The western edge of the Shan plateau massif is well marked both physically and geologically. It rises abruptly from the valley and for 400 or 500 mi. the edge is formed by a long strip of granitic or gneissic rocks. The predominant rocks in the Shan plateau are gneisses, which yield the rubies and other gems for which Burma has long been famous, and a massive limestone of Devonian-Carboniferous Age. Rocks of all ages from Precambrian to Jurassic occur in the massif, while deposits of Late Tertiary and Pleistocene Age occupy old lake basins. In Precambrian rocks at Mogok occur the principal ruby mines, but the industry is now of minor importance. At Bawdwin, associated with a group of ancient volcanic rocks, are very extensive deposits of silver-lead ore, mainly argentiferous galena, which are worked and smelted at the nearby works of Namtu. The refined silver and lead are sent by rail to Rangoon for export. Other silver-lead deposits are known in other parts of the Shan state and have been worked in the past by the Chinese. Tenasserim forms a continuation of the tin-bearing belt of Malaya, and large quantities of tin and tungsten are obtained. Geologically this portion of the Indo-Malayan mountains consists of large granitic intrusions, elongated in the north-south direction and intruded into a series of ancient rocks of unknown age. The basin of the Irrawaddy (*q.v.*) between the Arakan Yoma and the Shan plateau consists almost entirely of Tertiary rocks. The beds are remarkable for their enormous thickness; the Eocene beds are more than 15,000 ft. thick, the Oligo-Miocene (Peguan) more than 16,000 ft. and the Mio-Pliocene (Irrawaddian) more than 5,000 ft. This Tertiary basin has been separated into a broader western basin and a narrower eastern one by the complex fold range forming the Pegu Yoma. Forming a line down the centre of the western basin are the oil fields of Burma. The oil occurs mainly in rocks of Peguan age. From north to south are the fields of Indaw, Yenangyat-Lanywa, Singu-Chauk, Yenangyaung, Minbu and several minor fields. The most important fields are Yenangyaung and Singu. The oil fields are each anticlinal upfolds. Brown coal also occurs in considerable quantities in the valley of the Chindwin and elsewhere in the Tertiary rocks, but as yet has been little used. Along a line running roughly along the centre of the ancient Tertiary trough are numerous extinct volcanoes; some form small tuff cones with small crater lakes; others are plugs of rhyolitic matter, but the largest is the complex cone of Mount Popa.

2. Physiography.—The three physical units into which Burma is naturally divided have been mentioned as geomorphological units. Burma is separated from India and East Pakistan by a long fold range, uplifted at the same time as the Himalayas in India. In the north the range is narrow and known as the Patkai range. Farther south the direction changes from southwest to south and the ranges broaden out enclosing the Manipur plateau. The individual parts have received different names and include the Naga hills, Chin hills (*qq.v.*), Lushai hills (*see* MIZO) and the Arakan Yoma. As such it becomes narrower, curves round to south-southeast and terminates in Cape Negrais, though geologically the same series of folds is continued in the Andaman and Nicobar Islands (*qq.v.*). A small part of Burma, the division of Arakan (*q.v.*), lies between the Arakan Yoma and the Bay of Bengal. Some of the peaks of the western hills rise to 10,000 ft., and the highest is believed to be Saramati (12,663 ft.). The whole range forms an effective barrier between Burma and India proper. The east of Burma, including the whole of the Shan state (*q.v.*), is occupied by a plateau, which forms part of the Yünnan plateau of China. The plateau averages 3,000 ft. in height, but its surface has been much dissected; and running through the centre from north to south is the deep trough occupied by the Salween (*q.v.*) river. Southward, the plateau passes through Kayah state and the Karen state (Kawthoolei) into that part of Burma known as Tenasserim (*q.v.*), and gradually loses its plateau character.

Between the Arakan Yoma on the west and the Shan plateau on the east lies the basin of the Irrawaddy and its great tributary the Chindwin, and the basin of the smaller Sittang (*q.v.*). This is for the most part a lowland area, with ranges of hills, of which the Pegu Yoma is the most important, running from north to south. Almost in the centre the extinct volcano of Popa reaches 4,985 ft. above sea level. The Arakan coast of Burma is Pacific in type; it is rocky and dangerous, backed by high mountains and fringed by islands. Of the islands, Ramree and Cheduba (*q.v.*) are the largest. The Tenasserim coast is similar; in the south is the Mergui archipelago. Between the Arakan and Tenasserim coasts lies the low delta of the Irrawaddy and Sittang rivers.

Most of the hilly and mountainous regions were formerly forested and over large areas have good, fertile forest soils. Where clearings have been made, temporary cultivation has destroyed the virgin richness of the soil. In the wetter regions the heavy rains often wash the soil entirely away from cleared hillsides and expose the bare rock. The limestone rocks of the Shan plateau are usually covered by a thin red soil from which the lime has been entirely leached out. The richest soils in the country are the alluvial soils of the flat Irrawaddy delta and the broad river valleys. Excellent loamy soil is also afforded by the mixed clays and sands of the Peguan rocks, but the Irrawaddian and other sandy series give rise to extensive tracts of very light soil, almost pure sand. In the wetter parts of Burma, because of the well-marked dry season, a thick mantle of lateritic soil stretches over most of the lowland tracts.

The rivers of Burma fall into three groups. There are numerous short, rapid streams, such as the Naf, Kaladan, Lemro and An Chaung, which flow down from the Arakan Yoma into the Bay of Bengal. The centre of Burma is drained by the Irrawaddy and its tributaries and by the Sittang. The Shan plateau is drained mainly by the Salween and its tributaries; in Tenasserim there are again a number of short, rapid rivers flowing from the hills into the Gulf of Martaban. The longest is the Tenasserim river.

The largest lake in Burma is a shallow stretch of water in the Shan plateau known as Inle lake. It is the remnant of a much larger lake, is rapidly becoming smaller and occupies a hollow in the surface of the plateau. Another large lake, the Indawgyi, with an area of 100 sq.mi., is in the north of Burma near Mogaung. It is surrounded on three sides by ranges of hills but is open to the north where it has an outlet in the Indaw Chaung. In all the lowland tracts there are numerous small lakes occupying deserted river meanders. In the heart of the Irrawaddy delta numerous large lakes or marshes, abounding in fish, are formed by the overflow of the river during the rainy season but disappear in the dry.

3. Climate.—Burma forms part of the great monsoon region of Asia, but its climate is profoundly modified by the relief of the country. There are really three seasons: the cool season, which is also rainless, setting in toward the end of October and lasting till February; the hot season (rainless) from March to the end of May; and the rainy season from June to October. October is an unpleasant month; the rains have almost ceased, but the temperature and humidity are high. Along the coast, and especially in the south, both the daily and annual range of temperature are small. In Moulmein the annual range is 8° F.; in Rangoon it is 10°. Away from the moderating influence of the sea, the range of temperature increases greatly and is especially large in the dry belt. The annual range in Mandalay is 20°. The average temperature in the south of Burma is 80°.

From October to May Burma is under the influence of the northeast trade wind or the northeast monsoon as it is more often called. The north and south alignment of the mountains causes this wind to blow almost directly from the north. It is a cool wind, but becomes less cool toward the end of the dry season. The change to the southwest monsoon is heralded by thunderstorms toward the end of May. The southwest monsoon, blowing as it does from the Indian ocean, brings rain. The coastal districts receive the full force of the wind and a heavy rainfall in consequence. Much of Arakan and Tenasserim have nearly 200 in. of rain. Rangoon enjoys an annual fall of 99.1 in. The heart of Burma lies in the lee of the lofty Arakan Yoma and the rainfall is scanty, as little as 24 in. in the heart of the dry belt. Mandalay lies in this dry region and receives an average of 33.4 in. Because of its elevation, the Shan plateau has a moderately good rainfall.

4. Vegetation.—The wide range of rainfall in Burma is responsible for great variations in the natural vegetation. Frost never occurs in the lowlands, but roughly above 3,000 ft. the occasional frosts have caused a great change in vegetation. Above that level evergreen oak forests, sporadic pine forests and wide areas of open land, with bracken and grass, are the rule. Rhododendron forests occur at high levels. Below the frost level the natural vegetation depends mainly upon the rainfall: (1) With more than 80 in. of rain, evergreen tropical rain forests occur. The trees of the forests are of many species, but more than one-half belong to the Dipterocarpaceae. The timbers are hard and little used. (2) With between 40 and 80 in. of rain are the monsoon forests which lose their leaves during the hot season. These forests are the home of the valuable teak trees as well as the pyinkado and other timber trees. (3) With less than 40 in. the forest becomes very poor and passes into scrubland and semidesert. There is little or no true grassland. (4) Extensive areas of the Irrawaddy delta are clothed with tidal forests, in which some of the trees reach a height of more than 100 ft. and are of considerable value.

Forest covers about 60% of the surface of Burma but the wasteful methods of the indigenous cultivator resulted in the destruction of vast areas of valuable tree resources in the hills. The practice was to cut down and burn a tract of virgin forest, cultivate the field (*taung-ya*) so formed for two or three years while the pristine freshness of the soil lasted and then to desert it for a fresh tract. It was but rarely that the forest established itself again over the deserted *taung-ya;* more often the area became covered with a tangled mass of bamboo, bracken or grass. After 1856, however, the forest department set to work and all the valuable forests were constituted into government reserves. Teak is about 20% of the total timber production; pyinkado (pyengadu) rather less but in-kanyin more than 30%. Timber ranks second or third among Burma's exports. By 1958, however, an important new development was the export of green teak. Various privileges were accorded to the people who lived within the reserved areas. The timber, mainly teak for construction work and pyinkado for railway sleepers, was worked either by the government or by lessees (public and private companies) under supervision. Extraction was so controlled that it should not exceed regeneration. After independence in 1948 most of the extraction was by the State Timber board.

5. Animal Life.—The anthropoid apes are represented by two gibbons, and there are about a dozen species of monkeys. Tigers are still common throughout the country; leopards and several species of wildcat also occur. The Himalayan black bear and the Malayan bear are found in the hills. Bats are numerous and the huge flying fox is particularly common in several of the large towns. Elephants are still numerous in many of the denser forests and some are caught annually in keddahs and trained for forest work. Two species of rhinoceros occur but are now far from common. Among wild animals the *pyaung* or bison and the very dangerous *saing* or wild buffalo are common. The small barking deer (*gyi*) is the commonest of the larger animals and is still widely distributed. The thamin, sambar and hog deer are also common. A licence is required for hunting most of the large animals, and many of them enjoy a closed season. The half-wild pariah or "pi" dogs swarm in every village. Among the numerous birds, the bright-hued small parrots may be specially noted along with the ubiquitous paddy bird. Crows are exceedingly abundant and very bold. Sparrows have become general in the towns and villages, mynas less common. A characteristic lizard is the house gecko or *taukte* (so called because it makes a loud croaking noise like "taukte," repeated four to ten times). Snakes, including the python, are numerous.

II. GEOGRAPHICAL REGIONS

For an adequate study of this large and varied territory, a division into at least seven natural regions is desirable: (1) The Arakan coastal strip is hilly or mountainous, has a very heavy rainfall and is covered with the remnants of a dense evergreen forest which has, however, been largely replaced by dense bamboo thickets. This region is sparsely inhabited and the population is concentrated round the principal town and port of Akyab. Communication with the rest of Burma is difficult except by sea. The region coincides roughly with the districts of Akyab, Kyaukpyu, Sandoway and the western strip of Bassein. (*See* ARAKAN and AKYAB.) (2) The Tenasserim coastal strip is similar but is of importance as the region producing tin and tungsten. Rubber plantations are increasing in importance. The chief town is Moulmein. The region coincides roughly with the Tenasserim division and most of the Karen state (districts of Mergui, Tavoy, Amherst and Thaton). (*See* TENASSERIM.) (3) The western hills region consists of the mountainous, sparsely inhabited tracts of the Arakan Yoma and its hill ranges. It coincides to a considerable extent with the Chin Hills Special Division (*q.v.*). (4) The northern hills region occupies the north of the country and includes the course of the Irrawaddy and its principal tributary the Chindwin. The region is as yet little developed. It includes the district of the Upper Chindwin and the Kachin state. (5) The Dry Belt occupies the heart of Burma. It is a flat and fairly thickly populated region, extensively cultivated and having some irrigated areas. The oil fields, with one exception, lie in this region. It coincides with the districts of Lower Chindwin, Shwebo, Sagaing, Mandalay, Kyaukse, Pakokku, Myingyan, Meiktila, Minbu, Magwe, Thayetmyo and Yamethin. (6) The delta region, including the deltas of the Irrawaddy and Sittang rivers and the intervening forested ridge of the Pegu Yoma, is the most important and the most thickly populated part of Burma. It includes the districts of Hanthawaddy, Pyapon, Maubin, Myaungmya, most of Bassein, Henzada, most of Prome, Tharrawaddy, Insein, Pegu and Toungoo. (7) The Shan plateau was formerly cut off in a remarkable way from the rest of Burma and still preserves many distinctive features. The region coincides with the Shan state passing southward into Kayah state. (L. D. S.)

III. THE PEOPLE

1. Racial Types.—The inhabitants of Burma belong to many races (see *Population* below) and speak many languages. In general they are of Mongoloid stock. It is believed that Burma was populated by successive waves of migration from the north. Indeed the advance of the Kachin races was still in progress in 1885. The Burmans or Burmese proper occupy the fertile lowlands; most of the other races are restricted to the hills and are in general less advanced. The Karens inhabit the Karen state (comprising the Papun district and the eastern parts of Toungoo, Thaton and Amherst districts), the Irrawaddy delta, the Pegu Yoma and the states of Karenni (now the Kayah state). The Shans occupy most of the eastern plateau and are also found in the upper part of the Chindwin valley. The Kachins belong mainly to the north and northeastern mountains, and the Chins to the northwestern mountains. On the Chinese borders are found the Palaungs and Was (some of whom are still headhunters). In the past large numbers of Indians were attracted to Burma by the higher rates of wages and the opportunities for trading and cultivation. In 1941 these numbered about 1,000,000. As a result of World War II and of Burmese independence this number has been reduced to 450,000. The Chinese are a smaller but important and rapidly expanding community. There were 194,000 in 1941 but they were believed to number about 500,000 in the mid-1960s. Except on the border in the northeast, where the Yünnanese and Chinese Shans are found, the Chinese belong essentially to the artisan and merchant class. Europeans, mainly British, numbered 12,000 in 1941; very few were permanent residents and the numbers decreased thereafter. Eurasians numbered 20,000 in 1941 and were probably about the same in the early 1960s. (*See* KACHIN; PALAUNG; CHIN; SHAN; MON.)

2. Languages.—More than 100 indigenous languages, not mere dialects, are spoken in Burma, most of them by illiterate hill tribes. The only Austric languages (*q.v.*) to survive are Mon, akin to Cambodian (Khmer), in the plains, and the languages of two tribes, the headhunting Wa and the tea-growing Palaung, in the hills. Most languages, even in the hills, belong to a totally different family, Tibeto-Chinese, which includes both Pyu and Burmese and represents a more enduring succession of immigrants, some of them, the Kachin tribes, continuing to arrive from the north in modern times.

The Burmese language is monosyllabic, agglutinative and closer to Chinese than to the Indian languages. A single syllable may have several meanings according to tone or stress. Many dialects and languages belonging to the Burma group are distinguished. The Shans, Kachins and Karens mostly speak entirely distinct languages. (*See* SHAN LANGUAGE; KAREN LANGUAGES.) Burmese is the official language. The Burmese adapted alphabets borrowed from the old rock-cut Pali of India. Thus their alphabet, their religion and a considerable number of words are of Indian origin. (*See* BURMESE LANGUAGES; TIBETO-BURMAN LANGUAGES.)

3. Religion.—The Burmese are mostly Buddhists, and their religion occupies a large place in their life. The spiritual head of every village is the yellow-robed *pongyi* or monk. The monastery, or *pongyi-kyaung,* just outside the village, is also a school (see *Education* below). Every village has its pagoda, and gilded or whitewashed pagodas crown almost every hill, but there are no temples in the ordinary sense of the word. The chief religious principle of the Burmese is to acquire merit as a foundation for rebirth into a better existence by good works done in this life. The bestowal of alms, offering of food to priests, the founding of a monastery, the erection of a pagoda or of a rest house for travelers are all works of religious merit. The Sixth Buddhist synod was held in Rangoon in 1954–55 to revise the text of the scriptures (Pali Canon) and was attended by representatives of all neighbouring Buddhist countries.

EWING GALLOWAY

PUPILS STUDYING IN MONASTERY SCHOOL AT CHAWK

The Shans too are Buddhists. The other hill people are in general animists though Christianity has made some advance, especially among the Karens.

4. Customs and Culture.—Most of the people live in villages, sometimes fenced as a protection against robbers and wild animals, in houses of bamboo and thatch built on stilts. Monogamy is almost universal though polygamy is not forbidden by law or

(TOP) VAN BUCHER—PHOTO RESEARCHERS, INC., (BOTTOM) FUJIHIRA—MONKMEYER

(TOP) WORSHIPERS KNEEL IN HOMAGE TO THE LORD BUDDHA, WITHIN THE PRECINCTS OF THE SHWE DAGON PAGODA, RANGOON. (BOTTOM) WOMAN GIVING ALMS TO A GROUP OF JUNIOR MONKS. EACH MONK CARRIES HIS OWN ALMS BOWL AS PART OF HIS EQUIPMENT

religion. Burmese women enjoy an amount of freedom unusual in non-European races. The staple food is rice. The national dress is a cylindrical skirt, called a *longyi*, worn folded over in front and reaching to the ankles. The *longyi* is worn by both sexes; and men wear also a single-breasted short jacket called an *eingyi* or *aingyi;* the women's garment is similar but double breasted, often short sleeved and usually of transparent white material. All Burmese, of both sexes, prefer silks of bright but delicate shades. The small handloom weaving industry retains a steadily decreasing share of the market against competition from machine looms.

As a whole the Burmese are characterized by cleanliness, a sense of humour and a love of sport. Pagoda festivals and the funerals of famous monks attract great crowds. These are entertained with traditional drama, dancing and clowning of high merit, combined in the *pwe* (theatrical performance) which has many of the vital characteristics of the old-fashioned English music hall. Burmese music is distinctive but essentially an adjunct to the *pwe*. Melodies are mainly composed of five notes C, D, E, G, A; semitones are not used so the chromatic scale is unknown. Characteristic instruments include the *kye-waing*, a series of gongs cast out of a bell metal arranged in a circular frame of stout cane and the *saing-waing*, composed of 18 circular drums hung from a circular frame. In towns motion pictures are increasingly ousting traditional forms of entertainment. There are historical chronicles, and wood carving and lacquer, gold and silver work are not altogether lost arts (see *Industries* below). There is a popular literature (*see* Burmese Literature), and some painting, which largely apes the west.

The Burmese months (dependent on the waxing or waning of the moon), with their approximate Gregorian equivalents, are: Tagu (April), Kason (May), Nayon (June), Waso (July), Wagaung (August), Tawthalin (September), Thadingyut (October), Tasaungmon (November), Nadaw (December), Pyatho (January), Tabodwe (February), Tabaung (March). Every third year, a second or Dutiya Waso is intercalated. (F. S. V. D.)

IV. ARCHAEOLOGY

The Paleolithic cultures of Burma, called Anyathian, are characterized by their uniformity throughout the period and by the absence of the true hand ax. Anyathian implements consist mainly of simple choppers or hand adzes and chopping tools made of silicified tuff and fossil wood. Neolithic material from Burma, some of which was found in association with potsherds of mat- and cord-marked ware, comprises chipped tools similar to Anyathian implements, edge-ground tools and several varieties of completely ground tools which suggest a cultural intrusion. The main Anyathian sites and Neolithic stations are located along the Irrawaddy river between Magwe and Nyaungu.

Among the earliest datable material from Burma are the bull and trident coins of Arakan. Inscriptions on the obverse of several coins repeat the names of some of the kings listed in the Anandacandra inscription now at the Shitthaung pagoda in Mrohaung. If this Sanskrit inscription, dated on paleographic grounds to the early 8th century A.D., is reliable, the coins belong to a period from the end of the 4th to the beginning of the 8th century. Other Sanskrit inscriptions of Arakan, some of Buddhist texts, range in date from the 7th to the 10th century A.D. Fragments of sculpture also suggest that Buddhism and Shivaism were the religions of the period. The figures of Vishnu, Garuda and Buddha from the Shitthaung pagoda are of a later period as are the other religious monuments of Mrohaung. Wethali, about 8 mi. (12.8 km.) N.W. of Mrohaung, where there are remains of a wall and a moat and where many of the coins and one inscription were found, is likely to prove the site of the capital of the Candra kings.

Other early archaeological material from Burma comes from Peikthano-myo (Vishnu City) near Taungdwingyi, and from Hmawza and Halingyi, two sites associated with the Pyu people. Peikthano-myo, a walled city with a variety of brick buildings, promises to be the earliest city site in Burma. The remains of the city of Sri Ksetra are at Hmawza, about 5 mi. (8 km.) S.E. of Prome. Another site believed to be a later capital is located at Halingyi near Shwebo. At Sri Ksetra, a walled and moated city roughly circular in plan and about 18 sq.mi. (46.6 sq.km.) in area, the remains of the palace are situated in the southern sector of the city and consist of a wall and a moat surrounding a brick platform 210 ft. (64 m.) square. Outside the city walls are the burial grounds of the Pyu from which have been excavated urns of stone bronze, copper and earthenware containing bones and ashes, ornaments of gold and silver, nails, hooks and blades of iron, silver coins and white pebbles. Some urns are inscribed in the Pyu language in a script resembling a 6th-century script of Kadamba (west India). These inscriptions and other Pyu inscriptions from Hmawza record existence of a ruling family with names ending in *vikrama* and *varman* which flourished in the 7th and 8th centuries.

Religious architecture at Hmawza includes solid cylindrical brick stupas of which the Bawbawgyi is the best example, and hollow vaulted temples either with a single cella like the Bebe or constructed with a central pier surrounded by a space for circumambulation like the Leymyethna. The radiating arch is a feature of these vaulted temples. From these and other ruins of Hmawza have come images and reliefs of the Buddha and terra-cotta votive tablets showing the influence, at different periods, of early South Indian and Gupta art, together with gold and silver plates inscribed in Pali, Sanskrit and Pyu, gold and silver ornaments and some silver coins. Three sculptures of Vishnu of the 8th and 9th century are clues to the syncretic nature of the religious beliefs and practices of the inhabitants of Sri Ksetra.

At Halingyi there is a rectangular city site with traces of a wall and a moat. Within this area is a walled palace site. Some inscriptions in Pyu and silver coins similar to the ones found at Hmawza are evidence of its association with the Pyu. Evidence for the survival of the Pyu after the Burmese expansion can be seen in the Pyu inscriptions from Pagan, one of which—the Pyu face of the Rajakumar inscription—is dated A.D. 1113.

At Pagan innumerable religious monuments and inscriptions testify that it was the centre of a strong and expanding Burmese state from the 11th to the 13th century. The variety of languages (Sanskrit, Pali, Mon and Pyu) in which religious records were inscribed before Burmese predominated indicate the different cultural influences to which Pagan was exposed. The earliest inscriptions found at Pagan are some seals of Aniruddha in Pali and Sanskrit. Next in sequence are the Mon inscriptions of Htiluin Man (Kyanzittha). The Rajakumar inscription dated A.D. 1113 is the earliest dated record inscribed in the Burmese language. From this date Burmese inscriptions become very numerous, and although they primarily record pious gifts and dedications, they are also a major source of the political and social history of the Burmese during the next four centuries.

The monuments of Pagan consist of stupas, temples, monasteries, libraries and ordination halls, the design and decoration of which reflect the influence of northeastern India, Ceylon, Sri Ksetra and Thaton upon the religious architecture of Pagan. But by the end of the 12th century there was a distinctly Burmese style of temple architecture of which the Shwegugyi, Thatbyinnyu, Sulamani, Htilominlo and Gadawpalin are examples. The earlier Pathothamya, Nagayon, Abeyadana, Kubyaukkyi and Nanpaya represent the Mon style in religious architecture at Pagan, and the Ananda and Dhammayangyi are considered intermediate forms. There have been few innovations in Burmese religious architecture since the Pagan period. Secular buildings, including palaces of kings, have not survived because they were of wood.

At Thaton and Pegu, centres of two medieval kingdoms of the Mon, few antiquities can be dated with any certainty; an important exception is the Kalayani inscription, in Pali and Mon, of Dhammaceti, king of Pegu, which is dated A.D. 1476. (*See* also Indian Architecture: *Malaysia: Burma.*) (C. A. Ru.)

V. HISTORY

Burma is mentioned in Ptolemy's geography (*c.* A.D. 140) and in Chinese records somewhat later, a few brief sentences in all. The inhabitants must already have comprised two main stocks, overlaying Negrito and other primitive types: (1) Mediterranean, still occupying the remoter hills untouched by successive civilizations, for example the Naga tribes in north Burma, who are head-hunters and cousins of the Dayak now in Borneo but still on the mainland of Indochina in the 1st century B.C.; and (2) Mongoloid, now long predominant in the populous plains but so intermingled with other stocks as to be often indistinguishable.

N BUCHER—PHOTO RESEARCHERS, INC.

HE DESERTED PAGODA CITY OF PAGAN, SHOWING BUDDHIST TEMPLES IN ARIOUS STAGES OF DISREPAIR

Civilization arrived from India, Chinese influence being absent throughout. But save for its Buddhist content it remained an alien civilization. It spread from the coast into the great central plain; most of the hills, even the hills nearest India, were beyond its reach. Yet the people of the plains retained their own customs; the caste system struck them as so strange that to this day their word for Indians is *kala,* "the caste people," from an old Indian word for caste. Indians had made their way into Burma long before, but the great expansion of Indian shipping in the 1st century A.D. was decisive: Hindus and Buddhists, missionaries as well as traders, could now settle as far afield as Indochina and Java, along the coast and up the rivers in the interior.

The earliest inscriptions are of the 5th–7th centuries A.D., at Prome just above the Irrawaddy delta; some are in the local language, Pyu, but in Kadamba (Bombay) script; and they give the king Indian titles. In the 8th century the Pyu were defeated, apparently by the Karen and Mon; they fled north to Shwebo and, as tributaries to the powerful Shan kingdom of Nanchao (Yünnan), sent missions to China in 800–802; but in 832 the Nanchao army sacked their capital and deported its citizens, the language died out and the people merged with the surrounding races.

The other people attested at this time are the Mon or Talaing. They held most of Thailand and in their westward expansion into Burma established themselves in strength round the Gulf of Martaban with Martaban, Thaton and Pegu as their centres. Kyaukse marked the limit of their northward advance. They introduced wet rice cultivation into Burma. Their 8th-century inscriptions are in Pallava (Madras) script; and the name Talaing is derived from Telingana, the Pallava country from which they derived their civilization. There are, save for some in Thailand, less than 400,000 Mon, mainly near Moulmein, distinguishable from the Burmese only in language. Yet it is they who gave Burma its writing and its religion, Buddhism. Archaeological remains, whether Pyu or Mon, show that the imported religion, displacing the native animism, was as often Hindu as Buddhist; it is probably the Mon connection with the great Hinayana centre at Kancheepuram (Madras) that began to tip the scale in favour of Buddhism.

The Burmese proper came from the north from the hills east of Tibet. They were among the tribes subject to the kingdom of Nanchao, entering the Irrawaddy plain probably after the overthrow of the Pyu in 832. They settled at Kyaukse, where, among the Mon, they could evade the unending conscription that Nanchao inflicted on its peoples; and there they began to write their language, using the Mon script, and to absorb the Buddhist religion. From Kyaukse they spread westward to Minbu and thence over the hills, where finally they founded the kingdom of Arakan. But their main centre was Pagan on the left bank of the Irrawaddy river

1. Kingdom of Pagan, 1044–1287.—In the mid-11th century the Burmese under their king Aniruddha (Anawrata), who reigned at Pagan from 1044 to 1077, advanced northward against the Kadu up to the Irrawaddy-Shweli junction. In the south they captured the whole of lower Burma from the Mon. After Aniruddha's death the Mon rebelled but were pacified by Kyanzittha who was elected king in 1084. Kyanzittha's policy was to adopt Mon culture and to consolidate the whole of Burma under one central authority. Following a Sinhalese invasion there was a period of unrest between 1165 and 1174: then Aniruddha's line was restored with Sinhalese help. There was a marked difference between the earlier culture of Pagan which was under Mon influence and the later culture which came to be regarded as Burmese.

Aniruddha's dynasty, the Dynasty of the Temple Builders, gave Burma its golden age, the flowering time of its art. Many brick temples and buildings have survived around Pagan, but even so, the inscriptions state that wooden buildings were predominant.

The downfall of the kingdom came when the Wa-Palaung tribes in the north, resenting the spread of Burmese power, brought their grievances to the notice of the Mongol emperor of China. In 1273 the emperor Kublai Khan sent three ambassadors to Burma to demand homage and they were never heard of again. It was not until 1287, however, that the Mongol armies invaded Burma. Pagan was captured and was garrisoned by Mongol troops from 1287 to 1301.

2. Shan Period, 1287–1531.—After the Mongol invasion the Pagan kingdom split into states under Shan princes from the hills near Kyaukse. They had served the Pagan dynasty and taken the lead in resisting the Mongol. Their official language was Burmese; they and their people had long shared the Buddhist culture of the Burmese.

Most Burma languages, whether hill or plain, belong to the western or Tibeto-Burman subfamily, but Shan is different, belonging to the eastern or Tai-Chinese subfamily of Tibeto-Chinese. The Nanchao kingdom was Tai, *i.e.*, Shan, the same word as Siam; and in Burma, people of this subfamily still dominate the Shan states, occupying the fertile valleys and leaving the bare hills to earlier tribes. The Mongol conquest of Yünnan drove them south to displace the Mon in Thailand and the Khmer, the builders of Angkor, in Cambodia. There they became civilized; but the rear guard remained barbarous and it was this rear guard that began, late in the 14th century, to overrun the Pagan succession states till Burman and burmanized Shan alike fled south to Toungoo.

The Mon retained the farther south. Their dynasty at Pegu, though partly of Shan descent, repelled all attacks from the north; and it produced Shin Sawbu (1453–72), the only queen regnant of Burma, where, however, the status of women has always been high. Shin Sawbu enlarged the Shwe Dagon pagoda at Rangoon, giving her own weight in gold to gild the famous spire; and she left so gracious a memory that centuries later the Mon could find no fairer thing to say of Queen Victoria than to call her Shin Sawbu reincarnate.

RICHARD HARRINGTON—THREE LIONS, INC.

EXTERNAL VIEW OF THE LONG ARCADE LEADING INTO THE SHWE DAGON PAGODA. THE GRADATION OF THE ROOF RESULTS FROM THE NUMEROUS STEPS INSIDE, WHICH ASCEND TO THE INTERIOR OF THE SHRINE

3. Early European Contact.—The first European to reach Burma, about 1435, was a merchant of Venice. Further Italian trading prospectors followed, Santo Stefano in 1496 and Ludovico di Varthema in 1505. A Portuguese envoy came from Malacca in 1511 to promote trade. Later, Portuguese mercenaries and firearms played a decisive part in the conquests of the Burmese king Bayinnaung. Felipe de Brito, with 50 companions, made himself king of Syriam in 1600 and ruled the delta coast for 13 years. In 1550 several hundred Portuguese seized Chittagong, then under Arakan, making it one of the most dreaded pirate centres in the Indian seas and helping the king of Arakan, the only ruler in Burma who had a navy, in his slave raids up the Ganges delta; in 1666 the Mogul emperor's forces destroyed them and ended the prosperity of Arakan. (G. E. Hy.; T. Tu.; X.)

4. Toungoo Dynasty, 1531–1752.—After the breakup of the Pagan kingdom, Toungoo in the Sittang valley became a new centre of Burmese power, and when the Shans conquered Ava in 1527 so many Burmese chiefs came to Toungoo that its rulers were able to restore Burmese control over the whole country. Tabinshwehti (1531–50) conquered the rich Mon kingdom of Pegu and much of central Burma, making Pegu city his capital. But a Mon rebellion cost him his throne and his life. His brother-in-law Bayinnaung saved the situation: he crushed the revolt and became king in 1551. His career as a conqueror was perhaps the most remarkable in Burmese history. He subjugated the Shans, conquering Ava and extending Burmese suzerainty over the great block of principalities forming the Shan state in the modern Union of Burma. Chiengmai and Luang Prabang also came under his control, and finally the largest and richest of all the Tai states, Thailand, with its capital at Ayutthaya. His megalomania, with its impossible demands upon manpower which ruined the agriculture of the Mon country, and the cruel deportations of people from conquered territories brought its own nemesis, for during the reign of his son Nanda Bayin (1581–99), Thailand under the leadership of Phra Naret (King Naresuan) freed itself. Thousands of the Mon fled from Burmese tyranny to Thailand, and under the stress of internal rebellions coupled with Thai and Arakanese invasions Burma again broke up into fragments without any central control.

In 1613 Anaukpetlun, a grandson of Bayinnaung, reunited the country, restored Pegu as its capital, recovered Chiengmai, and planned a new invasion of Thailand. He was removed, however, in favour of his brother Thalun (1629–48), who abandoned the policy of expansion, moved the capital to Ava in the Burmese heartland, and revived Burmese traditionalism and isolationism. The impoverished Mon country stagnated until the British conquest of 1852. During the following century the court of Ava also stagnated until in 1740 the Mon suddenly threw off the Burmese yoke and installed their king again at Pegu. In 1752 they captured Ava and the Toungoo dynasty finally collapsed.

The Dutch and English East India companies had opened depots in Burma in Thalun's reign. These did not prosper but from the end of the century the English were regularly sending ships to Syriam for repairs. The French at Pondicherry, urged on by Joseph Dupleix, began to follow suit in 1729. During the 1730s both English and French were building teak ships there, until the Mon revolt brought these activities to an end. Dupleix, as governor of Pondicherry, saw in the revolt an opportunity to establish French influence in Burma and sent such aid as could be spared, and an agent, the Sieur de Bruno, to reside at Pegu. The English replied by seizing the island of Negrais (Hainggyi) at the mouth of the Bassein river in 1753. Mon dominance over upper Burma, however, soon collapsed and from the early months of 1754 they were on the run before a new Burmese resistance leader hailing from Shwebo, who assumed the royal title as Alaungpaya ("Embryo Buddha"). In 1755, at the end of a lightning campaign into the Mon country, he founded a new port, to be called Rangoon, at the Mon fishing village of Dagon, famous for its pagoda (Shwe Dagon). He persuaded the British at Negrais to supply him with weapons. Then, in 1756, he destroyed Syriam, executing Bruno and taking several shiploads of military equipment. Pegu and the rest of the kingdom fell in 1757.

5. Alaungpaya Dynasty, 1752–1885.—Alaungpaya was the founder of the last dynasty in the history of Burma. He established effective control over the whole area previously under the

WING GALLOWAY

DANCERS PERFORMING IN TRADITIONAL COSTUME

way of the Toungoo dynasty. He also dealt out frightful punishment to the Meithei who had been raiding Burma. He occupied mphal and deported thousands of its inhabitants. Finally he nvaded Thailand and his meteoric career ended in 1760 through n accidental wound sustained while directing the siege of Ayutthaya. In 1759 he had destroyed the British settlement at Negrais ecause of a rumour it had helped the rebel Mon. The East India ompany then withdrew the rest of its personnel from Burma.

The Alaungpaya dynasty led Burma in an orgy of expansionism, which was only brought to an end by defeat in the first Anglo-Burmese war of 1824–26. Hsinbyushin overran Thailand and estroyed Ayutthaya in 1767. He failed to retain his conquest ecause he had to meet a series of Chinese invasions from Yünnan ut later Bodawpaya, who reigned from 1782–1819, revived the truggle to dominate Thailand. He failed, and the war became a matter of raids and counterraids. The destruction of the Mon ingdom, and the frightfulness of suppressing rebellions in 1773 nd 1783, caused a second great exodus to Thailand.

Bodawpaya's conquest in 1784–85 of the kingdom of Arakan rought in a new era of Anglo-Burmese relations, for thousands f Arakanese fled to the British-held Chittagong area, and nationalist leaders began to use it as a base for attempts to recover their country. The British failure to cope adequately with this situa- on embittered relations with the Burmese, and when in 1820 urma proceeded to conquer Assam and its neighbour Manipur, he British had to act, for hordes of refugees poured into Bengal nd rulers of states threatened by the Burmese begged for protec- on. And it was also clear that the Burmese generalissimo Bandula lanned to strike at Calcutta.

The first Burmese War resulted in the cession to British India f Assam and the two long coastal strips of Arakan and Tenas- erim. As a means of preventing further trouble a Burmese minis- er was to reside in Calcutta and a British resident at Ava. Diffi- ulties arose at once. The court of Ava would not send a minister o reside in Calcutta but was willing to receive a British resident n the hope of using him to bring pressure upon the government of ndia to restore what had been lost in the peace treaty. Henry Burney, who was British resident from 1830 to 1837, established good relations with King Bagyidaw and his ministers, but all relations ceased with the revolution which placed Tharrawaddy on the throne in 1837. He publicly denounced the peace treaty of 1826 and forced the withdrawal of the British resident. Another war was then only a matter of time, especially when central control over the administration weakened in the reign of the inept Pagan Min, and an outrage committed by the governor of Rangoon upon British subjects provoked Lord Dalhousie, the governor-general of India, into a course of action which made a peaceable solution impossible (*see* DALHOUSIE, JAMES ANDREW BROUN RAMSAY). The second Burmese War of 1852 led to the annexation of the potentially wealthy province of Pegu. It also led to the deposition of Pagan Min early in 1853 in favour of Mindon Min, the most honoured today of all the monarchs of his line.

Mindon made great efforts to modernize his country. He minted Burma's first coinage, constructed a telegraph system, instituted fiscal reforms, developed state enterprise by running a fleet of river steamers and erected factories, using European machinery. In 1871 he convoked at Mandalay, his new capital, the Fifth Buddhist council; *i.e.*, the fifth in the history of the religion. Toward the end of his reign Anglo-Burmese relations deteriorated, partly over the king's measures to control trade. When Mindon died in 1878, a reactionary group placed a younger son Thibaw on the throne and proceeded to control him through his wife Supayalat. His revival of the traditional "massacre of the kinsmen" caused the withdrawal of the British resident and the renewal of the demand for intervention which had come from commercial interests in Mindon's time. Thibaw's negotiations with France (1883–85) and his clumsy attempt to mulct the Bombay-Burmah Trading company of a huge sum of money for alleged infringements of its timber extraction licences forced the British government to take action. A British ultimatum demanding arbitration in the timber case and the submission of his external relations to the control of the Government of India was rejected by Thibaw and the third Burmese War followed. A British force was sent to occupy Mandalay (Nov. 1885), and Thibaw and Supayalat were deported to India. After much discussion of alternatives the decision was taken to annex the kingdom and its feudatory states and to form the whole of Burma into a province of the Indian empire (Jan. 1, 1886).

6. British Burma.—In 1862 Pegu, Arakan and Tenasserim were amalgamated to form the province of British Burma. Because of the immense strength of national feeling the "pacification" of Burma after the further annexations of 1886 took several years and involved the remodeling of the administration along British-Indian lines. Under the Morley-Minto reforms of 1909 Burma's legislative council was given a nonofficial majority, and although popular election was not introduced, it became clear during World War I that responsible self-government was the goal of British policy for India. When Burma was excluded from the scope of the Government of India act of 1919 introducing dyarchy to the Indian provinces (*see* INDIA-PAKISTAN, SUBCONTINENT OF), Burmese national feeling burst into such a storm of protest that the British parliament in 1921 extended the system to Burma. Burma also received five seats in the new Indian legislature at New Delhi. Afterward recruitment to the highest grade of the civil service, hitherto almost confined to the British, was placed upon a 50-50 basis. The next step toward full self-government was taken in 1937 when Burma was separated from India and came directly under the British parliament. The general administration was entrusted to a cabinet of ministers, limited to ten, responsible to a bicameral legislature. Important powers were still reserved to the governor.

Expansion of Trade.—The British annexation of Pegu was the prelude to a vast expansion of rice production in the Irrawaddy delta region. Rice exports grew until just before the Japanese invasion in 1942 they were about 3,000,000 tons, just under two-fifths of total world exports. Teak remained an important article of export, and after the annexation of Upper Burma the expansion of the activities of the forest department ultimately provided the state with 20% of its total revenue. Petroleum, mainly from the Yenangyaung oil field, became important after 1900, as did tungsten and tin from Mawchi and Tenasserim, and lead and silver from the great Namtu mine in the Shan states after 1914. Most of Burma's trade, both export and import, was with Asia. India was by far its biggest supplier and customer.

World War II and After.—Japan's entry into the war in 1941 and the capitulation of Thailand led to the Japanese invasion of Burma. By the end of May 1942 the remnants of the British Burma army had retreated into the Manipur hills. The Burma Independence army, which had been recruited in Bangkok by the Japanese-trained "Thirty Heroes," members of the Burmese Dobama Asi-ayon (Thakin) party, marched in with the Japanese but was soon disbanded by them for indiscipline and banditry. A civil administration under Ba Maw was set up, and on Aug. 1, 1943, Burma was declared an independent state. In Ba Maw's cabinet Aung San, one of the "Thirty Heroes," was in charge of defense and U Nu of foreign affairs. A small Burma National army (the B.N.A.) was organized under Ne Win.

The Japanese occupation was disastrous to Burma's economy. In 1945 the B.N.A., switched to the British side by Aung San, harried the retreating Japanese. Aung San now became the national leader and his creation, the Anti-Fascist People's Freedom league (the A.F.P.F.L.), had overwhelming support throughout Burma. Demanding complete independence, Aung San and his associates won their way into the governor's council in Oct. 1946, and Britain's Labour cabinet expressed its willingness to accept the verdict of the Burma electorate. The A.F.P.F.L. won a complete victory in the elections for a constituent assembly and Aung San secured the agreement of the hill peoples—except the Karens—to his proposals for a Union of Burma. On July 19, 1947, he and several of his closest associates were murdered at a cabinet meeting, but under his successor U Nu, Burma's progress toward independence went ahead. On Oct. 17, 1947, a treaty was signed with Britain under the terms of which the independent republic of the Union of Burma came into existence at 4:20 A.M. (hour chosen by astrologers) on Jan. 4, 1948.

7. Independence.—The new state had a western parliamentary constitution based upon adult suffrage. There were to be separate Shan, Kachin, Karen and Kayah states and a special division for the Chins. U Nu's government was Socialist with a program of nationalization. But it had to fight for survival against almost universal disorder complicated by a Communist rebellion, a Karen rising, which was far more serious, and, in 1950, the arrival from Yünnan of General Li Mi's Kuomintang division after its rout by the Chinese Communists. Gradually the government gained the upper hand and with the passing of the most dangerous phase of disorder was able to take measures for the burmanization of the big European business concerns and to deal with the distribution of land, the problem of agricultural indebtedness and the marketing of Burma's chief article of export, rice. After June 1953 world rice prices gradually weakened. Burma had therefore to seek new markets and thus came to develop economic relations with the Chinese People's republic, Japan and the U.S.S.R. In foreign policy U Nu espoused Indian Prime Minister Jawaharlal Nehru's neutralism.

Relations with China became increasingly important after the Communist victory of 1949 in that country. Burma was one of the earliest states to recognize the new regime. In 1954 it refused to join the Southeast Asia Treaty Organization. Disputed frontier questions were settled by a treaty signed at Peking in 1960. A treaty of friendship and nonaggression was signed the same year. But China's cultural revolution caused relations to cool; in June 1967 pro-Communist China rallies caused riots against local Chinese, and Rangoon was placed under martial law for a month. China in retaliation discontinued its economic aid to Burma. In 1969 Chinese construction battalions were reported to be building strategic roads in Kachin State.

After the general election of 1956 serious trouble began to develop inside the A.F.P.F.L., which caused U Nu to hand over the premiership temporarily to U Ba Swe. U Nu resumed office in Feb. 1957 but in Oct. 1958 resigned in favour of General Ne Win, the army chief of staff, who pledged himself to restore internal peace. A general election held on Feb. 6, 1960, resulted in a victory for U Nu's wing (the "Clean Wing") of the A.F.P.F.L. and U Nu took office again as prime minister on April 4. The "Clean Wing" was renamed Pyidaungsu (Union party). On March 2, 1962, General Ne Win, backed by the army, arrested U Nu, suspended parliament and proclaimed a new anti-Communist government under a Revolutionary council. Its policy outlined in its manifesto *The Burmese Way to Socialism* was to nationalize the whole economy, including banking, and abolish private enterprise. "Burma for the Burmese" became the guiding principle, and vast numbers of Indians, among other foreigners, were expelled. The Burma Socialist Program party was the only political party allowed. Many politicians, trade union leaders, and journalists were taken into custody; the majority were not released until 1968. Education and the universities were completely reorganized and brought under government control. In contrast to the emphasis placed by the Nu regime on industrialization, the improvement of agriculture became the military regime's chief economic concern, but rice production dropped alarmingly. The measures to nationalize the retail trade provoked failures in distribution and in 1967 there were food riots in no less than 20 towns. The year 1967 was one of economic crisis. (D. G. E. H.)

VI. POPULATION

Burma is essentially a rural country, perhaps more accurately described as a country of villages. There are fewer than 300 urban groupings which could be classified as towns (about one-third with municipalities). Most Burmese (about 85% of the nation's population) live in more than 50,000 villages. The average density according to 1964 estimates was about 85 persons to the square mile; in the thickly populated delta districts this could exceed 200.

The capital is Rangoon (pop. [1962 est.] 800,993). Other major towns are Mandalay (198,974), Moulmein (112,373) and Bassein (262,453). Smaller towns such as Sittwe, Taunggyi, Pyè and Pegu are ports, collecting and distributing centres, hill stations or have achieved some importance as headquarters of districts. The dry belt is the natural geographical centre of Burma and therein lie the old Burmese capitals: Pagan, Shwebo, Ava, Amarapura and Mandalay, with Prome on the southern border. In 1941 the population was 16,823,798. In 1966 it was estimated to be 25,246,000. (M. Z.)

VII. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution.—The independent republic of the Union of Burma came into existence on Jan. 4, 1948, with a western parliamentary constitution based on adult suffrage. On March 2, 1962 the government was overthrown by a military coup led by Gen. Ne Win, chief of staff of the armed forces. Western parliamentary democracy was discarded as being inappropriate to the needs of Burma. (See *History* above.)

2. Administration.—Administrative divisions are: Arakan 14,194 sq.mi. (36,762 sq.km.) (Akyab, Kyaukpyu and Sandoway districts); Pegu, 19,423 sq.mi. (50,305 sq.km.) (Rangoon, Pegu, Tharrawaddy, Hanthawaddy, Insein and Prome); Irrawaddy, 13,578 sq.mi. (35,167 sq.km.) (Bassein, Henzada, Myaungmya, Maubin and Pyapon); Tenasserim, 21,297 sq.mi. (55,159 sq.km.) (Thaton, Amherst, Tavoy, Mergui and Toungoo); Magwe, 17,297 sq.mi. (44,800 sq.km.) (Thayetmyo, Minbu, Magwe and Pakokku); Mandalay, 13,225 sq.mi. (34,526 sq.km.) (Mandalay, Kyaukse, Meiktila, Myingyan and Yamethin); Sagaing, 38,282 sq.mi. (99,150 sq.km.) (Shwebo, Sagaing, Katha, Upper Chindwin and Lower Chindwin [Bhamo, Myitkyina, Naga Hills]); the Shan State, 61,090 sq.mi. (158,222 sq.km.); Kawthule State, 11,091 sq.mi. (28,725 sq.km.); Kachin State, 33,903 sq.mi. (87,808 sq.km.); Kayah State, 4,506 sq.mi. (11,670 sq.km.); and the Chin Hills Special Division, 13,903 sq.mi. (36,000 sq.km.).

All administrative officers have been made members of security and administrative councils that include officials and nominated representatives of the public and always have an army officer as chairman. Even so, real power throughout the country rests with the cadres of the Burma Socialist Program party. There have been extensive pockets of insurgency in many parts of Burma. The rebels included the Mon, Karens, Kachins, Shans, Padaungs, Kokang Chinese and White-Flag and Red-Flag Communists. In the late 1960s the government claimed considerable success in its long-fought battle against insurgency.

3. Political Parties.—The internecine warfare of the old political parties was a chief cause of the coup on March 2, 1962. On July 4, 1962, as foreshadowed in the *Burmese Way to Socialism*, he Revolutionary council formed the Burma Socialist Program arty to mobilize the support of the masses for the principles in hat manifesto. Beginning in Aug. 1963 most of the leaders and nfluential members of the other parties were imprisoned. In March 1964, all Burmese political parties except the Burma Social- st Program party were dissolved, and their property and assets confiscated. Burma became a one-party state. The revolutionary government released political detainees in batches after the end of 1966 when U Nu was released. In Dec. 1968 an advisory board consisting of some former political leaders was formed to uggest measures for strengthening the fabric of national unity.

4. Living Conditions.—The vast majority of the people of Burma are peasant cultivators living in villages, many building heir own houses of bamboo and thatch. Landlords have disap- eared as a class, and most cultivators are in practice owners of heir land, paying land revenue to the state and living on the proceeds of cultivation. The government has followed a vigorous policy of state ownership of the means of production, distribution nd external trade. Virtually all industrial and commercial under- akings, whether foreign or indigenous, have been nationalized. here are acute shortages in parts of the country because of fail- res in the system of distribution.

OSS MADDEN FROM BLACK STAR

AMBOO HOUSES AND TEMPLE BUILDINGS ON A HILLSIDE NEAR THE VILLAGE F TAUNGGYI, CENTRAL BURMA

5. Welfare Services.—Burma has little to show in the area of ublic welfare apart from the medical and public health services, nd even these are seriously short of doctors. With the help of he World Health organization much has been done toward eradi- ating malaria. In fact, Buddhist charity and the tradition of fam- y responsibility have rendered unnecessary much of the care hich must be officially provided in western countries.

6. Justice.—Civil and criminal justice is administered by dis- ict and sessions judges and district magistrates, and by subordi- ate courts with widely varying powers. On March 30, 1962, the preme and high courts were abolished and the chief justice im- risoned. A new chief court was set up to replace the abolished urts, but its judges could be dismissed by the Revolutionary uncil. The law administered has not generally been repealed or nended; instead it is interpreted in line with the Burmese So- alist program. There is a civil police force, now known as a preventive force, and about 29 prisons. A jail to receive 3,000 political prisoners was constructed after 1959 on the Cocos Islands. More important prisoners are held at Insein or Mingaladon.

7. Education.—World War II disastrously affected education. In the 1950s a great effort was put into its rehabilitation. In the mid-1960s there were about 13,900 state primary and about 1,500 state secondary (middle and high) schools, with approximately 1,186,000 and 871,000 pupils, respectively. In 1964 Burmese was made the sole language of instruction. In the background are about 40,000 monastic schools inculcating a respect for religion, rudimentary education and a certain discipline, a tradition dating from the 8th century but of little academic value. A number of private (mostly mission) schools continue, in the face of great difficulties, to provide education of a better standard.

University education was reformed in Nov. 1964, by decentralizing organization, by emphasizing the more practical and technical aspects of the curriculum and by requiring the inculcating of socialist moral values. Security clearance was enforced to exclude political nonconformists. The University of Rangoon (founded in 1920) was reorganized into the Arts and Science University and six professional institutes (medicine, technology, education, economics, animal husbandry and veterinary science). The University College of Mandalay, which became a university in 1958, was reorganized into the Arts and Science university and the institutes of medicine and agriculture. Colleges were created at Moulmein and Bassein and intermediate colleges at Taunggyi, Magwe and Myitkyina. There was also the Defense Services academy at Maymyo. In the mid-1960s there were ten institutions of university rank in the country, with a total of about 25,000 students.

The Central Services Training school at Paunggyi in Insein district trains public servants in the concepts of the *Burmese Way to Socialism.* Basic military training forms a fundamental part of the program; other subjects include political and social studies, fiscal law and accounting. Emphasis is also placed on agriculture and animal husbandry. (F. S. V. D.; M. Z.)

VII. THE ECONOMY

1. Agriculture and Fisheries.—Burma is essentially an agricultural country. Agriculture, which employs more than 66% of the working population and accounts for about 75% of exports, is concentrated on the alluvial lands of the delta and the valleys of the Irrawaddy, Chindwin and Sittang.

At the time of the British annexation of Burma there were some old irrigation systems in the Kyaukse and Minbu districts and these were renewed and extended. In addition, the Mandalay canal, 42 mi. (67 km.) in length, with 14 distributaries, was opened in 1902; the Shwebo canal, 27 mi. (43 km.) long, was opened in 1906, and later two branches 29 mi. (46 km.) and 20 mi. (32 km.) in length; and the Mon canal, 53 mi. (85 km.) long, was started in 1904. Before World War II more than 1,500,000 ac. (607,000 ha.) were devoted to fruit, vegetable and tobacco growing, and 400,000 ac. (161,880 ha.) were under cotton. Excluding the Shan state and certain hill tracts, in the late 1950s about 21,826,000 ac. (8,832,982 ha.) of land were classed as cultivable waste, as against 21,241,000 ac. (8,596,232 ha.) of "occupied" land; 14,953,000 ac. (6,051,479 ha.) of land were sown to crops. The Revolutionary council has nationalized land and appointed a Central Land Reclamation committee to bring under cultivation about 2,000,000 ac. (809,300 ha.) of "lost" paddy land in the Pegu and Irrawaddy divisions. There has been an increase in the sown acreage of many crops. In the mid-1960s estimated sown acreage for the whole country was about 19,721,000 (7,980,764 ha.). The main crops were: rice 12,593,000 ac. (8,181,000 tons); pulses 2,580,000 ac. (353,000 tons); peanuts 1,803,000 ac. (522,000 tons); sesamum 1,601,000 ac. (113,000 tons); cotton 672,000 ac. (78,000 tons); maize 364,000 ac. (110,000 tons); sugarcane 108,000 ac. (1,388,000 tons).

In the late 1930s the number of rubber plantations increased in spite of restrictions on output, and Burmese production of crude rubber reached an annual average of 9,000 tons, the main producing areas being Mergui and Tavoy. In the mid-1960s production was maintained above 10,000 tons yearly.

(TOP LEFT) VAN BUCHER—PHOTO RESEARCHERS, INC., (LEFT) EWING GALLOWAY, (ABOVE) RICHARD HARRINGTON THREE LIONS, INC

(TOP LEFT) WOMAN TENDING MODERN SILK THREAD MACHINE IN SILK MANUFACTURING PLANT, MAYMYO, UPPER BURMA. (LEFT) WATER BUFFALO PULLING A PLOW. (ABOVE) WOMAN STRETCHING LINE, TO MAKE ONE OF THE LARGE FISH NETS (BEHIND) ON THE BANKS OF THE IRRAWADDY RIVER

Small humped oxen are kept everywhere as beasts of burden and for use in plowing. They are replaced to a considerable extent in the delta and wetter areas by the heavier water buffalo. Herds of small goats are numerous in the Dry Belt, and small numbers of poorly bred sheep are reared.

Fisheries and fish curing exist along the seacoast of Burma and in inland tracts. Salted fish, especially freshwater varieties, along with boiled rice, forms one of the chief items of food among the Burmese. A little mother-of-pearl is gathered in the Mergui archipelago (see *Physical Geography: Vegetation* above for forestry).

2. Minerals.—The mineral wealth of Burma is considerable but in many cases little developed. Petroleum is the most important mineral. Production declined drastically during World War II. In Jan. 1963 the Burmese Oil company was nationalized. Estimates for production in the mid-1960s were: crude oil 160,874,000 gal.; gasoline 47,581,000 gal.; kerosene 25,303,000 gal.; other fuel oil 63,563,000 gal.

Extensive deposits of brown coal (lignite) occur, chiefly in the Chindwin valley and in old lake basins in the Shan plateau, but production was negligible and ceased entirely in 1926. Oil shale is also found in the latter region. Silver-lead ores occur at Bawdwin in the north Shan state. Output of silver amounted to 6,194,151 oz. in 1939 and was below 800,000 oz. in the early 1960s; in this same period lead production declined more than 75%.

There are deposits of tin and tungsten in Tenasserim and Yamethin and in the Kayah state. Annual production of tin ores and concentrates in the mid-1960s amounted to about 780 tons; of tungsten ores and concentrates to about 90 tons; of mixed tin and tungsten to about 1,300 tons. Production of lead amounted to 32,500 tons and of zinc to nearly 15,000 tons.

The Burma ruby mines, after many vicissitudes, went into liquidation in 1925–26 and are now unimportant. The famous jade of China was found in the north of Burma and exported overland to China via Mogaung and Bhamo. The mines are situated beyond Kamaing, north of Mogaung, in the Myitkyina district. The miners were all Kachins, and the right to collect the jade duty of $33\frac{1}{3}\%$ was farmed out by the government to a lessee, who before World War II was always a Chinese. The amount obtained varied considerably. The value of the jade varies enormously according to colour, but semi-transparency, brilliancy and hardness are essentials. There is a fluctuating but considerable production and export.

Gold is found in many rivers of upper Burma. Production of minerals fell in the 1940s and had not reached prewar levels by the 1960s. Amber is found in the Hukawng valley, but is of poor quality. Salt is manufactured in various places. The occurrence of natural gas near Thayetmyo led to the establishment of a cement industry.

3. Industries.—Agriculture has always been the staple industry of Burma, but by the 1960s the government was encouraging new manufacturing industries. Prior to this the principal occupations apart from farming and forestry were rice husking, silk weaving and dyeing. The most important of the nonagricultural manufacturing industries was that connected with the working and refining of oil.

The introduction of cheap cotton and silk fabrics dealt a blow to hand weaving, while aniline dyes began to drive out the native vegetable product; but both industries lingered in the rural tracts. The best silk weavers are to be found at Amarapura. The chief dye product of Burma is cutch, a yellow dye obtained from the wood of the *sha* tree (*Acacia catechu*). Cutch boiling forms a means of livelihood of a number of the poorer classes in the Prome and Thayetmyo districts of lower Burma, and a subsidiary means elsewhere. Cheroot making and smoking are universal with both sexes.

The state runs the Burma Pharmaceutical industry (B.P.I.) and modern industrial developments include the making of gunny bags (since 1957), cigarettes, textiles, sugar and bricks and tiles. The Baluchaung hydroelectric power project in Kayah state, completed in 1960, supplies power to Rangoon.

The chief arts of Burma are lacquer working (centred at Pagan), wood carving and silverwork. The floral wood carving is remarkable for its freedom and spontaneity. The carving is done in teakwood when it is meant for fixtures, but teak has a coarse grain, and for other purposes *yamane* clogwood, said to be a species of *Gmelina*, is preferred. The tools employed are chisel, gouge and mallet. The design is traced on the wood with charcoal, gouged out in the rough and finished with sharp fine tools, the mallet being used for every stroke. The great bulk of the silverwork is in the form of bowls of different sizes, in shape something like the lower half of a barrel, of betel boxes, cups and small boxes for lime. In wood carving and silverwork Burmese art objects generally display boldness of design but suffer from want of careful finish.

4. Trade and Finance.—Approximately 86% of the foreign rade passes through Rangoon. Other leading ports are Bassein, a rice port on the west of the delta, Sittwe, the outlet of Arakan, and Moulmein, Tavoy and Mergui, which serve the Tenasserim division. The principal exports are normally rice, oil cake, timber, ubber and cotton. The principal imports are textiles, tobacco, paper, rubber products, machinery and hardware. In the late 1960s he main export destinations were: India, Japan, China, the U.K. nd West Germany. The main import sources were: Ceylon, China, Indonesia, Malaysia, Pakistan and the U.K.

The unit of currency is the kyat (which replaced the Burma rupee on July 1, 1952) of 100 pyas with a par value of 4.64 kyats o the U.S. dollar (1 kyat = 1*s*. 9*d*.). Estimates for 1966–67 were: revenue, 11,363 million kyats; expenditure, 11,333 million kyats. The share capital of the Union Bank of Burma is owned by the state. In February 1963 all private banks, including branches of foreign banks, were nationalized. They then became known as People's Banks.

5. Communications.—From early times the principal highway of Burma has been the Irrawaddy (*q.v.*) and its tributaries. The rrawaddy is navigable up to Bhamo, about 900 mi. (1,448 km.) rom the sea, and the Chindwin for nearly 400 mi. (644 km.). The rrawaddy delta has about 1,700 mi. (2,735 km.) of navigable water. Railways tended to supplement rather than replace the ivers as highways of trade. The railways, all of metre gauge and ,667 mi. (4,292 km.) in length (1941), were taken over by the overnment in 1929. Damage in World War II reduced their ength to 1,777 mi. (2,860 km.). By the 1960s restoration had been steady but not complete (1,858 mi. [2,990 km.] in 1964). A Rangoon Circular railway was completed in 1959. The main line runs from Rangoon to Mandalay (386 mi. [621 km.]), crosses he Irrawaddy by the Ava bridge (1934) and continues to Myitkyina. A direct service between Prome-Rangoon-Ye was introduced in 1964. There was no railway connection with India nor with any other country by the 1960s and Yenangyaung, in the oil elds, was not accessible by rail. The Burma road (*q.v.*) was the ne transfrontier route that became famous during World War II. By the mid-1960s there were more than 15,000 mi. (24,000 km.) of oads in Burma. Union of Burma Airways has a network of internal services, and international services are maintained with Bangkok, Calcutta and Chittagong.

In the mid-1960s there were about 19,000 telephones, more than hree-quarters of them in Rangoon. Foreign communication links were provided by radiotelephones or direct wireless telegraph nes. The Burma Broadcasting service operates from Rangoon.

See also references under "Burma" in the Index.

(L. D. S.; M. Z.)

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BURMA ROAD, originally a 681-mi. highway from K'unming, Yünnan Province, China, to Lashio in Burma, constructed as a supply route from interior China to the outside world during the 1937–39 Chinese-Japanese war. In 1944, during World War II, Allied forces constructed a 478-mi. supply route, the Stilwell or Ledo Road, from Ledo, India, which, twisting through mountains, swamps, and jungles, connected with the Burma Road.

BURMESE LANGUAGES. Burmese is the official language of the Union of Burma and is spoken as a first language by approximately 10,000,000 Burmans and as a second language by large numbers of speakers of other languages in the union. It is numerically the largest member of the Tibeto-Burman group of languages which includes also in Burma the numerically inferior Jinghpaw (Kachin), Chin, Naga and Lolo groups (*see* TIBETO-BURMAN LANGUAGES). The dialects of Burmese have not been adequately described and it is possible only to say that there are local forms of speech which are more or less mutually intelligible. These include such varieties as Arakanese, Tavoyan and a number of smaller groups spoken in northern Burma and the Kachin state as well as others in the Shan states. These languages are similar in structure and consist of syllables of uniform structure made up of an initial consonant or consonant cluster plus a vowel and spoken in one of four tones (contours of pitch and stress which distinguish otherwise identical syllables). The parts of speech are verbs, nouns and particles (postpositive bound forms, proclitics and enclitics). The sentence types are equational (two noun expressions are equated: "my father [is a] lawyer") and verbal. The latter consists of a verb expression standing alone or preceded by one or more modifiers or subordinations. Special classes of particles mark syntactic relationships of the modifiers and subordinations to the main verb expression while other classes serve to define in various ways the scope and range of the verbal description.

The earliest writing of the Burmese dates from the middle of the 11th century and is in a modification of the "square" Pali (*see* PALI LANGUAGE) borrowed from India and used in carving inscriptions on stone. Later the alphabet assumed its characteristic rounded shape from being inscribed on palm leaves with a stylus. This contact with Pali over the centuries has left in Burmese an important legacy in the form of a large number of words of Indic origin.

Next in numbers to the speakers of Tibeto-Burman languages are the Shans, who speak a language related to the Tai of Thailand (*see* SHAN LANGUAGE). The Karen languages (*q.v.*) are of uncertain affiliation linguistically but exist in a number of forms, the two main divisions of which are the Sgaw and the Pwo. The Mon-Khmer group has as its important member in Burma the language of the Mons, of great historical importance in Burma but of late years losing in influence. There are in addition speakers of non-indigenous languages of China, India, Pakistan and Europe. English is widely used but is the only European language of importance.

For the distribution of population by language groups, *see* BURMA: *Population*.

BURMESE ALPHABET

SIGN	EQUIVALENT	SIGN	EQUIVALENT
က	ka	ဗ	ba
ခ	hka	ဘ	ba
ဂ	ga	မ	ma
ဃ	(gha)	ယ	ya
င	nga	ရ	ya ra
စ	sa	လ	la
ဆ	hsa	ဝ	wa
ဇ	za	သ	tha
ဈ	za	ဟ	ha
ည	nya	ဠ	(ḷa)
ဋ	(ṭa)	အ	qa
ဌ	(hṭa)	အာ	qa-
ဍ	(ḍa)	အိ ဣ	qi
ဎ	(ḍa)	အီ ဤ	qi-
ဏ	na		
တ	ta	အု ဥ	qu
ထ	hta	အူ ဦ	qu-
ဒ	da	အေ ဧ	qei-
ဓ	da	အဲ	qe:
န	na	အော ဩ	qo
ပ	pa	အော် ဪ	qo-
ဖ	hpa		
		အံ	qan-

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BURMESE LITERATURE. The stone inscription is the oldest form of Burmese literature. The earliest datable extant specimen is the inscription of A.D. 1113 found at Myazedi near Pagan. It begins by recounting the circumstances that led to the dedication of a golden Buddha image by Prince Rajakumar, then gives the dedication itself and describes the gift of slaves to the image and the cave pagoda in which it was enshrined. It ends with a prayer for the upholders of the benefaction and a curse on those who damage it. The inscription was chiseled on stone in archaic Burmese characters and language. During the next 250 years more than 500 dedicatory inscriptions similar in pattern but more developed in style were engraved on stone. Many contain eloquent poems and prayers offered by royal ladies. Later inscriptions dating from A.D. 1365 to the mid-19th century were in the same vein, although the style and orthography become more like those of the palm-leaf and folded-paper literature.

Palm-Leaf and Folded-Paper Literature.—Imaginative literature scratched on palm leaf with a stylus or written on folded paper in steatite pencil originated under the auspices of Buddhist monarchs and flourished from the 14th century until after printing became prevalent in the 19th century. The authors were Buddhist monks, monastery-trained courtiers and a few court poetesses. Its most notable features were Buddhist piety and courtly refinement of language. Various kinds of poems, works in prose and in the "mixed style" (prose and poetry) constitute this literature. Of more than 50 extant types of versification the major genres are:

1. *E-gyin*, historical ballads, some of which were sung as cradle-songs. Others were written to inform young princes and princesses of the achievements of their ancestors. The earliest known work is the *Ya-khaing Min-tha-mi* ("The Princess of Arakan"), written in 1455 by Adu-nyo, a minister at the Arakan court. The *Min-re-deip-pa Min-tha E-gyin* (1618?), by Shin Than Kho, and the *Sin-gu Min-tha E-gyin* (1774?), by U Hpyaw, are among the best known. The end of the Burmese monarchy (1886) was naturally the end of the *e-gyin*, though a curious and solitary *e-gyin* was written in 1922 on the prince of Wales.

2. *Maw-gun*, panegyric odes. Their subjects range from the arrival at the court of a white elephant to the conquest of Siam, from the completion of a canal to an essay on cosmography. In 1472 Shin Htwe Nyo wrote the *Pye-son* ("The King's Journey Down to Prome"). A notable *maw-gun* is the *Ta-da-u-ti Min-ga-la Ce-ti* ("A Pagoda in Ava") written in 1480 by Ra-hta-tha-ra, a Mon monk. He formalized this genre and set the tone for his successors. His most famous disciple was Na-wa-de II, who composed at least 15 odes of which the *Wi-la-thi-ni* (1806) in praise of King Bodawpaya and the royal elephant was his masterpiece. An unusual *maw-gun*, the *Ma-ra-na-sa-ti* ("Meditation on Death"), was written by Saya Pwa in 1924. This caused violent repercussions in the literary world because of the alleged misuse of the title *maw-gun.*

3. *Pyo*, metrical versions of Buddhist stories and of stories of Buddha's birth and teaching, which transferred the originals to a Burmese setting and made them more vivid by adding small imaginative details, and homilies. Ra-hta-tha-ra's *Bhu-ri-dat Lin-ga-gyi* ("Birth Story 543"), written in 1484, is the earliest extant *pyo*. The poet's tour de force was, however, the *Ko-gan* ("Birth Story 509") written in 1523. He had many famous followers; notably two monks, Agga-tha-ma-dhi and Te-zo-tha-ra in the 16th century, and another monk Mon-ywe Sa-ya-daw and a minister, Twin-thin-taik-wun, in the 18th and 19th centuries. His contemporary and literary rival Thi-la-wun-tha, a monk poet, also composed several *pyo*, of which two held in high esteem by Burmese scholars are the *Pa-ra-mi-daw-gan* ("The Ten Perfections"; 1491) and the *Su-taung-gan* ("Prayers to Become Buddha"; 1495?). Pa-de-tha-ya-za (*c.* 1684–1754), a minister of advanced ideas, wrote some exquisite *pyo*, but he was censored by orthodox Burmans for using the medium on non-Buddhist themes.

4. *Lin-ga* (Pali *alamkāra* "ornamentation"), a variety of *pyo* but generally shorter, often used as a generic term for all kinds of verse. A *taw-la* ("forest journey") of nine stanzas written by a monk, Utta-ma-gyaw, in 1476, claims a place of distinction among works of this type. It is a devotional poem remarkable for sensitive perception and personification of nature. Ra-hta-tha-ra's *taw-la* of four stanzas, describing his journey to the Sacred Footprints, is another *lin-ga* of equal poetical merit. Burmese literature abounds in short *lin-ga*, but in 1904, a monk, Man-l Sa-ya-daw, produced a magnum opus known as *Mag-gha-de-wu Lin-ga-thit* ("Birth Story 9") comprising 625 stanzas. It is a collection of trenchant and memorable sayings.

5. *Ya-du* (Sanskrit *ritu* "season"), the shortest type of poem usually of three stanzas or less. These deal generally with romantic subjects such as the emotions called forth by the changing seasons, the mood of longing for and memories of loved ones. Two court poetesses, Mi Phyu and Mi Nyo, wrote outstanding *ya-du* in the 16th century. Nevertheless the form was not fully developed until the end of that century. Na-wa-de I (fl. 1545–1600), a courtier and soldier poet, composed more than 300 romantic *ya-du* His successor was the ill-fated and frustrated lover Prince Nat shin-naung of Toungoo, whose elevated and pathetic odes still sti the emotions of Burmese readers. Ze-ya-yan-da-meit and Shin Than Kho in the 17th century and Sein-da-Kyaw-thu in the 18th

century were other noted lyrical writers. A minister, Let-we-thon-da-ra, wrote two immortal *ya-du* in 1766.

The poems of these five genres are all composed in lines of four syllables with regular "climbing rhymes" in one or more of six different rhyme schemes, each stanza ending in a line with an odd number of syllables, usually 7, 9 or 11. In other forms of verse the rhyme scheme is freer. Double and triple rhymes are not unusual. Some are in the "mixed style" (*see* above). Mention may be made of a few of the best known types:

The *Ya-gan*, a seriocomic epic in which the author tries to score points over others, appeared in the 18th century. *Mwe-nun* ("A Mon Princess") by Shwe-daung-nan-da-thu is the earliest extant *ya-gan*, but U To's *Ra-ma*, written between 1819 and 1837, is acclaimed as supreme.

Myit-ta-za originated in the 15th century as exhortatory letters in the classical verse form (four syllables to a line) addressed to kings by their abbots, but from the 17th century they were written to others besides the king, and in freer rhyme-schemes or in the "mixed style." Kyi-gan-ko-yin-gyi, Ok-kan-tha-ma-la and Pon Nya (*c.* 1817–66) gained recognition in this sphere. Pon Nya's letters are renowned for their human touch, wit and style.

Drama, like the *ya-gan*, seems to have been born from cultural contact with Siam. U Sa (1766–1853), a minister, adapted a Siamese play, *Ee-naung*, into Burmese, and this was followed by the Princess Hlaing's two palace plays, *Wi-za-ya-ka-ri* and *Ein-da-wun-tha*, written in prose and verse. These were intended to be read and performed by courtiers. Kyin U (*c.* 1819–53) and Pon Nya, two protagonists of the *pya-zat* (stage plays) wrote several plays to be produced as operas either before the king or at the court of provincial governors. Kyin U's *De-wa-gon-ban* and Pon Nya's *Wi-za-ya* were looked upon as models of *pya-zat* writing.

Among numerous songs of various types, the bucolic poems of Pa-de-tha-ya-za (early 18th century), *te-dat* ("six-section songs") by the queen of Sin-gu (1776–82) and Po Thu-daw U Min (early 19th century), *le-jo* ("four-section songs") and *dwe-jo* ("two-section songs") by Lu U Min and Po Thu-daw U Min and *baw-le* (plaintive songs) by the Princess Hlaing must have a place in any anthology of Burmese literature.

Prose works in this period are comparatively few. They are mainly translations or adaptations of stories from Buddhist scriptures, chronicles of kings and legal precedents. Sentences tend to be lengthy with loosely knit clauses and arbitrary punctuation. *Wut-htu* ("religious stories") are represented by works such as Thi-la-wun-tha's *Pa-ra-ya-na* (1511); by the translations (1782–7) by the poet monk Aw-ba-tha of eight of the ten great Birth Stories; and by the 537 minor birth stories by Nyaung-gan Abbot. The secular side is represented by *Ya-za-win-gyaw* ("The Celebrated Chronicle") (1520) by Thi-la-wun-tha; by the *Ma-ha Ya-za-win-gyi* ("Great Chronicle"), the earliest full scale history of Burma, by Kala (fl. 1714–33); and by the *Hman-nan Ya-za-win-daw-gyi* ("Glass Palace Chronicle") (1829) by a committee of learned monks and ministers.

Printed Book Literature.—The introduction of printing in lower Burma led to a change in the trend of Burmese literature. From 1875 onward the owners of Burmese printing presses began to publish popular works such as *pya-zat*, written at full length in the authentic stage idiom, complete with songs and stage directions. *Ma-ha-za-na-ka* (1875) by U Kho was the earliest printed play, but the dominating figure of the period between 1875 and 1885 was U Ku. His tragic dramas *Lu-wun Maung-hna-ma Pya-zat* ("The Orang-outang Brother and Sister") (1875) and *Uk-ka-la-pa Ya-za-win* ("History of Rangoon") (1877) caught the imagination of the public. Other well-known dramatists of this period were U Yaw, Pok Ni, Su Tha and Chan Mya. At the end of the decade the literary standard of the plays fell as they became overcharged with sentiment and sensationalism.

In 1904 another literary form appeared. A *wut-htu* (novel) called *Maung Yin Maung Ma Mè Ma*, by James Hla Gyaw, an incomplete adaptation of the *Count of Monte Cristo* marked the beginning of modern Burmese fiction. It was followed by *Maung Hmaing* ("The Roselle Seller") by U Kyi also in 1904 and two novels of recognized merit by U Lat, *Sa-be-bin* (1913) and *Shwe-pyi-zo* (1914). Gradually the novels too deteriorated as the plays had done.

In 1920 Burmese literature received a fresh impetus from the founding of the University of Rangoon. A new generation of writers developed modern prose writing, mainly short stories and essays, in a versatile literary form not too remote from current colloquial speech. Some short poems were also written and two of Molière's plays were translated. Thein Pe wrote a sensational novel, *Tet Hpon-gyi* ("The Modern Monk") in 1936.

The creation of the republic of the Union of Burma in 1948 stimulated interest in the national culture. Burmese began to replace English both as the official language and as the medium of instruction. The Burma Translation society, founded in 1947, awarded prizes for novels both in translation and as original works. *Mo-auk Mye-byin* ("The Earth Under the Sky") (1948) by Min Aung was the first novel to receive the award. Since then many, including a novel *Mon-ywe-ma-hu* ("Not That I Hate") (1955) by a lady novelist Ja-nè-gyaw Ma Ma Lay, have gained this distinction. The prime minister U Nu contributed two noteworthy literary works: a memoir, *Nga Hnit Ya-thi Ba-ma Pyi* ("Five Years in Burma") (1945) and a play *Lu-du Aung-than* ("The Victorious Voice of the People") (1953); both of these have been translated into English. Two biographies *Yok-pon-hlwa* ("Profiles of Eminent Burmans") (1955) by Da-gon Ta-ya and *Maung Hmaing* (1956) by Thein Han must be mentioned as outstanding works of the modern period.

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BURNABY, FREDERICK GUSTAVUS (1842–1885), English traveler and soldier who acquired fame for his winter journey to Khiva through Russian Turkistan in 1875–76 and through Turkey from Scutari to Erzerum and Batum in 1876–77. Born at Bedford, March 3, 1842, he was commissioned into the Royal Horse Guards in 1859 and rose to command; he helped to found *Vanity Fair* in 1868, and was *Times* correspondent with the Carlists in Spain in 1874; he contested Birmingham as a Conservative in 1878; he crossed the English channel in a balloon in 1882. Burnaby covered the Russo-Turkish War of 1877 as agent of the Stafford House (Red Cross) committee, accompanying Valentine Baker Pasha and his Turkish troops in their Bulgarian campaign. He participated, without official leave, in the Suakin campaign of 1884 and in the Gordon relief expedition of 1885; he was killed at Abu Klea on Jan. 17, 1885. His *Ride to Khiva* (1876) and *On Horseback Through Asia Minor* (1877) were widely read.

See T. Wright, *The Life of Colonel Fred Burnaby* (1908); M. Alexander, *The True Blue: Life and Adventures of Col. Fred Burnaby* (1958). (D. Mn.)

BURNE-JONES (originally Jones), **SIR EDWARD COLEY,** Bart. (1833–1898), English painter and designer, best known for his romantic neomedieval paintings and stained glass, was of Welsh extraction and was born at Birmingham on Aug. 28, 1833. He was educated at King Edward's school, Birmingham, and at Exeter college, Oxford, where William Morris was a fellow student. In 1854 they read John Ruskin's Edinburgh lectures on the Pre-Raphaelites (1853), and saw Sir John Millais' "Return of the Dove to the Ark" on exhibition in Oxford, and W. Holman Hunt's "The Light of the World" at the Royal Academy; that same year, Burne-Jones was deeply impressed by D. G. Rossetti's illustrations to William Allingham's "The Music Master and Other Poems." Early in 1856 his meeting with Rossetti in London marked a turning point in his career and he left Oxford without graduating. Morris and he then settled in Red Lion square, London, working under Rossetti's guidance, and in 1857 they began the ill-fated Oxford union frescoes. Lack of systematic artistic training sorely tried Burne-Jones, but already he had designed for stained glass, first for Messrs. Powell and after 1861 for Morris and company. In 1859 he visited Florence, Pisa and Genoa.

Burne-Jones's vivid imagination delighted in the stories of medieval chivalry best typified by Robert Southey's edition of Sir Thomas Malory's "Morte d'Arthur" (1856), Tennyson's "Idylls of the King" (1859) and Chaucer; artistically, he selected the formal elements in Filippo Lippi and Botticelli, suffusing them with a mood of romantic mysticism peculiar to a Celtic temperament. Two paintings of 1860, "Sidonia von Bork" and "Clara von Bork" (Tate gallery, London), are boldly characterized, decorative works, which, with Morris' "La Belle Iseult" (1858, Tate gallery), show the strong influence Rossetti then exerted. Burne-Jones and his wife accompanied Ruskin to Venice in 1862, where paintings by Carpaccio and the Bellini were particularly admired. From 1864 he exhibited at the Royal Watercolour society, but his first big success came with the Grosvenor gallery's inaugural exhibition in May 1877 of eight works, including several series of oils such as "Days of Creation," "The Beguiling of Merlin" and "The Mirror of Venus." These were carefully worked up from studies, using a technique of a single colour underpainting, brilliant colours and strong chiaroscuro. The slave figures in "The Wheel of Fortune" (1871–80) are based on Michelangelo's slaves, carved for the tomb of Pope Julius II (Burne-Jones visited Rome in 1871). "King Cophetua and the Beggar Maid" (1884, Tate gallery) represents Burne-Jones's mature style in which oil technique is mastered, but it is typical of his "dreamy medievalism" that the armour was designed by him without reference to historical accuracy. In 1894 he received a baronetcy. He died on June 17, 1898.

Burne-Jones's influence was felt far less in painting than in the field of decorative design, particularly in that of ecclesiastical stained glass. He executed reliefs in metals, tiles and gessowork, decorations for pianos and organs and cartoons for tapestries. Among the latter may be noted the "Adoration of the Magi" (Exeter college, Oxford). Burne-Jones is well represented at the Birmingham Art gallery. Besides several illustrations to other Kelmscott books, he made 87 designs for the *Chaucer* of 1896.

See O. von Schleinitz, *Burne-Jones* (1901); *Memorials of Edward Burne-Jones* (1904). (D. L. Fr.)

BURNELL, ROBERT (d. 1292), chancellor of England, who was the greatest and most trusted minister of Edward I, was born at Acton Burnell in Shropshire. He had entered the service of the lord Edward (afterward Edward I) by 1260, and was employed (1264–65) on confidential business by Henry III and Edward during the Barons' War, winning Edward's lifelong confidence and friendship, and becoming his chief household official. Before leaving for the Holy Land (1270), Edward unsuccessfully urged the Canterbury chapter to make Burnell archbishop, and he appointed him one of the commissioners to act for him during his absence. When Henry III died in 1272, Burnell and the other two commissioners then surviving, Walter Giffard, archbishop of York, and Roger Mortimer, ensured Edward's smooth accession by taking over the government, Burnell becoming the active regent. On his return Edward made Burnell chancellor of England (Sept. 21, 1274) on terms reversing all the changes made by Henry III and the baronial reformers; he held office for life, appointed his own deputy, and kept the profits of the great seal instead of accounting for them and drawing a fixed salary; the chancery, under Burnell's firm control, was unaffected by the administrative scandals of 1286–89. He discharged important diplomatic missions in France (1277–78, 1279, 1286–89) and in Wales (1282–83); he was the leading official member of the tribunal investigating complaints by and against the Welsh prince Llewelyn ap Gruffydd (1276) and of the great commission of inquiry (1289) into complaints of misgovernment during Edward's recent absence. Edward made him bishop of Bath and Wells (1275) and again tried, unsuccessfully, to make him archbishop of Canterbury (1278) and bishop of Winchester (1280). Though completely worldly and unspiritual, he ruled his diocese powerfully. He amassed a vast fortune in land, developing the family manor of Acton Burnell as his favourite seat, and he held the Shropshire barony of Castle Holgate and about 80 manors in 19 English counties on his death at Berwick-upon-Tweed on Oct. 25, 1292.

A self-made man of no academic learning but of great practical intelligence, "busy, trusty, congenial," often unscrupulous in action, Burnell's position was unique, and there were no more chancellors like him until Wolsey. As Edward's chief minister, controlling both the chancery and the royal household, Burnell by his expert knowledge, skill, energy and devotion, ensured most of the success of the first 20 years of Edward's reign. (R. F. T.)

BURNES, SIR ALEXANDER (1805–1841), explorer and political envoy whose *Map of Central Asia* and *Travels Into Bokhara* (1834) brought him geographical renown, was born at Montrose, Scot., on May 16, 1805. He became an ensign in the Bengal army in 1821 and from 1823 to 1829 was on political duty in Cutch, where he first became interested in the geography of Afghanistan and central Asia. In 1831 he was sent up the Indus on a mission to Maharaja Ranjít Singh of Lahore and the following year made a remarkable journey in disguise via Peshawar and Kabul to Bokhara, Meshed and the Caspian and thence through Tehran to Bushire on the Persian gulf. At the end of 1836 he was sent on a political mission to Amir Dost Mohammed, with whom he had made close contacts at Kabul. Contrary to Burnes's advice, Lord Auckland, the governor-general, decided to support the unpopular Amir Shah Shujah's claim to the Afghan throne, and Burnes was sent back under Sir William Macnaghten to Kabul to reinstate him in 1839; he became India's regular political agent at Kabul. He was assassinated there on Nov. 2, 1841. (K. M.)

BURNET, GILBERT (1643–1715), English bishop and historian, author of *History of His Own Time* (1724–34), was born in Edinburgh, Sept. 18, 1643. He was the youngest son of Robert Burnet (1592–1661), afterward Lord Crimond, who had been twice exiled because of his refusal to sign the covenant of 1638, in opposition to a new liturgy for the Church of Scotland, but was nonetheless a severe critic of the government of Charles I. His attitude certainly influenced his son Gilbert, who was educated at Marischal college, Aberdeen, and in 1661 became a probationer for the Scottish ministry. In that year his father died and Gilbert was offered a benefice which he declined on account of the unsettled state of church affairs. He visited Oxford and Cambridge, was much influenced by the Cambridge Platonists and their successors and after six months' absence returned to Scotland. He again refused offers of preferment and went to Holland and France. In Amsterdam he studied Hebrew and met Protestants of all shades of opinion and in Paris he also met the leading Protestant ministers.

On his return to England in 1664 he became intimate with Sir Robert Moray and John Maitland, afterward duke of Lauderdale both of whom at that time favoured leniency toward the Scottish Covenanters. While in London Burnet also became a member of the newly established Royal society. During his absence abroad, the living of Saltoun, East Lothian, had been kept open for him; he began his ministrations there in Nov. 1664 and was ordained priest early in 1665. In 1669 he resigned his parish to become professor of divinity in the University of Glasgow. He had already begun to differ from Lauderdale, who was moving in the direction of repression, and became Leighton's right hand in the attempt to secure a compromise between episcopacy and presbyterianism. He had on his side Anne, duchess of Hamilton, on whose behalf he edited *Memoirs of the Lives and Actions of James and William, Dukes of Hamilton and Castleherald . . .* (1676). Meanwhile, he had married an heiress, Lady Margaret Kennedy, daughter of the 5th earl of Cassilis and a cousin of Lauderdale. He renounced all claim to his wife's fortune and the marriage itself was kept secret for three years.

The ascendancy of Lauderdale in Scotland induced Burnet to settle in England. He went to London in 1673 to arrange for the publication of the Hamilton *Memoirs* and on his return to Scotland found that Lauderdale would not see him and had denounced him to Charles II as a centre of Scottish discontent. Burnet returned to London and resigned his professorship at Glasgow. He had been appointed one of the court chaplains, but Charles II struck him off the roll. He became, however, preacher at the Rolls chapel and was elected lecturer at St. Clement's. Up to April 1675 he had enjoyed the favour of the duke of York, who was, however, alienated when Burnet gave evidence before a committee of the house of commons against Lauderdale.

He presently began the preparation of his *History of the Reformation of the Church of England.* This book was prepared from he original sources, but unfortunately Burnet was denied access to the Cotton library, largely through William Sancroft's influence. The first volume was published in 1679, the second in 1681 and the third in 1715. During the agitation about the popish plot in 1678 he acted with moderation and tried to save at least one of he victims, William Staly. He proposed a compromise in place of the Exclusion bill, a course which led to a very brief reconciliation with the court. He was known to have received the confidence of John Wilmot, earl of Rochester, before his death, and he attended Lord Russell on the scaffold; further, against his own wish, it is true, he preached the usual anti-Catholic sermon on Guy Fawkes day (1684). He was consequently deprived of his appointments by order of the court, and on the accession of James II retired to Paris and eventually to The Hague, where he took he precaution of naturalizing himself as a Dutch subject by way of protection against a prosecution for high treason threatened in England. His first wife was now dead and he married a Dutch heiress of Scottish descent, Mary Scott.

Burnet was able to render great service to William, prince of Orange, because of the confidence placed in him by Princess Mary, whom he persuaded to offer to leave the whole political power in her husband's hands in the event of their joint succession to the English crown. At the revolution he returned to England with William and Mary and the English text of their declaration was drawn up by him. On his own account he published *An Enquiry into the Measures of Submission to the Supreme Authority*, defending the revolution. For these services he was rewarded by the see of Salisbury and was consecrated on March 31, 1689, by a commission of bishops, Archbishop Sancroft having declined personally to perform the office. Burnet commanded the confidence of Queen Mary and after her death William III appointed an ecclesiastical commission, of which Burnet was a prominent member, for the disposal of vacant benefices, which had been personally supervised by Mary. The provision for the poorer livings afterward carried out by the measure known as Queen Anne's Bounty was originally a proposal made by Burnet. He became tutor (1699) to Princess Anne's son, the duke of Gloucester, but his influence at court declined after Queen Mary's death and disappeared after the accession of Queen Anne.

From 1685 onwards Burnet had been employed on his *History of His Own Time,* but he had from time to time written pamphlets in defence of the Broad-Church position. Of these, probably the most important was his *Exposition of the Thirty-nine Articles* (1669), which was intended to pave the way for the readmission of Nonconformists to the Church of England and gave great offense to the High-Church clergy. He was an exemplary diocesan bishop and his *Discourse of the Pastoral Care* was a favourite book on the ministerial office. His *History of His Own Time* was, by his direction, not to be published until six years after his death. Even then, the work (2 vol., 1724–34) appeared with some omissions made by his sons Gilbert and Thomas. Burnet has frequently been charged with misrepresentation, notably in his account of the birth of James, the Old Pretender. The most valuable part of his work is naturally that relating to transactions of which he had personal knowledge, notably the church history of Scotland and the events leading up to the revolution.

Burnet's second wife died in 1698 and in 1700 he married Elizabeth Berkeley, the author of *A Method of Devotion,* posthumously published in 1710. Of his children by his second wife, WILLIAM (d. 1729) became a colonial governor in America; GILBERT (1690–1726) became prebendary of Salisbury in 1715 and chaplain to George I in 1718; and SIR THOMAS (1694–1753), his literary executor and biographer, became in 1741 judge in the court of common pleas.

BIBLIOGRAPHY.—The chief authorities for Bishop Burnet's life are his "Rough Draft of my own Life" (ed. by H. C. Foxcroft, 1902, in the *Supplement to Burnet's History*), the life by Sir Thomas Burnet in the *History of His Own Time,* vol. vi (1823), and the *History* itself. A rather severe but detailed and useful criticism is given in L. von Ranke's *History of England,* vol. vi, pp. 45–101 (Eng. ed., 1875). Burnet's letters to his friend George Savile, marquess of Halifax, were published by the Royal Historical society (*Camden Miscellany,* vol. xi). The *History* (1724–34) ran through many editions before it was reprinted at the Clarendon press (1823; supplementary vol. 1833) with the suppressed passages of the first volume and notes by the earls of Dartmouth and Hardwicke and the remarks of Swift. This edition, under the direction of M. J. Routh, was enlarged in a second Oxford edition of 1833. A new edition, based on this, but making use of the Bodleian ms., which differs considerably from the printed version, was edited by Osmund Airy (1897, etc.). In 1902 Miss H. C. Foxcroft edited *A Supplement to Burnet's History of His Own Time* (Clarendon press), prefixed with an account of the relation between the different versions of the *History*—the Bodleian ms., the fragmentary Harleian ms. in the British museum and Sir Thomas Burnet's edition; the book contains the remaining fragments of Burnet's original memoirs, his autobiography, his letters to Admiral Herbert and his private meditations. His *History of the Reformation of the Church of England* was ed. by N. Pocock (Clarendon press, 1865).

See also T. E. S. Clarke and H. C. Foxcroft, *A Life of Gilbert Burnet, Bishop of Salisbury* (1907), with an introduction by C. H. Firth, which contains a chronological list of Burnet's published works. There is a valuable critical appreciation by H. W. C. Davis in *Typical English Churchmen from Parker to Maurice,* ed. by W. E. Collins (1902). Of Burnet's personal character there are well-known descriptions in ch. vii of Macaulay's *History of England* and in W. E. H. Lecky's *History of England in the Eighteenth Century* (1878–90).

BURNET, SIR (FRANK) MACFARLANE (1899–), Australian physician-virologist, co-winner, with P. B. Medawar (*q.v.*), of the 1960 Nobel prize for physiology and medicine for the discovery of acquired immunological tolerance to tissue transplants, was born Sept. 3, 1899, at Traralgon, Victoria. He studied at Geelong college and at Melbourne university, where he received his M.D. in 1923. A research fellow at the Lister institute in London in 1926–27, he became assistant director of the Hall Institute for Medical Research at Melbourne hospital in 1928. In 1944 he became director of the Hall institute and professor of experimental medicine at Melbourne university.

Burnet's major works, besides those on human transplants, included a technique for culturing viruses in living chick embryos and a method for identifying bacteria by the bacteriophages that attack them.' By his virus researches he increased knowledge of the way in which influenza viruses cause infection and brought nearer the conquest of diseases (myxomatosis, Murray Valley fever and Q fever) particularly troublesome in Australia. He was made a fellow of the Royal society in 1942, was awarded its medal in 1947, was knighted in 1951, won an Albert Lasker award in 1952, and received the Order of Merit in 1958.

Among Burnet's publications are *Biological Aspects of Infectious Disease* (1940), revised in 1953 and retitled *Natural History of Infectious Diseases; Production of Antibodies* (1941); *Virus as Organism* (1945); *Viruses and Man* (1953); *Principles of Animal Virology* (1955); *Enzyme, Antigen and Virus* (1956); and *Clonal Selection Theory of Acquired Immunity* (1959).

BURNETT, FRANCES ELIZA HODGSON (1849–1924), English-born novelist and short-story writer, three of whose books for children have become classics. *Little Lord Fauntleroy* (serialized 1885; 1886) brought her fame and wealth; *A Little Princess* (1905; first version serialized as *Sara Crewe . . .*, 1887; dramatized 1903) and *The Secret Garden* (1910) won her lasting critical esteem. Never out-of-print, these stories have carried generations of children into a world of "magic that really works"—as "Mary" (in *The Secret Garden*) says. They are not fairy tales, and the heroes and heroines, though unusual children to whom strange things happen, belong to the real world. A born storyteller, Mrs. Burnett makes the unusual credible by firm adherence to moral principle, so that what happens is seen in the end to be the natural consequence of behaviour.

Born on Nov. 24, 1849, at Cheetham Hill, Manchester, Frances Hodgson early experienced the sudden change of fortune that forms the mainspring of the action in these books. After her father's death in 1855 his business failed, and the family moved into the city. In 1865 they emigrated to Knoxville, Tenn., and in 1873 Frances married Swann Burnett, a Knoxville doctor. She had begun her literary career in 1868, with "competent potboilers" for magazines, and her first novel, *That Lass o' Lowrie's* (serialized 1875; 1876), a realistic story of Lancashire working-class life, made her widely known. *Little Lord Fauntleroy*, her first full-length story for children, took America and England by storm; the sentiment, somewhat sweet for modern taste, suited the public for whom it was written, and when, in 1877, she went to Europe with her sons (the younger, Vivian, was the original of "Fauntleroy"), they were greeted enthusiastically. In Washington she had moved in literary and social circles; in England, her home till 1901, Henry James was among her admirers. Divorce, a remarriage that ended in separation, the death in 1890 of her elder son, did not destroy her zest for life or halt her pen. Though most of her vast output is forgotten—notable exceptions being *The Making of a Marchioness* (1901; new ed. with introduction by M. Laski, 1966), a clever social comedy; and *The Lost Prince* (1914; new abridged ed. 1967), a Ruritanian romance for children—her contemporary popularity was enormous. She died at her home at Long Island, N.Y., on Oct. 29, 1924.

See V. Burnett, *The Romantick Lady* (1927); M. Laski, *Mrs. Ewing, Mrs. Molesworth, and Mrs. Hodgson Burnett* (1950). (D. M. Pa.)

BURNEY, CHARLES (1726–1814), English organist, composer, and foremost music historian of his time in England, was born on April 7, 1726, in Shrewsbury. After some schooling there he attended Chester Free School (1739–42). He returned to Shrewsbury, assisted his half-brother, a church organist, and learned violin and French from Nicola Matteis. In 1744 he began a musical apprenticeship with Thomas Arne at Drury Lane, in London, where he later collaborated with David Garrick. After two years he was engaged as domestic *maestro* and companion by Fulke Greville. He married Esther Sleepe in June 1749, became organist at St. Dionis' Backchurch in October, and that winter succeeded John Stanley as organist and harpsichordist of the concerts at the King's Arms, Cornhill. During 1749 Burney became a Freeman of the Musicians' Company.

Because of serious illness, Burney left London in 1751 and settled in King's Lynn, where he served as organist at St. Margaret's Church. But his activities demanded the larger arena of London, and he returned there early in 1760. In 1762 Burney's wife died; five years later he secretly married Mrs. Stephen Allen, widow of a wealthy merchant. He was elected to the Society of Arts in 1764, was appointed to positions in the king's musical establishment in 1767 and 1774, took his D. Mus. at Oxford in 1769, and became a Fellow of the Royal Society in 1774.

In 1770 Burney toured France and Italy collecting materials for a projected history of music. A similar visit to the Netherlands, Germany, and Austria followed in 1772. He published accounts of these travels in 1771 and 1773. On his return he devoted to his *General History of Music* every moment he could spare from teaching.

His final appointment was as organist at Chelsea Hospital from 1783. Burney virtually retired in 1805 and returned to his *Memoirs*, begun in 1782. He was granted a king's pension in 1806 and in 1810 became a correspondent of the Institut de France. He died at Chelsea, Middlesex, on April 12, 1814.

Burney was a practising musician, but his ambition was for success as a writer. Most of his publications between 1748 and 1770 were musical compositions—chamber music for various instrumental combinations and music for the theatre. During the 1750s in Norfolk he became increasingly interested in the history and theory of music, and his general intellectual curiosity, too, was intensified by extensive reading—poetry, history, travel, and science. He was stimulated in particular by the writings of D'Alembert and Rousseau among his contemporaries.

Burney was also an amateur astronomer and his first literary publication was *An Essay Towards a History of the Principal Comets that Have Appeared Since the Year 1742* (1769). But his first success as a writer came with the publication of his travel journals, *The Present State of Music in France and Italy* (1771) and *The Present State of Music in Germany, the Netherlands and the United Provinces* (1773). Material from these was incorporated into Burney's major work, *A General History of Music*, published between 1776 and 1789 in four volumes. Progress was interrupted between volumes two and three; under the king's supervision Burney wrote an account of the 1784 Handel centenary celebrations. A three-volume *Memoirs of the Life and Writings of the Abate Metastasio* appeared in 1796. Between 1801 and 1805 Burney wrote the music articles for Abraham Rees's *Cyclopaedia*, and was handsomely rewarded with a fee of £1,000.

Burney's *General History of Music* established him as the foremost writer on music in the country. It was not an antiquarian's history, but a "readable" account, catering to amateurs as well as professionals and embodying the author's firsthand experience of music in England and Europe. What most interested Burney—and his subscribers—was contemporary music; he was an enthusiastic champion of Haydn, and devoted a long chapter to Italian opera in England. Burney warmed also to early music: that he could write on the Renaissance at greater length and far more sympathetically than he had originally envisaged is evidence of his musicality and responsiveness. Nevertheless it is principally for its insight into fashionable musical taste in 18th-century London that Burney's *History* is indispensable.

See R. Lonsdale, *Dr. Charles Burney* (1965); P. A. Scholes, *The Great Dr. Burney*, 2 vol. (1948). (C. R. T.)

BURNEY, FANNY (Frances d'Arblay) (1752–1840), English novelist and letter writer, author of *Evelina*, a landmark in the development of the novel of manners. The daughter of Charles Burney (*q.v.*), she was born at King's Lynn, Norfolk, June 13 1752, the third child in a family of six. One brother, James, was a sailor and another, Charles, a distinguished classical scholar In 1760 the family moved to London, where her father taught music. Mrs. Burney died in 1762. Though her sisters Esther and Susan were sent to school in Paris, Fanny educated herself by omnivorous reading at home: Shakespeare, such classics as Plutarch's *Lives*, history, sermons, courtesy books and other ethica works, poetry, plays and the novelists Richardson, Fielding, Smollett, Prévost, Marivaux and others. The early reading was accompanied by early scribbling, but all her works, including a novel "The History of Caroline Evelyn," were burned on her 15th birthday.

Fanny's development was much influenced by her father's friend Samuel Crisp, a cultivated littérateur who had retired to Chessington hall, near Epsom, Surrey. Since the hall was in fact a boarding-house, the Burneys often went there for holidays or to work; Burney's *Tour* to Italy was written there and much of Fanny's *Evelina* and *Cecilia*. The journal-letters or reports that Samue Crisp encouraged her to write on London and on the visitors to her father's lively house in St. Martin's street were the basis for the epistolary accounts that Evelina addressed to the fictiona Mr. Villars. It was to "Daddy Crisp," whom she loved better than anyone outside her own family (and to whom she became "the dearest thing in the world"), that she addressed the early journals and such works as the journals of her visits to Streatham with its accounts of Dr. Johnson.

In 1767 her father married Elizabeth Allen, a widow with three children, and when in 1770 the two families moved into one large house tensions soon developed between the Burney children and their stepmother. In 1774 the family moved to Newton house, in St. Martin's street, Leicester square, and it was there that the social and musical evenings took place, so graphically described in Fanny's journals and those of her sisters. The young Burneys favoured witty and humorous visitors, among whom were the Rev. Thomas Twining (Aristotelian Twining) and David Garrick. The journals also describe the London of the 1770s and '80s, the pleasure gardens, assemblies, theatres, exhibitions and the operas and occasionally, give firsthand accounts of events like the Gordon riots.

In 1767 when "The History of Caroline Evelyn" was burned

Fanny's invention turned to Caroline's motherless daughter Evelina, whose adventures expanded as the young Burneys themselves grew up, while the "sentiments," given largely to Villars, derived from courtesy books. When her father was writing his *Tours* of Italy and Germany (1771–73), Fanny was employed as amanuensis. Burney's *History of Music* came next, but when the first volume went to press (Dec. 1775) she was free again. The neglect of her journals and correspondence in 1776–77 indicate her absorption in *Evelina*.

It was unheard of, however, for a young girl to write a novel and the publisher Dodsley refused to consider an anonymous work. Thomas Lowndes was applied to and no scene in *Evelina* is more amusing than the secret dealings of the young Burneys, when Charles, disguised as "Mr. King" in "an old great coat and a large old hat," carried letters and manuscripts to the publisher and received replies addressed to "Mr. King" at the Orange coffee house. Lowndes liked the first volume and what he saw of the second but declined to publish an "Unfinish'd book." With publication in prospect Fanny revised the colloquial and racy language of the first drafts. The "gentles" were given elegant speeches while the natural dialogue of the "cits" contributed much to the book's realism and humour and served to differentiate the characters.

'The book, published in Jan. 1778, was an astounding success. By the summer everyone was reading *Evelina, or, the History of a Young Lady's Entrance Into the World.* Burke had sat up all night to read it; Dr. Johnson had laughed uproariously at the Holborn beaux. Evelina's journal-letters often read like lively scenes in a comedy of manners. Fanny was observant with an attentive ear for dialect and the differentiation of London speech, and the presentation of contemporary scenes make *Evelina* a lively period piece. The realism of the scenes of low life reminded readers of Fielding. The novel also exposed the heart and mind of a young girl and traced the development of a heroine subject to human error, in short, a human being, rather than a paragon of the virtues. The plot terminated in marriage, the mistakes of untutored young girlhood constituting the impediments. A plot concerned with contemporary manners, the development of which depends upon the erring and uncertain conduct of the heroine, was an innovation that pointed the way for Jane Austen. The novel also offered the pathetic scenes so much prized in the age of sensibility and in Villars' letters, a compact but complete courtesy book. Finally, in describing the delicate balance of the tensions between Evelina and Lord Orville, it told a love story of enduring strength. Addressed to the young, the novel has a quality perennially young. Before the close of 1779 it had run to four editions and it remains a classic.

Though by June 1778 her father had read reviews of *Evelina* he did not know, any more than the rest of London, who had written the book. Informed by Susan, who confessed that Fan was the culprit, he could not restrain his tears at the lines to himself ("O Author of my being!") or suppress his pride. In spite of his daughter's wish for anonymity, he told the secret to his literary friends, among them, Mrs. Thrale (*see* Piozzi, Hester Lynch), who at once invited Fanny to Streatham. A close friendship developed between the clever and hospitable mistress of Streatham place and the shy wit, who was soon found to be "a girl of prodigious Parts," able, once she had overcome initial shyness, to hold her own with the wits of literary London including Dr. Johnson himself. The great man was very kind to her and between 1779 and 1783 when, like him, she was a guest of the Thrales for months at a time, often accompanying them to Tunbridge Wells, Brighton and Bath, she had opportunities for observing and recording that Boswell might have envied. New scenes and personages provided fresh matter for journal-letters and the Streatham, Brighton and Bath journals of 1778–82 (vol. i and ii in Austin Dobson's edition) have been prized for their vignettes of contemporary scenes and personages and especially of Dr. Johnson, his kindness and his sense of fun. He in turn loved all the Burneys he knew and some he did not and loved them "for loving each other."

Richard Brinsley Sheridan, Arthur Murphy and others who had noted the lively dialogue of the comic scenes in *Evelina* now persuaded Miss Burney to try her hand at comedy. In 1779 she completed "The Witlings," a satire on literary pretensions. The play was a comic and satiric exposé of the blue-stockings: so clearly could the "Queen of the Blues," Mrs. Montague, be discerned that Crisp and Fanny's father, fearing reprisals, hastily repressed the piece, which remains unprinted.

The same monitors now began to press the writer to write another novel. *Cecilia, or Memoirs of an Heiress,* five volumes (1782), written under pressure, lacked the spontaneity of *Evelina.* Now known herself and realizing that what she wrote would be read by the old and wise, she felt heavily responsible. The plot, more massive than that of *Evelina,* incorporated improving themes meant to inculcate lessons, give status to the suspect novel and please the age. The scope was still wide in its cross section of London life and the social satire as amusing as before. The work won great respect and in the years 1782–85 Fanny was much lionized in London literary assemblies and drawing rooms, where she often met Sir Joshua Reynolds, Dr. Johnson, Burke, the fashionable Miss Monckton, Richard Owen Cambridge and his son George Owen.

Henry Thrale died in 1781, "Daddy Crisp" in 1783 and Dr. Johnson in 1784. These years were also perplexed by the ambiguous attentions of the young clergyman George Owen Cambridge, which came to nothing. In 1785 Fanny was presented to Queen Charlotte and King George III and in the summer of 1786 she was invited to court as second keeper of the robes with a salary of £200 a year.

Fanny was now 34. Disappointment in love, difficulties with her stepmother together with her father's delight in having a daughter at court overcame her regret at such a retirement from her family and the world. Her duties were often strenuous, but what she found more difficult to bear was the impingement on her time and liberty exacted by the first keeper of the robes, the cruel and abusive Mrs. Schwellenberg, who insisted on her company at picquet and at the tea table where the king's equerries were entertained in the evenings. Fanny's loyalty to the royal family and her sympathy and help during the king's illness at Kew (1788–89) won her the affection of the queen and the princesses, proved by about 200 affectionate letters to the ageing Madame d'Arblay (written between 1818–40) from the princesses Elizabeth, Mary and Sophia. The strain of court service told on her health and in 1790 her father was persuaded to request that she be allowed to resign. She was released in July 1791 with a pension of £100 a year.

The literary output of the years 1786–91 consisted of the court journals, often dispatched in monthly packets to her sister Susan at Mickleham and to the Lockes of Norbury park (vol. iii and iv in Austin Dobson's edition). She dutifully repressed the court gossip of the appalling years of the king's madness, the schemes for the regency, etc., but retailed her own life and events of public interest like the trial of Warren Hastings. To beguile the weary year of 1790–91 she wrote four blank-verse tragedies: "Edwy and Elgiva," "Hubert De Vere," "The Siege of Pevensey" and the unfinished "Elberta." "Edwy and Elgiva," though acted by Mrs. Siddons, Bensley and Kemble, ran at Drury Lane theatre in 1795 for one night only.

On visits to Norbury park and Mickleham in 1792 Fanny met Alexandre Gabriel Jean-Baptiste Piochard d'Arblay, adjutant-general to Lafayette, one of the group of French Constitutionalists (*see* Feuillants, Club of the) who in Aug. 1792 fled to England, some of them finding refuge at Juniper hall, near Mickleham. Romance developed rapidly; the general offered his hand and though Fanny's father objected to the *emigré's* circumstances, the marriage took place on July 28, 1793, in Mickleham and never, wrote Fanny later, was "union more blest." The D'Arblays soon moved to a cottage in Great Bookham and on Dec. 18, 1794, a son, Alexander Charles Louis Piochard, was born.

In 1793 Madame d'Arblay published a charity sermon, *Brief Reflections Relative to the Emigrant French Clergy.* In 1796 she completed a potboiler, the courtesy novel *Camilla: or a Picture of Youth* (5 vol.), which yielded £1,000 with another £1,000 for the copyright and enabled D'Arblay to build a new house, Camilla cottage, in West Humble near Mickleham, Surrey, where they moved in Nov. 1797. The West Humble days were perhaps the happiest of Fanny's life, though one of its sorrows was the failing health of her sister Susan, since 1796 an exile, as she felt, on her husband's estate in County Louth, in Ireland. Her death (Jan. 1800) removed the *raison d'être* of the thick packets of journal-letters (erroneously called diaries) that Madame d'Arblay all her life had sent to this sister, receiving thousands of confidential journal pages in return; although written as personal letters only, they are of social and historical interest. Later journals describing significant public or private events were usually composed at her husband's request to be handed down to his son.

In the West Humble period (1797–1801) Madame d'Arblay wrote three comedies, all unpublished: "Love and Fashion," accepted for production at Covent Garden, but withdrawn at Susan's death; "The Woman-Hater"; and "A Busy Day," a lively playable piece, reminiscent of the comic and satiric parts of *Evelina* and *Cecilia.*

In 1801 Alexandre d'Arblay returned to France, and Madame d'Arblay arrived in Paris with her son in May 1802 intending a visit of a year, but when war broke out again her stay (or exile, as she sometimes thought it) was extended to ten years. D'Arblay, loyal both to the old regime and to his wife's country, found employment as a civil servant. Madame d'Arblay managed to return to England in 1812 to see her father, who died in 1814. In London (1813–14) she completed *The Wanderer: or Female Difficulties* (five volumes), a critique attacking English insularity and inhospitality to foreigners, a great disappointment to readers expecting satiric pictures of Napoleonic France. She was paid £1,500 for the first edition, which was sold out before it was printed. No one since, it is said, has ever read *The Wanderer.*

In 1815, when Napoleon escaped from Elba, General d'Arblay, now maréchal de camp and second lieutenant of the king's guard, was with the troops who covered Louis XVIII's retreat to the coast. Madame d'Arblay fled with other royalists to Brussels, where she wrote long letters to her family describing the preparations for war and the aftermath of battle. In July 1815, learning that her husband had been injured at Trèves, she crossed France and parts of the Rhineland to join him. When he had recovered they traveled to London and late in 1815 settled in Bath. D'Arblay was decorated and made a lieutenant general but his personal fortunes remained in ruin, his health failed and he died in Bath in May 1818.

At the desire of her son—now a senior wrangler, a fellow of Christ's college, Cambridge, and about to be ordained—Madame d'Arblay moved to London, taking a house at 11, Bolton street, Piccadilly (1818–28), later moving to 1, Half Moon street, Berkeley square (1828–37). Both houses were near her brother James's lively home at Buckingham gate. In these years her mind was much occupied with the career of her brilliant but erratic son.

In this later London period (1818–32) she fulfilled her husband's requests by writing up journals of past events such as her adventures at Ilfracombe (1817), her journey to Trèves (1817) and her introductions to the duchesse d'Angoulême and Louis XVIII (1814). She edited a selection of journals for publication (those re-edited by her niece Charlotte Barrett and published by Colburn, 1842–46, and the papers re-edited by Annie Raine Ellis as the *Early Diary,* 1889). She also read through her father's "Memoirs" and correspondence, destroying and obliterating parts she thought would give pain, as she had done with other journals. In 1832 she published *Memoirs of Doctor Burney,* three volumes, a work much attacked for its inflated style and prejudiced selection of material.

Though still remembered as the famous Madame d'Arblay, she lived in quiet retirement, visited occasionally by famous men like William Wilberforce and Sir Walter Scott and faithful friends like Lady Keith (Queeney Thrale) and Amelia (Locke) Angerstein. The younger Burneys, paying duty calls, found her invariably kind, incredibly wise and often when her health permitted as entertaining as ever with her store of curious anecdotes related with all her old powers of narration and talents of mimicry. Neither her extraordinary memory nor her imagination failed. The family letters of this period (as of all other times) are filled with affection, charity and kindness and are written in a lively style sharply in contrast to that of the *Memoirs of Doctor Burney.*

The deaths of her son (1837) and of her sister Charlotte Broome (1838) saddened her closing years. She died on Jan. 6, 1840, and was buried with her son and her husband in Wolcot churchyard, Bath.

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BURNHAM, DANIEL HUDSON (1846–1912), U.S architect, an early advocate of metropolitan area planning, was born at Henderson, N.Y., Sept. 4, 1846. He was educated at Chicago and at Waltham, Mass. He worked in Chicago, and in 1873 formed a partnership with John W. Root. Their work was of vital importance in the development of steel skeleton construction. They were entrusted with the planning of the World's Columbian exposition at Chicago (1893). On Root's death this work fell wholly upon Burnham.

Other large commissions included the Rookery (1886) and the Monadnock building (1891), which was the world's tallest wall-bearing building, in Chicago; the Flatiron building (1902), which was the world's tallest building, and Wanamaker's store (1903) in New York; Filene's store (1912) in Boston; the Union station (1904) in Washington, D.C.; and Selfridge's store (1909) in London.

Burnham was asked to propose plans for improving severa cities, including Cleveland, San Francisco, Chicago and Baltimore and for cities in the Philippines. His "Plan for Chicago" (1909) sometimes called a "city beautiful" proposal, anticipated by 3 years the need for transportation, parks and residential development on a metropolitan area basis. He was chairman of the committee which produced the McMillan plan for Washington, D.C (1910).

He died in Heidelberg, Ger., on June 1, 1912.

See C. Moore, *Daniel H. Burnham, Architect, Planner of Cities* 2 vol. (1921). (R. R. I.)

BURNHAM, EDWARD LEVY LAWSON, 1st Baron (1833–1916), English newspaper proprietor who virtually created the *London Daily Telegraph,* was born in London, Dec. 28, 1833 and was educated at University College school. His father, Joseph Moses Levy (d. 1888), acquired the *Daily Telegraph and Courie* in 1855, a few months after it had been founded by Colonel Sleigh and, aided by his son, soon changed the current of its fortunes raising it to a leading position and making it the pioneer London penny paper. Edward Levy (he took the added name of Lawson under his uncle's will in 1875) acted as editor of the *Daily Telegraph* till his father's death and then became its managing proprietor and sole controller till 1903, when he was made a baron and passed over these duties to his son. He had received a baronetcy in 1892.

For many years Edward Lawson was one of the outstanding figures in English journalism. No one in Great Britain did more than he to brighten and humanize the daily newspaper and transform it from a plain, severe chronicle of the day's events (only mitigated by the occasional ferocity of its political judgments) into a readable and entertaining presentation of the world's news The abolition of the last of the paper duties (1861), in which Lawson himself bore an active part, called into being a host of fresh newspaper readers among the middle classes, which welcomed the popular features of the new journalism. His conception of a popular daily paper was that it should be a faithful mirror of the times and make a strong appeal to the feeling of its readers

Under his direction the *Daily Telegraph* raised large funds for national, patriotic and charitable objects, dispatched missions of exploration to Central Africa and elsewhere and started novel features, such as popular correspondences on live topics of the day, which later became the established commonplace of journalsm. For many years the *Daily Telegraph* warmly supported the Liberal party, but it strongly dissented from Gladstone's anti-Turkish policy and the final severance came on his Irish policy of Home Rule. Lawson was not by nature a strong political partisan; what interested him most was the social advancement of the people and the development of the British empire, to which causes he gave strong support whatever the politics of the government of he day. Edward VII, as prince of Wales and later as king, frequently visited his home.

He was president of the Institute of Journalists (1892–93) and he Newspaper Press Fund (1908–16) and in 1909 presided over he first Imperial Press Conference in London. In 1862 he married Harriette Georgiana (d. 1897), daughter of the actor-manager Benjamin Webster. He died in London, Jan. 9, 1916. (J. B. F.)

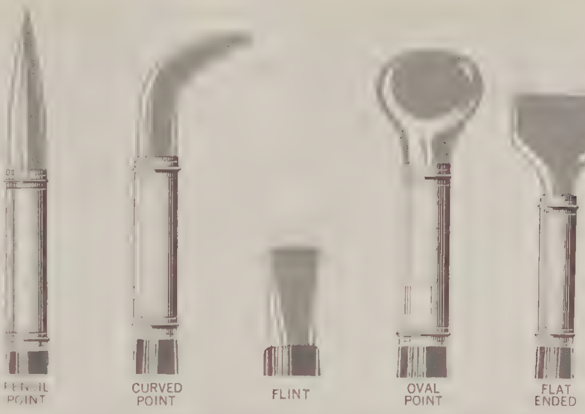
BURNHAM BEECHES, a woodland covering 600 ac. on a plateau of gravelly sand, is west of the road from Slough to Beaconsfield, Buckinghamshire, Eng. Once the property of Burnam abbey, it passed into private hands at the Dissolution. After 1878 the Corporation of the City of London acquired 492 ac. for public recreation. The fantastic shapes of the beech trees are due to the old practice of pollarding, whereby branches were lopped ff their short trunks, at intervals of several years, for firewood; resh shoots arose at a height beyond the reach of cattle. Oak and irch are also found, together with ferny open spaces.

(H. L. En.)

BURNHAM-ON-CROUCH, an urban district of Essex, Eng., is 20 mi. E.S.E. of Chelmsford by road. Pop. (1961) 4,167. Burnham lies 6 mi. from the North sea; below it the Crouch river s joined on the south side by the Roach, which branches into numerous creeks forming Foulness, Wallasea, Potton and other at islands. The church of St. Mary, mainly 14th century, has ne of the 40 bells cast by John Walgrave (1415). There are xtensive oyster beds in the Crouch estuary and a shellfish reearch laboratory was opened in 1953. Burnham-on-Crouch, which possesses four yacht clubs, is one of the best-known yachtng centres in the British Isles, and boatbuilding and sailmaking re carried on. The district is mainly agricultural, the only heavy ndustry being ironworks.

BURNING BUSH, a common name for the gas plant and for *uonymus americanus. See* Gas Plant; Euonymus.

BURNISHER, a tool used principally in the arts, as the ame implies, to give a high polish to a decorated surface. The ool differs in size, shape and material, according to the purpose or which it is intended. The burnisher used by the artist is genrally about 10 to 12 in. in length. At one end is an agate, flint r blood stone, very smoothly polished, and cut in various shapes, anging from a point to a round, square or oblong end, curved ook or spear shape, firmly set in a metal ferrule. The burnisher, s a finishing tool, is brought into the process of gilding after the urface has been carefully prepared—scraped, cleaned, polished, ashed in an acid solution and thoroughly dried. The gold leaf then applied and the colour brought out by means of rubbing ith the burnisher. On very early panel and mural paintings, and n illuminated manuscripts is found a thinly beaten gold leaf or nely powdered metallic gold, applied over a smooth priming or oundation, similar to what today is called burnish gold size. This as prepared by the early gilders from a very high grade of rabbit r hide glue, mixed together with natural red bolus, a variety of ay. After the gold size has dried smooth and hard, the gold leaf r powder is carefully applied and then very gently rubbed with the urnisher until the desired high finish is obtained. It is necessary at the gold to be burnished be laid on a very smooth and hard rface to obtain the most brilliant results. Today, burnish gold af, a variety differing only slightly from the ordinary gold leaf—bout one carat softer—is used extensively. Genuine metallic gold owder is seldom employed because of its high cost. Imitation old powder, or so-called burnishing bronze, is widely used commercially. Gilders of picture and mirror frames, book edges, greeting and playing card edges, illuminated manuscripts and other productions are the principal users of these burnishers.



FLINT AND AGATE BURNISHERS USED IN BOOKBINDING

Another style of burnisher made of a very high-grade steel is used by the artist etcher and metalworker to remove rough burrs or to obtain a highly polished surface to parts of the copper or zinc plate, or to make corrections. The leather carver also employs a burnisher to give a desired finish to tooled leather. The burnisher used by the ceramic artist to finish gold decorations on china or porcelain is made of spun glass. The gold on the china is quite dull after leaving the firing kiln. It is carefully burnished with the glass burnisher until the required finish is obtained.

There is no record of any definite date or period when burnishers were introduced in the arts. From earliest times there is evidence of their use. (F. W. We.)

BURNLEY, a municipal (1861), county (1888) and parliamentary (1867) borough of Lancashire, Eng., is situated at the junction of the rivers Brun and Calder, 24 mi. N. of Manchester by road and on the Leeds and Liverpool canal. Pop. (1961) 80,588. Burnley's growth from a township of 2,000 in 1790 depended on the canal, its coal and its position in the weaving areas of Lancashire. By the early 19th century the cotton trade had entirely superseded that of wool and in time Burnley became important not only for its cotton cloth but also for the manufacture of looms. The town suffered severely during the cotton famine consequent upon the American Civil War. Cotton weaving and coal mining are still two of the principal industries, the third being light engineering, including the manufacture of kitchen equipment, electric fires, automobile accessories and gas turbines. The weekly market and annual fair were granted by a charter of 1294. Towneley hall (mainly 17th century but said to date in part from the time of Edward III) is now a municipal museum and art gallery. There are the Municipal college, grammar and technical schools and 477 ac. of parks and recreation grounds. The parish church of St. Peter dates from 1120 and has a Perpendicular tower, but has been much restored. In 1890 Burnley was created a bishopric suffragan of the Manchester diocese but later it was included under the diocese of Blackburn founded in 1926.

(C. V. T.)

BURNOUF, EUGÈNE (1801–1852), French orientalist, by whose labours a knowledge of the Zend language was first brought to Europe, was born in Paris on Aug. 12, 1801. He published in 1826 an *Essai sur le Pâli . . .*, written in collaboration with Christian Lassen, and in the following year *Observations grammaticales sur quelques passages de l'essai sur le Pâli.* His next great work was the deciphering of the Zend manuscripts brought to France by Anquetil-Duperron. He caused the Vendidad Sade, part of one of the books bearing the name of Zoroaster, to be lithographed with the utmost care from the Zend manuscript in the Bibliothèque Nationale, and published it in folio parts (1829–43). From 1833 to 1845 he published his *Commentaire sur le Yaçna, l'un des livres liturgiques des Parses;* he also published the Sanskrit text and French translation of the *Bhâgavata Purâna ou* *histoire poétique de Krichna* in three folio volumes (1840–47). His last works were *Introduction à l'histoire du Bouddhisme Indien* (1844) and a translation of *Le Lotus de la bonne Loi* (1852). He died at Paris on May 28, 1852.

BURNS, SIR GEORGE, Bart. (1795–1890), Scottish shipowner and one of the founders of the Cunard line, was born in Glasgow on Dec. 10, 1795. In partnership with a brother, James, he began as a Glasgow general merchant, and in 1824, in conjunction with a Liverpool partner, Hugh Matthie, started a line of small sailing ships which ran between Glasgow and Liverpool. Later, the vessels were also sailed to Belfast, and steamers replaced the sailing ships. In 1830 a partnership was entered into with the MacIvers of Liverpool. In 1839, with Samuel Cunard, Robert Napier and other businessmen, the partners (David MacIver and Burns) started the British and North American Royal Mail Steam Packet company, later known as the Cunard line. They secured the British government's contract for the carrying of the mails of North America. Burns retired in 1858 and was made a baronet in 1889. He died on June 2, 1890, at Castle Wemyss, Renfrewshire.

John Burns, 1st Baron Inverclyde (1829–1901), his eldest son, as Sir John Burns, became head of the Cunard company in 1880, and was created a peer in 1897.

George Arbuthnot Burns, 2nd Baron Inverclyde (1861–1905) became chairman of the Cunard company in 1902. He took part in the application of turbine engines to ocean liners.

BURNS, JOHN ELLIOT (1858–1943), British labour leader, was described by Beatrice and Sidney Webb in their *History of Trade Unionism* (1894) as "in many respects, the most striking personality in the Labour movement." When, in 1906, he became the first man of working-class origin to enter the cabinet, his record, his intelligence, his dignity of manner and appearance seemed to promise a future as distinguished as his past; but by 1914 his career was virtually ended and in 1918 he retired from public life altogether.

Born in London on Oct. 20, 1858, he began work at 10; and at 14 was an engineering apprentice, supplementing his scanty education by attendance at night school and extensive reading. A period as an engineer on the west Niger, and contact on his return with V. Delahaye, a French communard, widened his horizons. He early proved an effective speaker at first on temperance and, later, on industrial and political topics; he was arrested in 1877 for an address on Clapham common, and in 1878 for braving a "Jingo" crowd at a demonstration in Hyde park. He joined the Amalgamated Engineering union, and became, with Tom Mann, a leader of the "New Unionism" (*see* Labour [Trade] Union). His outlook was always political and not merely industrial. In 1883 he joined H. M. Hyndman's Social Democratic federation (S.D.F.)—the one professedly socialist body then available—and in 1885 stood, unsuccessfully, for parliament. During the following years of economic slump, he became known as a champion of the unemployed. In 1886 he was, with three other S.D.F. leaders, prosecuted for sedition; on his acquittal, his speech for the defense—"The Man With the Red Flag"—was printed and widely read. In 1887 he was sentenced to six weeks imprisonment for participating in a riot in Trafalgar square on Nov. 12, a day that came to be known as "Bloody Sunday." In 1889 he was the dominating figure in the great London dock strike, which brought the casual and the unskilled worker into the organized trade unions.

In the same year, Burns was elected as a Progressive to London's new county council, and proved a useful and effective member, carrying through a motion imposing trade union rates in London county council contracts and fighting against private monopolies. In 1892 he was elected chairman of the Trades Union congress by an imposing majority. Although he took an active part in the transactions of the Labour Representation committee (L.R.C.), out of which the Labour party arose, he did not share the independent outlook of James Keir Hardie; when he stood for Battersea in 1892, he was not an L.R.C. candidate. Elected member of parliament, as again in 1895, 1900 and 1906, he stood aloof from the young Labour party, and in 1906 joined Sir Henry Campbell-Bannerman's Liberal cabinet, as president of the local government board—then the main authority for the poor laws. He opposed the Webbs and their crusade for fundamental reform of the poor laws, as expressed in the minority report of the royal commission o 1905–09. The portrait of Burns drawn in the *Diaries* of Beatrice Webb is coloured by this conflict, and by the fact that the onetime agitator had become the conciliator, as evidenced by his settlement of the London docks and transport strike of 1911. In 1914 he wa moved to the board of trade, but on Aug. 4 resigned rather than consent to British participation in a war. Between 1914 and 1918 when, because of Labour opposition, he lost his seat in Battersea he made no public statement either in or out of parliament. Hi interest was apparently concentrated in his remarkable library about London; he would often be seen on the Thames steamboats the centre of a lively group of youngsters. But, from his eloquent action of Aug. 4, 1914, until his death in London on Jan. 24, 1943 he was silent.

See William Kent, *John Burns: Labour's Lost Leader* (1950). (M. A. H.)

BURNS, ROBERT (1759–1796), the greatest Scottish poe after the middle ages, whose poems and songs have made him th national poet of Scotland, was born at Alloway, Ayrshire, o Jan. 25, 1759. His father had come to Ayrshire from Kincardineshire in an endeavour to improve his fortunes, but though h worked immensely hard first on the farm of Mount Oliphant whic he leased in 1766 and then on that of Lochlie which he took i 1777, ill-luck dogged him, and he died in 1784, worn out and bankrupt. It was watching his father being thus beaten down tha helped to make Robert both a rebel against the social order o his day and a bitter satirist of all forms of religious and polit cal thought which condoned or perpetuated inhumanity. The elde Burns was ambitious for his children, and Robert received som formal schooling from a teacher, as well as sporadically fro other sources; he acquired a superficial reading knowledge o French and a bare smattering of Latin, and he read most of th important 18th-century English writers as well as Shakespeare Milton and Dryden. Indeed, his formal education was turned entirely toward England; his knowledge of Scottish literature was i his childhood confined to orally transmitted folk songs and fo tales together with a modernization of the late 15th-century poem *Wallace,* a work which "poured a Scottish prejudice in my vein which will boil along there till the floodgates of life shut i eternal rest." Burns also studied biblical history, world geograph and English grammar; and he learned some physics, astronom and botany from such books as William Derham's *Astro-Theolog* and John Ray's *Wisdom of God Manifested in the Works of th Creation,* which presented scientific facts as arguments for th existence of God as a benevolent designer. Burns's religio throughout his adult life seems to have been a humanitarian deism

Proud, restless and full of a nameless ambition, the youn Robert Burns did his share of hard work on the family farm. Aft his father's death he was head of the household and tenant of th farm of Mossgiel to which the family moved. But he had alread started writing poetry, in which the tone of Scottish folk son and that of 18th-century sentimental and meditative poetry wer strangely mingled. Early in 1783 he began to keep a commonplac book in which he entered his first poem (a song, written for specific folk tune) in April, preceded by the comment: "There i certainly some connection between Love and Music and Poetr . . . I never had the least thought or inclination of turning Poe till I once got heartily in love, and then rhyme and song were, i a manner, the spontaneous language of my heart." The poem is a unpretentious, lilting piece, written in an English tipped wit Scots, but it becomes pure neoclassic English in the final stanza Shortly afterward he entered in the commonplace book sentimental, melodramatic or melancholy pieces whose thought reflected th family misfortunes of the time and whose vocabulary and manne derived from minor 18th-century English poets. He was cultivating, in a heavily self-conscious way, a gloomy sensibility. Bu suddenly we come across a lively, swinging piece deriving from th Scottish folk tradition rather than from contemporary Englis sentimentalists: "My father was a farmer upon the Carrick borde O." This was entered in the commonplace book in 1784, with a apologetic note that it was "miserably deficient in versification." Meanwhile his father's death freed him to seek male and female companionship where he would. He took sides against the dominant extreme Calvinist wing of the church in Ayrshire and championed a local gentleman, Gavin Hamilton, who had got into trouble with the Kirk Session for sabbath breaking. He had an affair with a servant girl at the farm, Elizabeth Paton, who in 1785 bore his first illegitimate child, and on the child's birth he welcomed it with a lively poem. This poem was written in a stanza that had had a long history in Scottish poetry, and had been used by Allan Ramsay and Robert Fergusson. Even more purely in the Scottish literary tradition is "The Death and Dying Words of Poor Maillie," entered in the commonplace book in June 1785, this is a "mock testament" put into the mouth of a dying sheep, done with shrewd ironical humour and considerable technical adroitness. Burns had by now available to him not only the Scottish folk tradition but also some at least of the traditions of Scottish "art" poetry both as they came to him through Fergusson and as he found them for himself in 18th-century collections of older Scottish poetry.

Burns developed rapidly throughout 1784 and 1785 as an "occasional" poet who more and more turned to verse to express his emotions of love, friendship or amusement or his ironical contemplation of the social scene. But these were not spontaneous effusions by an almost illiterate peasant. Burns was a very conscious craftsman; his entries in the commonplace book reveal that from the beginning he was interested in the technical problems of versification. If he never learned to distinguish emotional control from emotional self-indulgence in 18th-century English poetry, he did learn to appreciate economy, cogency and variety in the work of Pope and others, and, most important of all, he learned from older Scots literature to handle Scottish literary forms and stanza patterns, particularly in descriptive and satirical verse, with assurance and cunning. From the oral folk tradition he learned a great deal about song rhythms and the fitting of words to music; and out of his own Ayrshire speech, his knowledge of older Scots and his reading in standard English, he fashioned a flexible Scots-English idiom which, though hardly a literary language in the ense that Robert Henryson's or William Dunbar's language was, proved to be an effective medium for a poetry that was distinctly Scottish without being antiquarian.

Though he wrote poetry for his own amusement and that of his friends, Burns remained restless and dissatisfied. He won the reputation of being a dangerous rebel against orthodox religion, and when in 1786 he fell in love with Jean Armour, her father efused to allow her to marry Burns even though a child was on the way and under Scots law mutual consent followed by consummaion constituted a legal marriage. Jean was persuaded by her ather to go back on her promise; Robert, hurt and enraged, took up with another girl, Mary Campbell, who died soon after; on Sept. 3 Jean bore him twins out of wedlock. Meanwhile, the farm was not prospering, and Burns, harassed by insoluble emotional nd economic problems, thought of emigrating to Jamaica. But he rst wanted to show his country what he could do. In the midst of is troubles with the Armours (Armour threatened to sue him to provide for the upkeep of Jean's twins) he went ahead with his lans for publishing a volume of his poems at the nearby town of Kilmarnock. It was entitled *Poems, Chiefly in the Scottish Diaect,* and appeared on July 31, 1786. Its success was immediate nd overwhelming. Simple country folk and sophisticated Edinurgh critics alike hailed it, and the upshot was that Burns set out or Edinburgh on Nov. 27, 1786, to be lionized, patronized and howered with well-meant but dangerous advice.

The Kilmarnock volume was a remarkable mixture. It included handful of first-rate Scots poems: "The Twa Dogs," "Scotch Drink," "The Holy Fair," "An Address to the Deil," "The Death nd Dying Words of Poor Maillie," "To a Mouse," "To a Louse" nd some others, including a number of verse-letters addressed to arious friends. There were also a few Scots poems in which he was unable to sustain his inspiration or which are spoiled by a onfused purpose (such as "The Vision"), and one ("Hallowe'en") hich is too self-consciously rustic in its dogged descriptions of ountry customs and rituals and its almost exhibitionist use of archaic rural terms. There were also six gloomy and histrionic poems in English, four songs, of which only one, "It Was Upon a Lammas Night," showed promise of his future greatness as a song writer, and, what to contemporary reviewers seemed the stars of the volume, "The Cotter's Saturday Night" and "To a Mountain Daisy."

Burns selected his Kilmarnock poems with care: he was anxious to impress a genteel Edinburgh audience. In his preface he played up to contemporary sentimental views about the natural man and the noble peasant, exaggerated his lack of education, pretended to a lack of natural resources which was ridiculous in the light of the careful craftsmanship which his poetry displays and in general acted a part. The trouble is that he was only half acting. He was uncertain enough about the genteel tradition to accept much of it at its face value, and though, to his ultimate glory, he kept returning to what his own instincts told him was the true path for him to follow, far too many of his poems are marred by a naive and sentimental moralizing. "The Cotter's Saturday Night," which has stanzas of quiet beauty and impressive craftsmanship, also contains passages of intolerable histrionics and others where sharply etched realism and grandiose theatrical generalizations stand oddly side by side: Burns was not certain whether he was projecting a picture of Scottish peasant life from the inside or showing off the Scottish peasant for the edification of connoisseurs of sentimental beauties in Edinburgh. Burns the song writer was hardly represented in the Kilmarnock volume; most of his songs were still unwritten, but in any case the Edinburgh literati did not consider songs as one of the higher kinds of poetry. Burns the satirist was revealed in some degree: "The Holy Fair," written in the old Scottish tradition of poems describing popular festivities, describes with ironic humour the goings on at one of the great outdoor "tent preachings" that were held annually in connection with the communion service. "The Twa Dogs" achieves some deft thrusts at the Scottish upper classes through an innocent-seeming dialogue between two dogs. "An Address to the Deil," drawing on the devil of folklore rather than of Calvinist theology, uses a tone of amused familiarity in order to diminish the Devil (the poem is a fine example of Burns's technique of implicitly criticizing theological dogmas by translating them into the daily realities of ordinary experience). But Burns omitted his greatest satires in order not to shock his genteel audience. He omitted "The Ordination," a brilliant satire on Ayrshire church politics in the same stanza (an old Scottish verse form) as "The Holy Fair" and done with even greater verve and dexterity; "Address to the Unco Guid," an attack on Puritan hypocrisy; the amusing and skilful "Death and Doctor Hornbook"; and the rollicking satire "The Twa Herds," an early poem which Burns described as a "burlesque lamentation on a quarrel between two reverend Calvinists." And he omitted "Holy Willie's Prayer," the greatest of all his satiric poems and one of the great verse-satires of all time; it attacks the Calvinist view of predestination by putting a prayer in the mouth of a strict Calvinist convinced of his predestined salvation. Also omitted was his remarkable anarchist cantata "The Jolly Beggars," in which he assembled a group of social outcasts and put into their mouths roaring songs of conviviality, social defiance and swaggering independence. Burns's anarchism is not a mature or a complex attitude, but it does touch a fundamental human drive, and "The Jolly Beggars" gives brilliant expression to man as outcast and vagabond.

Some notion of the different degrees of skill and integrity displayed by Burns in the Kilmarnock volume can be obtained by setting side by side "To a Louse," "To a Mouse" and "To a Mountain Daisy." The first is easily the best, a bright, lively, humorous poem moving adroitly to a conclusion which is expressed with the gnomic pithiness of a country proverb, as the lady in church on whose bonnet a louse is crawling is restored to common humanity from which she tried to distinguish herself earlier in the poem. "To a Mouse," one of Burns's most charming and best-known poems, nevertheless lacks the tautness and the skilful manipulation of irony and humour of "To a Louse." The poet expresses his regret to the "wee, sleekit, cowrin, tim'rous beastie," on turning her up in her nest with the plough, and reflects that he himself is in an even worse situation. The fellow-feeling for the little creature is spontaneous and engaging, but the emergence of self-pity at the end as the real theme seems forced, and there is a touch of attitudinizing. This attitudinizing runs right through the sentimental "To a Mountain Daisy," in which he laments the fate of the crushed flower (also turned down with the plough) and compares it to that of a betrayed maiden. Burns was here posturing as a "man of feeling," and in his review of the Kilmarnock edition Henry Mackenzie, the original "Man of Feeling," singled out the poem for praise. This illustrates how pressure from those who dominated literary fashions in Edinburgh was continually directed at Burns to turn him from a vigorous and original Scottish poet to a minor imitator of Shenstone or Gray.

Edinburgh unsettled Burns, and after a number of amorous and other adventures there, and several trips to other parts of Scotland, he settled in the summer of 1788 at a farm in Ellisland, Dumfriesshire, leased to him by an admirer who was nevertheless a shrewd landlord. At Edinburgh, too, he arranged for a new and enlarged edition (1787) of his poems, but little of significance was added to the Kilmarnock selection. Substantially, it was by the Kilmarnock poems that Burns was known in his lifetime. He found farming at Ellisland difficult, though he was helped by Jean Armour, with whom he had been reconciled and whom he finally married in 1788, to the annoyance of the Edinburgh grass widow Mrs. Agnes Maclehose (the "Clarinda" of the poems), with whom he had been carrying on a violent flirtation which produced some indifferent lyrics and, at the final parting, one great song, "Ae Fond Kiss."

In Edinburgh Burns had met James Johnson, a keen collector of Scottish songs who was bringing out a series of volumes of songs with the music, and enlisted Burns's help in finding, editing, improving and rewriting items. Burns was enthusiastic and soon became virtual editor of Johnson's *Scots Musical Museum*. Later, he became involved with a similar project for George Thomson, but Thomson was a more consciously genteel person than Johnson, and Burns had to fight with him to prevent him from "refining" words and music and so ruining their character. The five volumes of Johnson's *Scots Musical Museum* (1787–97) and the four volumes of Thomson's *Select Collection of Original Scotish Airs* (1793–1805) contain the bulk of Burns's songs. Burns spent the latter part of his life in assiduously collecting and writing songs, to provide words for traditional Scottish airs and to keep Johnson and Thomson going. He regarded his work as service to Scotland and quixotically refused payment. The only poem he wrote after his Edinburgh visit which showed a hitherto unsuspected side of his poetic genius was "Tam o'Shanter," a spirited narrative poem in brilliantly handled octosyllabic couplets based on a folk legend associated with Alloway Kirk.

Meanwhile, Burns corresponded with and visited on terms of equality a great variety of literary and other people who were considerably "above" him socially. He was an admirable letter writer and a brilliant talker, and he could hold his own in any company. At the same time, he was still a struggling tenant farmer, and the attempt to keep himself going in two different social and intellectual capacities was wearing him down. After trying for a long time, he finally obtained a post in the excise service in 1789 and moved to Dumfries in 1791, where he lived until his death on July 21, 1796, caused by rheumatic heart disease contracted in his youth as a result of too much physical exertion on an inadequate diet. (The myth that Burns died of drink has long since been exploded.) His life at Dumfries was active. He wrote numerous "occasional" poems on contemporary political and other events, and did an immense amount of work for the two song collections, in addition to carrying out his duties as exciseman. The outbreak of the French Revolution excited him, and some indiscreet outbursts nearly lost him his job at a time when the excesses of the French revolutionaries had provoked the fiercest political reaction in Scotland. But his reputation as a good exciseman and a politic but humiliating recantation saved him. It was his attitude to the French Revolution, too, that estranged him from Mrs. Dunlop, an elderly female admirer who was genuinely fond of Burns and had been a real friend to him.

Burns was a man of great intellectual energy and force of character who in a class-ridden society never found an environment in which he could fully exercise his personality. After his death the lively literary lady Maria Riddel wrote a character sketch of him in *The Dumfries Weekly Journal* in which she said that his powers of conversation, his impromptu wit, his ability to grasp new ideas, his intolerance of stupidity and arrogance, his capacity for devastating ironic comment were in her opinion even more impressive than his poetry. But it was not only the class structure of his society, which led to his being alternately patronized and sentimentalized over, that constricted him. The fact is that Scottish culture in his day could provide no intellectual background that might replace the Calvinism which Burns rejected. The Edinburgh literati of Burns's day were second-raters. But the problem was more than one of personalities. The only substitute for the rejected Calvinism seemed to be a sentimental deism, a facile belief in the good heart as all, and this was not a creed rich or complex enough to nourish great poetry. That Burns in spite of this produced so much fine poetry shows the strength of his unique and remarkable genius, and that he has become the Scottish national poet, celebrated annually with rites associated with no other man of letters anywhere in the world, is a tribute to his hold on the popular imagination.

Burns perhaps exhibited his greatest poetic powers in his satires. There is also a remarkable craftsmanship in his verse-letters, which display a most adroit counterpointing of the colloquial and the formal. But it is by his songs that Burns is best known and it is his songs that have carried his reputation round the world. Burns is without doubt the greatest song writer Britain has produced. He found Scottish song in a confused and fragmentary state. Scottish airs had been popular since the latter part of the 17th century, and many collections of Scottish songs and song tunes appeared both in Edinburgh and London in the 18th century. But the great majority of older songs survived only in fragments. Burns's aim was to recover as many airs and sets of words as he could, and where the existing words were fragmentary o impossibly coarse or equally impossibly genteel, to re-create the song in the true spirit of the folk tradition. It was a staggering program, nothing less than the single-handed re-creation of the whole body of Scottish folk song. Further, Burns undertook to provide words to tunes which now existed only as dance tunes. He was anxious that all Scotland should be represented, and in his journeys scrupulously collected such songs and fragments as he could find to rework them into complete songs. We can trace his journeys in the provenance of the songs: a fisherman's song from Fife, an old Aberdeen folksong, a song about an ale-house keeper by the Moray firth and innumerable love songs connected with particular hills, valleys, streams and woods in various Scottish counties. If Burns had not been uncannily in tune with the folk spirit in Scottish song, he would be execrated today for having spoiled the original fragments by artificial improvements. But in fact he did not spoil them; he saved them from total corruption and disappearance and gave them new life and meaning and popularity.

Burns wrote all his songs to known tunes, sometimes writing several sets of words to the same air in an endeavour to find the most apt poem for a given melody. Many songs which we know from a variety of evidence must have been substantially written by Burns he never claimed as his. He never claimed "Auld Lang Syne," for example, which he described simply as an old fragment he had discovered, but the song we have is almost certainly his though the chorus and probably the first stanza are old. (Burns wrote it for a simple and moving old air which is *not* the tune to which it is now sung, as Thomson set it to another tune.) The full extent of Burns's work on Scottish song will probably never be known.

It is positively miraculous that Burns was able to enter into the spirit of older folk song and re-create, out of an old chorus such songs as "I'm O'er Young to Marry Yet," "Green Grow the Rashes O," "Sae Fair her Hair" (to the tune of "Gala Water") and a host of others. It is this uncanny ability to speak with the great anonymous voice of the Scottish people that explains the special feeling which Burns arouses, feelings that manifest themselves in the "Burns cult," a phenomenon associated with no other British poet. But his songs are not all in a simple folk idiom, though most of them have that air of simplicity (whatever the subtleties below the surface) so necessary to a sung poem. There is the symbolic colour and imagery of "Open the Door to Me Oh!" which so impressed W. B. Yeats:

> The wan moon is setting ayont the white wave,
> And time is setting with me, oh!

A wonderful mixture of tenderness and swagger—so characteristic of the male in love—appears in "A Red, Red Rose," Burns's rewriting of an old fragment. In "Yestreen I Had a Pint o' Wine" is the magnificent abandonment to the moment of experience:

> The kirk and state may gae to hell,
> And I'll gae to my Anna.

In the controlled historical melancholy of the Jacobite songs Burns gives this romantic lost cause a new meaning in terms of human emotion:

> Now a' is done that men can do,
> And a' is done in vain:
> My Love and Native Land fareweel,
> For I maun cross the main, my dear,
> For I maun cross the main.

In contrast there is the splendid drinking song, "Willie Brew'd a Peck o' Maut," with its rollicking chorus:

> We are na fou, We're nae that fou
> But just a drappie in our e'e; . . .

and, again, a brilliant counterpointing of folk feeling and high ceremony, of simple emotion and pageantry, in "Go, Fetch to Me a Pint o' Wine," where the whole atmosphere of medieval romance and ballad is concentrated in two stanzas. There is the magical tenderness of "O Lay Thy Loof in Mine, Lass" though there the tune is particularly important. There is the lilting love song he composed to one of his wife's favourite airs, "The Posie":

> O luve will venture in, where it daur na weel be seen,
> O luve will venture in, where wisdom ance has been; . . .

There is that sprightly piece of ironic self-compliment, "There Was a Lad Was Born in Kyle." There is the moving benedictory cadence, so perfectly wrought together with the music, in "Ca' the Yowes to the Knowes":

> Ghaist nor bogle shalt thou fear;
> Thou'rt to love and Heaven sae dear,
> Nocht of ill may come thee near,
> My bonnie dearie.

and the protective gentleness of "O, Wert Thou in the Cauld Blast," written as he lay dying, for Jessie Lewars who helped nurse him, to her favourite air, "Lennox, Love to Blantyre." Here the dying man reversed the actual roles of himself and the girl and wrote as the protecting male.

Love songs, work songs, drinking songs—Burns achieved brilliant success in all three varieties. He is one of the few love poets who relates sex to paternity and maternity, who links the sexual ecstasy with the prospect of children, who never isolates sexual passion into a Platonic ideal removed from given human relationships but keeps it always grounded in the known facts of experience. And he could sing the songs of either sex. Where else in English—or Scottish—literature can we find the happy audacity of "O Wha My Babie-Clouts Will Buy," the song he put into the mouth of Jean Armour when she was about to bear his child and which expresses both the female joy in sexual surrender and the female joy in maternity? Burns does not idealize lust, but he localizes and even domesticates it, something much more difficult to do. He is not a "romantic" poet. He never waxes enthusiastic over the mountains or the sea (he never mentions the former and very rarely the latter), but he sees the landscape of the countryside as a context within which the rhythms of human emotions and the farmer's year act themselves out. He is above all the poet of the realized moment of experience, of human feeling purged of all the accretions and falsifications of idealization and generalization. For portrait *see* article SCOTTISH LITERATURE.

BIBLIOGRAPHY.—*Poems: Poems, Chiefly in the Scottish Dialect* (1786); the enlarged edition of 1787 added, among others, "Death and Doctor Hornbook," "The Ordination" and "Address to the Unco Guid"; the 2-volume edition published in 1793 was the last edition with which Burns himself was directly concerned. Many of his finest poems were not published in his lifetime. "The Jolly Beggars" was first published as a chapbook in 1799 and was included in J. Walker's edition of the *Poems* (2 vol., 1811). "Holy Willie's Prayer" was first printed anonymously in an 8-page pamphlet in 1789, together with "Quotations from the Presbetyrian Eloquence."

The most important of 19th-century editions of the poems and of later editions, many with biographical accounts, are: *Life and Works of Robert Burns*, ed. by R. Chambers, 4 vol. (1856–57), and the revision of this by W. Wallace in 1896 (known as the "Chambers-Wallace" edition, still the most comprehensive of all works on Burns); *The Works of Robert Burns*, ed. by W. Scott Douglas, 6 vol. (1877–79); *The Poems and Songs of Robert Burns*, ed. by Andrew Lang and W. A. Craigie (1896); *The Poetry of Robert Burns*, ed. by W. E. Henley and T. F. Henderson, 4 vol. (Centenary edition, and still the standard edition, although in some respects out of date, 1896–97); *Poems and Songs*, ed. by J. Barke (1955); *Poems and Selected Letters* (Alloway bicentenary edition, 1959).

Songs: Most of Burns's songs first appeared (often anonymously) in James Johnson's *Scots Musical Museum*, 5 vol. (1787–97) and George Thomson's *Select Collection of Original Scotish Airs*, 4 vol. (1793–1805). *The Songs of Robert Burns*, by James C. Dick (1903) is an important scholarly edition of both words and music, giving the original airs for which the songs were written, and containing valuable historical and critical notes. Dick's *Notes on Scottish Song* (1908) and *Annotations of Scottish Songs*, by D. Cook (1922) contain useful information. A complete and accurate modern edition of Burns's songs with the original airs is still a desideratum.

Letters: The standard edition of Burns's letters is *Letters of Robert Burns*, ed. by J De Lancey Ferguson, 2 vol. (1931), but the *Selected Letters* (1953) ed. by De Lancey Ferguson has a few letters from original texts that had not been recovered at the time of Ferguson's complete edition.

Biography and criticism: R. H. Cromek, *Reliques of Robert Burns* (1808); J. G. Lockhart, *The Life of Robert Burns* (1828), founded a tradition of Burns biography but it is full of inaccuracies and misinterpretations; A. Angellier, *Robert Burns: La Vie, Les Oeuvres* (1829); H. Hecht, *Robert Burns: Leben und Werke des schottischen Volksdichters* (1919, Eng. trans. by J. Lymburn, 1936, 2nd ed., 1950); F. B. Snyder, *The Life of Robert Burns* (1932); De Lancey Ferguson, *Pride and Passion: Robert Burns* (1939); Robert T. Fitzhugh, *Robert Burns, His Associates and Contemporaries* (1943), presents important documents for the study of Burns's biography. *Burns as Others Saw Him* (1959) collects contemporary accounts of the poet; D. Daiches, *Robert Burns* (1950) is a critical study of the poems and includes an introductory chapter on the Scottish literary tradition; T. Crawford, *Burns: a Study of the Poems and Songs* (1960). *See* also *Burns Chronicle* (annually, since 1892). (D. Ds.)

BURNS. Burns and scalds result from the effect of contact with flames, hot substances, certain chemicals, radiation or electricity. The term scald, referring to injuries from hot water or steam, had almost completely dropped out of medical literature by the early 1960s, and all these injuries are now usually called burns. Burns of the skin are classified in three ways, according to depth, area and cause.

Depth of Burns.—The classification of depth most commonly used in the United States and the Commonwealth of Nations divides the cases into three degrees. In the first the skin is reddened, sore and tender but not blistered; the damage is confined to outer layers of the skin. In second-degree burns the skin is blistered and the blisters may break. The upper and intermediate skin cells are killed but the deepest cells of the skin are not; the skin is usually reddened, swollen and, if blisters are broken, weeping. In third-degree burns the full thickness of the skin and more or less underlying tissue is destroyed. The area looks dead white, brown, bright red or charred and may not be swollen at first. The depth of burns may be estimated shortly after injury but cannot be classified accurately in many cases for two to four weeks, when the killed tissue has separated from the wound. With or without treatment first-degree burns usually heal without scarring in six days or less and second-degree burns in six weeks or less with slight scarring. Third-degree burns more than two inches in diameter will heal only after months of treatment and with great scarring and deformity unless early grafting operations are done.

Area of Burns.—The areas of burns are classified according to percentage of the total skin surface involved. As a rough guide to making such an estimate, the area of one side of the victim's hand and fingers may be considered as 1% of the total. Shock is much more directly related to the area of the burn than to its depth or to the causal agent. Burns of 8% or more in infants or feeble adults and of 15% or more in healthy young adults may be expected to cause serious shock.

Causal Agents.—Most burns are caused by spilling hot liquids and by flames. However, sunlight, ultraviolet light, electricity, hot metals, chemicals, steam, X-rays, radium and atomic bombs also cause burns. The chief effects of contact with flame, hot water, steam, chemical and electrical burns are apparent promptly. There is a delay of several hours before the full effects of sun or ultraviolet burns are apparent and a delay of 10 to 30 days before the full effects of X-ray, radium or atomic burns are apparent.

Hot Fluids.—Most hot fluid burns are caused by splashing, and the contact with the hot fluid is of short duration and to small areas of the surface. As a result most such burns are of first and second degree only and are usually not fatal.

Flames.—When cotton or other inflammable clothes or bedclothes are ignited the flames can spread rapidly and will usually burn long enough to cause third-degree burns unless promptly smothered. A large proportion of fatal burns are due to flames.

Electricity.—Electricity may cause a burn by a flash or by setting clothes on fire. The latter burns are similar in effect to other flame burns of the same magnitude. An electrical current can also burn as it passes through the skin or other tissues. It may cause extensive deep injury that appears to be out of proportion to the surface injury.

Chemicals.—Strong acids, strong alkalies and many other chemicals can cause severe burns, which usually are the result of splashing or spilling of the fluid. Immediate removal of clothing and washing with water are essential to minimize the effect of the chemical, which continues to act at the expense of the patient's living tissue until it is wholly removed or neutralized.

Radiation.—Overexposure to X-ray and radium may result in severe burns that are insidious in onset and do not show any effect for about a week. After a single dose the peak effect comes during the third week. These burns penetrate much more deeply than others and if severe are healed only with great difficulty. Surgical operations may be needed to remove killed tissue and to cover open areas with skin grafts. Skin cancers may arise many years after such burns.

Burns from radioactive piles or solutions have the same characteristics as radium burns; in some recorded instances of accidental exposure, however, the energy released was so great that rapid death resulted. Extreme precautions must be taken to prevent exposure to radiation even when very small quantities of radioactive isotopes are used. In the explosion of an atomic bomb several kinds of energy are released. There may be burns caused by ultraviolet rays, by gamma rays or by exposure to radioactive deposits (akin to radium burns). Gamma rays and radium rays have great penetrating power and may destroy life by damaging deeply placed, sensitive body cells such as those in the bone marrow. Death may follow in patients whose skin injuries were of relatively small magnitude. Generally, a total body radiation of more than 150 roentgens is very serious and if more than 300 roentgens is usually fatal within a few weeks.

Treatment.—In general, treatment may be divided into four parts: the treatment of shock; the treatment of the burn by dressings and chemotherapy; the treatment of deep burns by surgery, and the nutritional treatment of the patient.

Shock.—Shock results largely from leakage of plasma from the circulation to the tissues under the burn and through it to the outside of the body. If more than a fifth of the blood volume escapes from the circulation, insufficient blood returns to the heart so that it cannot maintain blood pressure. Shock is measured by measuring the blood pressure, but the likelihood of its occurrence may be determined by testing the percentage of red blood cells in a specimen of blood (hematocrit). If it rises 10% or more above normal (45%), shock is present or threatened.

The treatment of actual or threatened shock consists of transfusions of blood plasma, serum albumin, whole blood, saline and glucose solutions, sodium bicarbonate or sodium lactate solutions and large doses of the water-soluble vitamins: thiamin, riboflavin, nicotinic acid and ascorbic acid. Treatment should always be given before shock starts if possible. The loss of plasma from the circulation may continue for two days. As much as five litres of plasma or blood may be needed, but this amount is never given all at the same time. After several hours severe shock is incurable by any treatment.

Dressings and Chemotherapy.—The treatment of the burn wound has two purposes—to reduce pain and to exclude infection. The washing of a burn or administration of an ointment is relatively unimportant. The important thing is to apply a large, sterile, firm dressing that is well fitted into place and extends well beyond the limits of the burn. It should act as a splint to prevent any motion that would cause pulling or rubbing between the dressing and the skin. Burn dressings should not be changed more than once a week. Anesthesia may be needed when dressings are changed.

Antibiotics are important in the treatment of some of the complications of large and deep burns. At mid-20th century, exposure treatment of burns as an alternative to dressings was revived as a treatment for certain patients. This treatment entails keeping the patient in a warm, isolated and relatively sterile room. It has real value in many extensive deep burns of the trunk, neck, head and perineum.

Surgery.—When the whole thickness of the skin is destroyed, natural healing can come only from the skin cells at the edges of the wound. If the area is more than one inch wide a graft is indicated. This should be a part-thickness graft cut with a razor or a dermatome and should cover the whole wound completely. Some surgeons excise the dead tissue to permit early grafts. In any case the graft should be done as early as possible but only onto a clean bed of healthy tissue cells. With successful early grafts, contractures and unsightly scars can be largely eliminated. If scars do occur, they may be removed later and further grafting done. (*See* PLASTIC SURGERY.)

Nutrition.—The loss of serum and pus from the wound and of other substances in the urine results in early depletion of essential protein, minerals and vitamins from the body. Seriously burned patients have difficulty in taking food and may be able to take only a small part of a normal diet. Poor intake of food, combined with severe losses, leads to rapid loss of weight and strength. Under such conditions, forced feeding through a stomach tube and into the veins may maintain the patient's strength. Protein digests with added glucose, salt and water-soluble vitamin should be given intravenously. A high-protein, high-vitamin, high-caloric and low-fat diet should be given orally or through a stomach tube. This diet may be most easily obtained by adding large quantities of skim milk, skim milk powder and vitamins to an ordinary diet and insisting that the patient take the liquid first. In severe cases it may be advisable to give 25% of 4,000 calories per day in the form of protein and to give 10 times the normal requirements of vitamins.

Prognosis of Burns.—With the treatment of shock already mentioned, patients with first- and second-degree burns of 90% of body area have occasionally been saved, and most patients with 50% burns or less should be saved. With third-degree burns only a few patients with 40% burns can be saved, but most with 20% or less should survive. This represents a great improvement ove the situation prior to the availability of plasma and whole blood for the treatment of shock (1940–43), when almost every patien with a 30%-area burn died.

Internal Burns.—The mouth, nasal cavity, respiratory tract, esophagus and stomach, vagina, bladder and rectum are all subjec to burns. Of these, burns of the respiratory tract and of the esophagus are the most common. Inhalation of hot smoke, gases and steam in burning buildings may cause severe burns of the trachea and the bronchi and may lead to death from asphyxia or pneumonia. Treatment consists of antibiotics to combat infection and oxygen to support respiration, or humidification of the air to moisten secretions and aspiration to remove secretions. An early tracheotomy may be lifesaving and, if indicated, should be done early.

Burns of the esophagus usually occur in infants as a result of drinking lye. If the child does not die a stricture is likely to esult. Instrumental dilation after two to three weeks is essential.

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BURNSIDE, AMBROSE EVERETT (1824–1881), U.S. army commander during the American Civil War, was born at Liberty, Ind., on May 23, 1824. He was appointed to the U.S. Military academy, West Point, N.Y., and graduated in 1847, when war with Mexico was nearly over. In 1853 he resigned his commission and for the next five years engaged in the manufacture of irearms at Bristol, R.I. In 1856 he invented a breech-loading arbine.

When the Civil War broke out Burnside took command of a Rhode Island regiment of militia and commanded a brigade in the rst battle of Bull Run (*q.v.*). On Aug. 6, 1861, he was commissioned brigadier general of volunteers and placed in charge of the xpeditionary force which sailed in Jan. 1862 for the North Carolina coast. He was promoted to the rank of major general soon fterward and was transferred to the Virginia theatre of war. Part f his forces fought in the last battles of Pope's campaign in Virginia, and Burnside himself was engaged in the battles of South Mountain and Antietam (*q.v.*). At the latter he was in command f McClellan's left wing, but the want of vigour in his attack was nfavourably criticized.

Burnside's patriotic spirit, modesty and amiable manners made im highly popular, and upon McClellan's final removal (Nov. 7) rom the army of the Potomac, President Lincoln chose him as uccessor. The choice was unfortunate. He sustained a crushing efeat at the battle of Fredericksburg (*q.v.*), and on Jan. 26, 863, he was replaced by Gen. Joseph Hooker. Transferred to Cincinnati in March 1863, he caused the arrest and court-martial f Clement L. Vallandigham (*q.v.*), lately an opposition member of ongress, for an alleged disloyal speech. Later in the year his measures for the suppression of press criticism aroused much pposition.

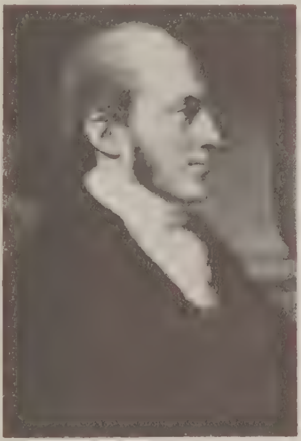
He helped to crush Morgan's Ohio raid in July; then, moving to relieve the loyalists in east Tennessee, in September entered Knoxville, to which the Confederate general James Longstreet unsuccessfully laid siege. In 1864 Burnside led his old corps under Grant in the Wilderness and Petersburg campaigns. After bearing is part well in the many bloody battles of that time, he was overtaken once more by disaster. The failure of the "Burnside mine" Petersburg brought about his resignation. (*See* AMERICAN IVIL WAR: *Military Operations, 1864–65*).

In 1866 Burnside became governor of Rhode Island and served or three terms (1866–69). He was a Republican member of the .S. congress from 1875 until his death at Bristol, R.I., on Sept. 13, 881. His name became synonymous with the type of side whiskers ater known as "sideburns") that he wore.

BURNTISLAND, a royal and small burgh in Fifeshire, Scot., n the northern shore of the Firth of Forth, 5½ mi. S.W. of Kirkcaldy by road and 5 mi. N. of Edinburgh across the firth. Pop. 961) 6,038. Its golf links and beach give it a reputation as a summer resort. The chief industries are shipbuilding and aluminium works. Coal is exported. On the rocks forming the western nd of the harbour stands Rossend castle which overlooks the harbour and is a house grafted on to a castle dating from 1382 here Mary Queen of Scots once lodged. The church (1592) is odeled on the North church at Amsterdam. The name Burntisland may refer to the time when the site, or part of it, formed n island, as sea sand is the subsoil even of the oldest quarters. nother derivation is from Gaelic words meaning "the island eyond the bend."

BURR, AARON (1756–1836), U.S. political leader, was born Feb. 6, 1756, at Newark, N.J. His father was the second president the College of New Jersey (later Princeton university) and his mother was the daughter of the eminent Puritan clergyman Jonathan Edwards. Shortly after his birth he was taken to Princeton, N.J., where both his father and mother died while he was still an infant. With his sister Sarah he was placed in the Elizabethtown home of an uncle, the Rev. Timothy Edwards, and brought up under the care of a tutor, Tapping Reeve, who later married Sarah and who subsequently became judge of the supreme court of Connecticut and a famous teacher of law.

Aaron was an attractive boy, quick and of good nature, but not willing to accept the austere discipline of his uncle. He prepared himself for college, as his family required, and entered the sophomore class of the College of New Jersey at 13 and graduated with distinction at 16. He spent the year after graduation in "busy idleness," reading and thinking. He was expected to follow in the steps of his forebears by becoming a torch-bearer of the Calvinistic faith, and, to satisfy his own mind, early in 1774 he undertook the study of theology. The result was that "completely and forever" he rejected the gospel according to Jonathan Edwards. But the times called for action rather than contemplation, and from the beginning of the colonies' dispute with England, young Burr espoused the patriot cause. He began the study of law at Litchfield, Conn., under his brother-in-law Tapping Reeve, but had made only slight progress when the call to arms was sounded.



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BURR, PORTRAIT BY JOHN VANDERLYN, 1809

First joining Washington's army at Cambridge, Burr served as captain under Benedict Arnold on the ill-fated expedition against Quebec. Next he served on Washington's staff, but he was not one to be held in check by military decorum. In only a few weeks the intimacy he enjoyed with his commander deteriorated to a mutual feeling of ill will. After being transferred to the staff of Gen. Israel Putnam, he distinguished himself during the New York campaign and in 1777 was promoted to the rank of lieutenant colonel in the Continental line. He fought at Monmouth, then resigned from the service in March 1779 because of ill-health. As a soldier his record was creditable but not distinguished. In accord with the custom of the times, he bore the title of "colonel" to the end of his life.

Soon after leaving the service, Burr resumed the study of law and in 1782 was licensed to practise. During the same year he married Theodosia Prevost, widow of a British officer and ten years his senior. Their only child was also named Theodosia. At the end of hostilities, Burr returned to New York city to practise law and met with marked success.

Burr's mansion at Richmond Hill was the scene of brilliant social gatherings, but extravagance and financial carelessness were already in evidence. In 1784 Burr was elected to the state legislature and in 1789 became attorney general under Gov. George Clinton. Finally, in 1791, at the age of 35, he defeated Gen. Philip Schuyler, father-in-law of Alexander Hamilton, for a seat in the U.S. senate. He failed of re-election in 1797 and spent the next two years in New York state politics. In 1800 he was named vice-presidential candidate on the Republican ticket headed by Thomas Jefferson. Using his Tammany Hall connection, Burr carried his state and thus helped bring about a national victory for his party. Under the procedures then prevailing the electors had cast their votes for both Jefferson and Burr without indicating which should be president and which vice-president. The ensuing deadlock resulted in a sharp contest in the house of representatives where, for 35 ballots, the pro-Burr Federalists, without Burr's aid, succeeded in stalling off the victory of Jefferson. But Hamilton's determined opposition to Burr finally resulted in Jefferson's election as president, and Burr became vice-president.

In Feb. 1804 Burr's friends in the New York legislature nominated him for the governorship of the state. Again Hamilton and his cohorts brought about Burr's defeat, and shortly thereafter George Clinton replaced him as vice-presidential candidate on the Republican ticket in the 1804 national election.

As a result of the charges Hamilton had made against Burr during that campaign, Burr demanded an explanation. He was not satisfied with Hamilton's response and the two men therefore fought a duel on July 11, 1804, at Weehawken, N.J., and Hamilton was killed. With warrants out for his arrest in both New York and New Jersey, Burr fled to Philadelphia, where he held conferences with his friend James Wilkinson. Though a general of the U.S. army, Wilkinson was a traitor in the pay of Spain. As war was expected to break out between the United States and Spain over boundary disputes, he and Burr planned an invasion of Mexico with the object of setting up an independent government there. Furthermore, because they overestimated the unrest of the western states, they hoped to foment a secession movement in that area and, joining it to Mexico, found an empire on the Napoleonic model with New Orleans as its capital. But Burr talked too much, Wilkinson became alarmed, and the general betrayed his fellow conspirator to President Jefferson. This resulted in Burr's arrest while he was trying to escape to Spanish territory, and he was sent to Richmond for trial before Chief Justice John Marshall. Though the evidence showed he had planned treason, his plot had been nipped in the bud before he had had time to commit the treasonable overt act, consequently he was acquitted.

Shortly afterward he went to Europe and tried to enlist the aid of Napoleon in an effort to conquer Florida. Failing in this, he lived abroad in penury for four years. Finally, in response to entreaties of his daughter, he returned to America in 1812; but the ship bringing Theodosia to meet him in New York was lost at sea. Bereft and lonely, he reopened his law office in New York and for 22 years engaged in his profession. In 1833, at the age of 77, he married the wealthy widow Eliza Jumel, about 20 years his junior. The marriage was not a happy one and the couple were divorced on the day of Burr's death, Sept. 14, 1836.

See also references under "Burr, Aaron" in the Index.

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BURRITT, ELIHU (1810–1879), U.S. philanthropist and advocate of peace, born in New Britain, Conn., on Dec. 8, 1810, was known popularly as "the learned blacksmith" because of his early trade and his wide knowledge of languages. On moving to Worcester, Mass., in 1837 he became interested in the cause of international peace and a leading member of the American Peace society, editing the society's magazine, *The Advocate of Peace.* He supported William Ladd's plan for a congress of nations to formulate international law and a court of nations to interpret the law, so that controversies might be settled peaceably by the principles of justice without resort to force. In 1848 he organized the Brussels Congress of "Friends of Peace," which was followed by congresses in Paris, Frankfurt am Main, London and other cities. After serving as consul in Birmingham, Eng., he returned to his farm in New Britain in 1870 and began distributing to newspapers in the United States and Europe a succession of single sheets known as *Olive Leaves* presenting arguments for peace with emphasis upon a code of international law. His published works, some 30 in number, dealt with religious topics, descriptions of English scenery and linguistic studies, justifying the designation of him as a great humanitarian.

See Charles Northend, *Elihu Burritt* (1879); M. Curti, *Learned Blacksmith* (letters, journals) (1937). (C. G. Fk.)

BURRO, the name of Spanish origin for the donkey. *See* Ass.

BURROUGHS, JOHN (1837–1921), U.S. writer on nature, was born near Roxbury, in Delaware county, N.Y., April 3, 1837. In his earlier years he engaged in teaching, journalism, farming and fruit raising, and for nine years was a clerk in the treasury department, Washington, D.C. He early recognized the genius of his friend Walt Whitman, publishing in 1867 a volume, *Notes on Walt Whitman as Poet and Person* (a subject to which he returned in 1896 with his *Whitman: a Study*). In 1871 he began with *Wake-Robin*, a series of books on birds, flowers and rural scenes which made him the successor of Thoreau as a popular essayist on the plants and animals environing human life. In 1873 he moved to a farm near Esopus, N.Y., in the Hudson River valley; from various retreats, including his cabin "Slabsides," he wrote for half a century on nature subjects. His later writings showed a more philosophic mood and a greater disposition toward literary or meditative allusion than their predecessors, but the general theme and method remained the same. His chief books, in addition to *Wake-Robin,* are *Birds and Poets* (1877), *Locusts and Wild Honey* (1879), *Signs and Seasons* (1886) and *Ways of Nature* (1905), all in prose, but he also wrote in verse, his one volume of poems, *Bird and Bough,*, being published in 1906. He traveled extensively, camping out with such friends as the naturalist John Muir and President Theodore Roosevelt, and accompanying the Harriman expedition to Alaska. *Winter Sunshine* (1875) and *Fresh Fields* (1884) are sketches of travel in England and France. Until his death, March 29, 1921, while returning from California to New York state, he continued to write essays on out-of-door life, some of which were assembled in the following volumes: *Time and Change* (1912), *The Summit of the Years* (1913), *The Breath of Life* (1915), *Under the Apple Trees* (1916) and *Field and Study* (1919). The John Burroughs Memorial association, a society to encourage writing in the field of natural science, was established in his memory.

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BURROWS, RONALD MONTAGU (1867–1920), British classical archaeologist and a leading champion of modern Greek independence, was born at Rugby, Aug. 16, 1867, and educated at Charterhouse and Christ Church, Oxford. While assistant to Gilbert Murray in the Greek department at the University of Glasgow, 1891–97, he went to Greece and undertook excavations at Pylos and Sphacteria (1895–96); the results were important in vindicating Thucydides as an accurate historian. He was professor of Greek at University college, Cardiff, from 1898 to 1908, and at the University of Manchester from 1908 to 1913; from 1913 until his death he was principal of King's college, London, the first layman to hold that post. Back in Greece in 1905 and 1907, he excavated tombs at Mycalessus (Rhitsona) in Boeotia, which helped to systematize the study of Boeotian archaeology. In 1907 he published *The Discoveries in Crete,* the first general account of Minoan civilization.

From 1913 onward he devoted much time to modern Greek affairs, having "discovered" Eleutherios Venizelos (*q.v.*) in 1912 and being invited by Venizelos during World War I (1916) to be the semiofficial diplomatic representative in London of the Greek provisional government. In 1915 the British cabinet adopted his plan for bringing Greece into the war by the offer of Cyprus. Confidant and adviser of Venizelos, he wrote and lectured extensively on near eastern political problems. At King's college he founded the many chairs concerned with European history and literature and the school of Slavonic studies. He died on May 14, 1920. (S. S. We.)

BURRUS, SEXTUS AFRANIUS (d. a.d. 62), praetorian prefect 51–62 and with Seneca (*q.v.*) the chief adviser of the emperor Nero. A native of Vasio in Gallia Narbonensis (Vaison), he held commissions in the Roman army and posts in the households of Livia, Tiberius and Claudius, and was made prefect of the praetorian guard in a.d. 51. He owed this promotion to the empress Agrippina, whose influence over Claudius had become dominant and who doubtless counted on Burrus' continuing support. But after Nero's accession in 54, Burrus, in concert with Seneca, soon subverted her power. It is reasonably supposed that till his death in 62 he and Seneca were mainly responsible for imperial policy and administration. The ancient allegations that in the end Nero poisoned him cannot be proved or refuted.

(P. A. Br.)

BURSA (formerly Brusa), the capital of an *il* (province) of the same name in northwestern Turkey, lies at an altitude of 700 ft. along the lower flank of Mysian Olympus (Ulu Dag) (7,500 ft.), with a northward prospect across the Nilufer valley toward the Sea of Marmara, which is hidden by a low line of hills. Pop. city (1960) 153,574; the *il* has an area of 4,323 sq.mi. and a population of 695,099. Bursa was a stronghold in Roman times of the Bithynian kings and capital of the early Ottoman sultans before the fall of Constantinople in 1453.

Set among plane tree, lime and fruit orchards, watered by plentiful streams from the mountain and with many historic buildings, hot sulfur springs and winter sports on Ulu Dag, the place has for long been a popular tourist resort. The much denuded walls of the citadel, crowning a high shoulder of rock, mark the site of he old fortified city. Beneath this the town is ranged on either side of a long boulevard, following the contours of the hill in either direction from the city centre, where municipal buildings and a bazaar (destroyed by fire in 1958) are grouped round the Ulu Cami (Great mosque). Some of the more famous mosques and ombs lie to the east, across a small ravine; the remainder are to he west of the town, by the road which passes thermal establishments, some of them in use for more than 1,000 yr., to the suburb of Cekirce. The Ulu Cami, a vast building with 20 domes, was completed early in the 15th century and is notable for the variety of calligraphic ornament decorating its walls. Of the monuments beyond the eastern ravine (Gok Dere) there are two principal groups associated respectively with the so-called Yesil Cami, built in 1421 by Mehmet I Celebi, and that built by Bayezid I and known as the Yildirim Cami. Both groups include a large medrese or ollege, a *turbe* (mausoleum) and other minor buildings. The medreses conform to the old college plan, used since the earliest days of Islam, with two-story chambers round a courtyard with n open *iwan* at one end. Beside the Cekirce road on the west ide of the town is the so-called Muradiye, a similar complex built by Murad II in the third decade of the 15th century, round which many other tombs and monuments have accumulated. Elsewhere re the tombs of Osman and Orhan, founders of the Ottoman dynasty. Bursa is connected by road and railway with a small seaport, Mudanya, to which a daily service of steamers from Istanbul voids the long overland journey round the Gulf of Izmit. From he 17th century onward Bursa has been famous for its silk and ther textiles which are still manufactured. Local products also nclude cheese, butter, tobacco and sugar beets as well as peaches nd other fruit from the Nilufer valley.

Founded by the Bithynian king Prusias I at the end of the 3rd entury B.C., Prusias-ad-Olympium became part of the Roman emire after the defeat of Mithradates VI (Eupator), king of Pontus. t gained prosperity in Byzantine times after Justinian built a alace there. It first fell to the Seljuks in 1075, but changed hands fter the arrival of the first crusade and, when Theodore I Lascaris made his capital at Nicaea (modern Isnik in Bursa *il*) after the ack of Constantinople by the Latins in 1204, it became a centre f Byzantine resistance. It was retaken by the Turks in the early 4th century and remained the capital of the Osmanli sultans until hey moved to Edirne (Adrianople) in 1413. In 1920 it was ocupied by the Greeks, who were ejected in Sept. 1922 after a etermined resistance.

See D. Magie, *Roman Rule in Asia Minor* (1951). (S. H. Ll.)

BURSCHENSCHAFT (from Ger. *Bursche*, "youth"), a corporation of students at the German universities that came into eing at the end of the Napoleonic Wars. There had existed earlier udent associations in Germany—notably the Landsmannschaften, hich was founded for mutual protection and was run on exclusvely aristocratic lines. On the other hand, the Burschenschaft, ounded in 1815 at the University of Jena, was egalitarian, admitng all students to full membership.

The early development of the Burschenschaften was characted by a vague kind of liberalism coupled with anti-Catholicism nd a marked form of nationalism. Students from different Geran universities who had fought side by side against the French herished the idea of the political unification of Germany, and this ndency was accentuated by the custom whereby German students used to attend two or more universities before taking their degree. The joint student demonstration at the Wartburg festival celebrating a Lutheran tercentenary (Oct. 18, 1817), the subsequent formation of the Allgemeine Deutsche Burschenschaft and, finally, the assassination of August Kotzebue (*q.v.*) on March 23, 1819, by the ultranationalistic Burschenschafter Karl Sand alarmed the German governments, and the Carlsbad decrees (*q.v.*) included measures for the official suppression of the Burschenschaften. In fact the Burschenschaften survived, surreptitiously or otherwise, to burst into open activity before and during the German revolution of 1848. Later, and especially after the foundation of the German empire in 1871, their liberal idealism came to be submerged by a new and aggressive wave of nationalism which led many of them to subscribe to rabid anti-Semitism and Pan-Germanism. Suppressed under Hitler, the Burschenschaften were resuscitated after World War II. They no longer play a significant part in German politics. (H. G. Sc.)

BURT, SIR CYRIL LODOWIC (1883–), one of the most distinguished British psychologists, was born near Stratford-upon-Avon on March 3, 1883. He was educated at Christ's Hospital and, as a classical scholar, at Jesus College, Oxford. He was attracted to study psychology by William MacDougall.

Burt taught at Oxford, Liverpool, and Cambridge universities, and at London's University College, where he became emeritus professor in 1950. He was knighted in 1946.

Burt had a wide influence in the study of juvenile delinquency, in the development of psychological testing, and in the use of statistics. His publications include *Mental and Scholastic Tests* (1921), *The Young Delinquent* (1925), *The Measurement of Mental Capacities* (1927), *Factors of the Mind* (1940), *The Backward Child*, 5th rev. ed. (1961), and *The Subnormal Mind*, 3rd ed. (1955). (F. C. Ba.)

BURTON, JOHN HILL (1809–1881), Scottish writer and author of the first *History of Scotland* based on accurate research, was born at Aberdeen on Aug. 22, 1809. After qualifying for the Scottish bar and practising as an advocate, he won notice with his *Manual of the Law of Scotland* (1839) and was one of the editors of *The Works of Jeremy Bentham* (1838–43) whose ideas greatly influenced him. For a short time Burton was editor of the *Scotsman*, and he long contributed to *Blackwoods' Magazine*, publishing his entertaining occasional essays in *The Book Hunter* (1860) and *The Scot Abroad* (1864).

In 1846 Burton achieved a high reputation with his intellectually acute but unimaginative *Life and Correspondence of David Hume*, based on extensive and previously unused manuscripts, and this was followed by many other works, including *Lives of Simon Lord Lovat, and Duncan Forbes, of Culloden* (1847), and *Narratives From Criminal Trials in Scotland* (1852). *The History of Scotland* (1853–70) is readable but lacks fire. It earned him the position of historiographer royal of Scotland. His editing of two volumes of *The Registers of the Privy Council of Scotland* (1877–78) was of great historical importance.

BURTON, SIR RICHARD FRANCIS (1821–1890), one of the greatest British travelers of the 19th century, British consul, orientalist and author of more than 50 books and translator of the "Arabian Nights," was born at Torquay, Eng., on March 19, 1821. He received an unconventional education, spending much time in France and Italy and showing at an early age considerable powers as a linguist. He entered Trinity college, Oxford, in Oct. 1840, but his eccentric behaviour eventually resulted in his rustication and he joined the East India company as a means of studying oriental life and languages. He arrived at Bombay in Oct. 1842 and soon became proficient in five of the Indian vernaculars as well as in Persian and Arabic. During seven years in India he laid the foundations of his detailed knowledge of eastern life and customs, especially among the lower classes. As an assistant in the Sind survey he was able to mix with the people and was able to pass himself off as a native in the bazaars. Here he commenced his great literary output, for besides government reports and contributions to the Asiatic society he wrote four books which were published after his return from India: *Scinde or the Unhappy Valley* (1851), *Sindh and the Races That Inhabit the Valley of the*

Indus (1851), *Goa and the Blue Mountains* (1851) and *Falconry in the Valley of the Indus* (1852).

Burton achieved fame with the pilgrimage which he made to Mecca in 1853. This he had planned while in India, becoming fully conversant with the required customs and practices. The journey was motivated by a sincere love of adventure, coupled with a desire to further geographical exploration. His aim was to reveal something of the nature of the "empty quarter" of Arabia and his plans were approved by the Royal Geographical society which contributed toward his expenses. Tribal conflicts made it impossible for him to carry out his plans in full and he was not able to penetrate further than Medina and Mecca. To accomplish this he traveled as an Indian Pathan to allow for any peculiarities and defects in his speech. For a European to make the pilgrimage was not unique, but to do it successfully required a detailed familiarity with Muslim ritual and custom. The remarkable journey was recorded by Burton in an even more remarkable book: *Pilgrimage to Al-Medina and Meccah* (1855). Its vivid descriptions, pungent style and intensely personal note distinguish it; its insight into modes of thought and its picture of Arab manners give it the value of a historical document; its grim humour, keen observation and reckless expression of opinion, written in peculiarly uncouth but vigorous language, made it a curiosity of literature.

Burton's next journey was more hazardous but attracted less attention. In 1854 the Indian government agreed to his proposal to explore the interior of Somali country in northeast Africa. He was assisted by Capt. J. H. Speke and two other young officers but accomplished the most difficult part of the enterprise alone, when he made the journey to Harrar, the Somali capital. He was unheard of for four months and suffered considerable deprivation. An attempt to repeat the journey was unsuccessful; one of the officers was killed and both Burton and Speke were wounded. His work was recognized by the award of a gold medal of the Royal Geographical society and was described in his classic, *First Footsteps in East Africa* (1856).

He served in the Dardanelles, but not at the front in the Crimea, and then returned to Africa in 1856, again accompanied by Speke, to search for the sources of the Nile, an expedition instigated by the Royal Geographical society and supported by the British government. They discovered Lake Tanganyika in Feb. 1858 and Speke, while Burton was ill, went on to discover Lake Victoria Nyanza which he rightly surmised to be one of the sources of the Nile. This separate discovery led to a bitter dispute between Burton and Speke but with the discovery of Lake Tanganyika it led the way to the subsequent explorations of Speke and James Grant, Sir Samuel Baker, David Livingstone and Henry Stanley. Burton and Speke's exploration was reported fully in vol. xxxiii of the *Journal of the Royal Geographical Society* and in *Lake Regions of Equatorial Africa* (1860). Three years after East Africa Burton was exploring in the Gold Coast, Dahomey and Benin and after a flying visit to the U.S. in 1860 wrote *The City of the Saints* (1861) about the Mormons in Salt Lake City, Utah.

In 1861 Burton entered the foreign service and was successively consul at Fernando Po, Santos in Brazil (1865), Damascus (1869) and Trieste (1871). The last post he held until his death at Trieste on Oct. 20, 1890. These postings and journeys associated with them produced a great spate of books: *Wanderings in West Africa* (1863), *Abeokuta and the Cameroons* (1863), *A Mission to Gelele, King of Dahomé* (1864), *Wit and Wisdom From West Africa* (1865), *The Highlands of Brazil* (1869), *Letters From the Battlefields of Paraguay* (1870), *Unexplored Syria* (1872), *Zanzibar* (1872), *Ultima Thule* (1875), *Etruscan Bologna* (1876), *Sind Revisited* (1877), *The Land of Midian* (1879) and *To the Gold Coast for Gold* (1883). There were other works also, including an unfinished history of the sword. Burton's output of writing was too great to allow for good style or great imagination which would have given his works immortality. His most celebrated literary work was his translation of the "Arabian Nights," *The Thousand Nights and a Night* (16 vol., privately printed, 1885–88). It is a great monument to his Arabic learning and his encyclopaedic knowledge of eastern life, though it may be criticized for sometimes lacking exactness in scholarship.

Burton married Isabel Arundell in 1861 and owed much to her courage, sympathy and devotion. She completed a *Life* of her husband in 1893 and instituted the "Burton Memorial Lecture Fund" which was inaugurated in 1921 and presents, through the Royal Asiatic society, a triennial medal to a prominent explorer of the lands with which Burton was associated. Burton was awarded the knight commander of St. Michael and St. George in 1887, though he was never actually knighted.

Bibliography.—Besides Lady Burton's *Life* (1893; abridged ed. 1898) there are: *A Sketch of the Career of R. F. B.*, by A. B. Richards A. Wilson and St. C. Baddeley (1886); *The True Life of Captain Sir R. F. B.*, by his niece, G. M. Stisted (1896); a *Life* by Thos. Wright of Olney (1906), an industrious and rather critical work which casts doubt on Burton's originality as an Arabic translator and emphasizes his indebtedness to Payne's *Arabian Nights* (1881); *The Real Sir R. B.*, by W. P. Dodge (1907); and a brief sketch by S. Lane-Poole prefixed to the *Pilgrimage* (1898), from which some sentences are here by permission, introduced. *See* also N. M. Penzer's *An Annotated Bibliography of Sir R. F. B.* (1923) and *Selected Papers on Anthropology, Travel, etc.* (1924). (R. M. P.)

BURTON, ROBERT (1577–1640), English scholar, writer and Anglican clergyman whose *Anatomy of Melancholy* is a masterpiece of style, a mine of curious information, a revelation of its author's sanity, humour and humanity and a valuable index to the philosophical and psychological ideas of the time. Born at Lindley Leicestershire, on Feb. 8, 1577, Burton was educated at Nuneaton and Sutton Coldfield and entered Brasenose college, Oxford, in 1593. He was elected a student (life fellow) of Christ Church in 1599 and lived there for the rest of his life, becoming a bachelor of divinity in 1614 and vicar of St. Thomas's church, Oxford, in 1616. He also held livings in Lincolnshire (1624–31) and Leicestershire, the latter bestowed by his patron, Lord Berkeley. His "silent, sedentary, solitary" life, as he himself describes it, lent his view of mankind an ironic detachment, but it certainly did not make it that of a scholar remote from reality: he is as informative on the pastimes of his time as on the ideas of the ancients, and as keen to recommend a rational diet as to relate man's disorders to his own essentially Christian view of the universe. His portrait at Brasenose college, Oxford, shows a face scholarly, shrewd, contemplative and humorous. He died at Christ Church on Jan. 25 1640, having previously predicted the date with considerable accuracy by a calculation of his nativity.

Burton's first work was the Latin comedy *Philosophaster* (1606) a vivacious exposure of charlatanism which has affinities with Ben Jonson's *Alchemist*. It was acted at Christ Church in 1618, and for long thought lost, but discovered and edited by W. E. Buckley (1862) with a number of minor academical exercises. His only English poem is the prefatory "The Author's Abstract of Melancholy" to the 1628 edition of the *Anatomy*.

The *Anatomy of Melancholy . . . by Democritus Junior* appeared in 1621, and five subsequent editions (1624, 1628, 1632, 1638 and 1651) incorporated Burton's revisions and alterations. The lengthy preface "Democritus to the Reader" explains his reasons for writing his treatise and for assuming the name Democritus Junior. He wished to show his gratitude for having been elected a student of "the most flourishing college in Europe" by writing something worthy of that noble society. He had read much: living in studious seclusion, he had been a critically observant spectator of the world's affairs. The philosopher Democritus was once found studying the causes and cure of "this *atra bilis* or melancholy" and Burton aimed to carry out the design he had planned. He anticipates the objections of captious critics, allowing that he has borrowed from innumerable books but claims that "the composition and method is ours only." He apologizes for faults of style on the ground that he had to work single-handed and digest his notes as best he might. If any object to his choice of subject, urging that he would be better employed in writing on divinity, his defense is that too many commentaries and sermons are already in existence Besides—and here is one of the curiously modern keynotes of his work—divinity and medicine are closely allied; and melancholy being both a spiritual and bodily infirmity, the divine and the physician must unite to cure it.

In the treatise itself, Burton sets himself in the first part to lefine melancholy, discusses its causes and sets down the symptoms. The second part is devoted to its cure. As it is of great mportance that we should live in good air, a chapter deals with Air Rectified, with a Digression of the Air." Burton never trav- led, but the study of cosmography had been his delight, and he ends his fancy flying north, east, south and west. Love melan- holy is the subject of the lively first three sections of the third art, and, a master of narrative, Burton includes as examples most f the world's great love stories, and shows again a modern ap- roach to psychological problems. The fourth section deals with eligious melancholy, and in his pages on the cure of despair he ises to heights of wisdom and of meditation.

Burton's style is as individual as his treatment of his matter. t is imaginative and eloquent, but, unlike that of many of his ontemporaries, his prose is not poetic. His vocabulary is col- oquial, lively and wide-ranging, full of classical allusions and atin tags which testify to his love of curious and out-of-the-way nformation as well as to his erudition. He is a master of lists and atalogues, but their sonorous roll is often broken by his humorous sides.

The *Anatomy*, widely read in the 17th century, lapsed for a me into obscurity, but it was admired by Dr. Johnson and aurence Sterne's borrowings from it are notorious. The devotion f Lamb, who recognized in "the fantastic great old man" a kindred irit, finding in his odd turns of expression, his whimsical fancies, s far-fetched conceits, his kindly sarcasm and his deep-lying athos a reflection of his own genius, helped to bring it into favour ith the Romantics, and its place in literature seems assured.

Bibliography.—A. R. Shilleto published a 3-vol. edition of the *natomy* in 1893, based on the inaccurate 7th edition; its errors were ointed out by E. Bensly (*Notes and Queries*, 1897–1908). There are liable editions by Floyd Dell and P. Jordan-Smith, 2 vol. (1927) nd by Holbrook Jackson in Everyman's Library, 3 vol. (1932). *hilosophaster* was ed. with trans. by P. Jordan-Smith (1931). *See* so P. Jordan-Smith, *Bibliographia Burtoniania* (1931); *Proc. and pers* of the *Oxford Bibliographical Society*, vol. 1, pt. 3 (1926); B. vans, *The Psychiatry of Robert Burton* (1944); Hardin Craig, *The nchanted Glass: the Elizabethan Mind in Literature* (1936).

BURTON UPON TRENT, a municipal (1878) and county orough in the Burton parliamentary division of Staffordshire, ng., lying mainly on the left bank of the Trent, on the Roman ad between Derby (9 mi. N.E.) and Lichfield (13 mi. S.W.) and the Grand Trunk (Trent and Mersey) canal. Pop. (1961) ,751. In the 9th century St. Modwen, an Irish nun, is said to ve established a convent on the Isle of Andressey opposite Bur- n. In 1002 Wulfric, earl of Mercia, founded there a Benedictine bey and in 1004 granted to it the town and lands in more than ne counties. The history of Burton was thereafter bound up with at of this rich and powerful abbey. A gatehouse, part of the walls d a fine doorway remain and on the site of the abbot's house at yney park stands a 15th-century half-timbered building. The bey became a collegiate church after its dissolution, but this s suppressed in 1549 and its lands and privileges were conferred Sir William Paget, ancestor of the marquess of Anglesey. Of any royal charters granted to Burton that of John gave an annual ir and a weekly market and Henry III's gave a second fair; Bur- n became famous for cattle and horse fairs.

The modern market hall was built in 1882 and the fish market in 25. The bridge, dating at least from the 12th century, spans the rent. The church of St. Mary and St. Modwen, built in the th century, embodies an older building. The museum and art llery was opened in 1914.

Brewing is an ancient industry of the town, originating with e monks of Burton abbey, but modern developments began with e building of the Grand Trunk canal in the 1760s and the open- g of the Trent for navigation in the early 18th century. By e middle of the century there was considerable trade with the ltic countries, and by 1801 Burton had nine brewing firms. e use of local well water impregnated with sulfate of lime de- ved from gypsum deposits is one factor in the localization of ewing there.

Burton, the home of several breweries, is noted for the excel- nce of its ales. There are also cooperages, foundries, and factories producing tires, footwear, chemicals, locomotives and castings.

BURUNDI, a republic in eastern equatorial Africa bounded north by Rwanda, east and south by Tanzania, southwest by Lake Tanganyika, and west by the Democratic Republic of the Congo. Area 10,707 sq.mi. (27,731 sq.km.). The capital is Bujumbura.

Physical Features.—Burundi is a high plateau of ancient rocks (Precambrian base with some ancient eruptive intrusions and granite massifs), including gneiss, schists, sandstones, and quartzites. The quartzites frequently form elongated ridges aligned in a south-southwest to north-northeast direction. A steep, strongly ravined escarpment on the western side of the plateau overlooks the rift of Lake Tanganyika and the valley of the lower Rusizi (Ruzizi). From the level of the lake there is a rapid rise of more than 5,000 ft. (1,500 m.) to the Congo-Nile divide. To the east of the divide plateaus between 6,500 and 5,000 ft. (2,000 and 1,500 m.) slope gently toward the east and southeast. Altitude does not fall below 5,000 ft. except in the valley of the Ruvubu (Ruvuvu) in the east and in the plain of the Muragarazi in the southeast. The most southerly source of the Nile, the Kigira-Mukasenyi, lies in Burundi. In the north, along the frontier with Rwanda, a few valleys are occupied by shallow lakes.

The climate is tropical with annual rainfall of more than 55 in. (1,400 mm.) in the highest parts of the country and a little less than 40 in. (1,000 mm.) in the southeast and on the banks of Lake Tanganyika. The dry season lasts from three to four months (June, July, August, and sometimes September) with some rain in August. Irregular rainfall sometimes adversely affects the harvest and has been the cause of widespread famine. The average temperature is about 21° C (70° F) on the plateaus, with a maximum temperature of 33° C (91° F) and a minimum of 6° C (43° F) below 6,500 ft.

The People.—The population comprises two principal elements: the Tutsi (Watutsi) and the Hutu (Bahutu). There are also a very small number of pygmy Twa (Batwa). The Tutsi, who are often of tall stature, hold traditional political power (the former king was a Tutsi) and also possess most of the country's wealth, particularly livestock. The Hutu, who form more than four-fifths of the population, are essentially Bantu agriculturalists; they raise the greater part of the Tutsi's cattle. Both Tutsi and Hutu speak Kirundi, a Bantu language.

The origin of the Tutsi is obscure. It may be that they were pastoralists from the north or northeast, possibly Ethiopia, who imposed their authority, political and social organization, and religion on Bantu agriculturalists. The Hutu and Tutsi intermingled more thoroughly in Burundi than in Rwanda (*see* also Bantu [Interlacustrine]). In religious beliefs, they are divided between those who adhere to the traditional religion and Christians, principally Roman Catholics.

In the mid-1960s the population was estimated at 2,800,000. Burundi is, after Rwanda, the most densely populated state of tropical Africa, with more than 260 people to the square mile (101 per square kilometre). More than 50% of the population is under the age of 15. The annual rate of increase is about 3.5%. In 1962 Bujumbura, the only important town, had a population of 44,913.

History.—Until its achievement of independence in July 1962 Burundi (then known as Urundi) had formed part of the Belgian trust territory of Ruanda-Urundi (*q.v.*, for previous history). The post-independence period was marked by internal unrest, caused mainly by conflict between the Tutsi and the Hutu. In January 1965 the premier was assassinated, and in October of that year there was an attempted coup d'état by Hutu officers. Severe repressive measures, including the execution of most of the Hutu leaders, followed the unsuccessful coup.

On July 8, 1966, the *mwami* (king), Mwambutsa IV, absent in Europe, was deposed by his 19-year-old son, the crown prince Charles Ndizeye. As King Ntare V, he in his turn was deposed on Nov. 28, 1966, by his premier, Capt. Michel Micombero. A republic was then proclaimed.

Administration and Social Conditions.—*Government.*—After the proclamation of the republic in November 1966 Micombero declared himself president and was accorded the rank of colonel. All provincial governors were replaced by army officers, and the administration of the country was taken over by a group of 13 officers acting as a "provisional revolutionary committee."

Justice.—There are local tribunals of customary law. Other courts, including courts of first instance and appeal, operate under codified law.

Education.—In the mid-1960s there were about 100,000 pupils in primary schools, 3,000 in secondary schools, and about 100 receiving higher education. The Centre Universitaire Rumuri (later renamed Université Officielle de Bujumbura) was established at Bujumbura in 1961.

Health.—The country has about one doctor for every 55,000 inhabitants and one hospital bed for every 660. Malaria is endemic. Sleeping sickness is not found on the plateaus, but pulmonary diseases (particularly tuberculosis) are quite widespread.

The Economy.—Burundi is essentially an agricultural country, the basic crops being beans, sweet potatoes, maize (corn), sorghum, and peas. Agriculture is chiefly subsistence, and more intensive methods are used than in most of central Africa. To avoid famine the Belgian administration developed the cultivation of cassava. Each house (dwellings are dispersed and there are no villages) is surrounded by a small plantation of banana trees (for brewing beer). The chief export crop is arabica coffee (about 13,000 tons annually). The cattle population of more than 450,000 has little economic but considerable social value. The Hutu also rear sheep (about 300,000) and goats (780,000).

Industrial activity is insignificant and mineral production (cassiterite and amblygonite) is small. Industrial development is handicapped by the country's distance from the sea. Imports exceed exports considerably in value, the deficit being partially met by foreign aid, notably from Belgium. Bujumbura, the port of Lake Tanganyika, is connected with Kalemi (Congo) and Kigoma (Tanzania) and has an international airport. Burundi has no railways, but there is a network of roads and tracks. A good road joins Bujumbura with Bukavu (Congo). There is a radio station at Bujumbura.

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(HE. NI.; X.)

BURUSHASKI LANGUAGE. Burushaski is the mother tongue of about 20,000 people inhabiting the central portion of the states of Hunza and Nagar in Gilgit (*q.v.*) territory, northwest Kashmir, where the Hindu Kush and Karakoram ranges meet.

A distinct dialect, known as Werchikwār or Wershikwār, is spoken by the (about 7,000) people of Wershegum, part of the Yasin valley.

No affinity has yet been proved between Burushaski and any other language. The principal sounds of Burushaski are the vowels *a*, ʌ, ə, *æ*, ɛ, *e*, *i*, ɪ, *o*, ʊ, *u*, *ai* (æi and əi); the longer vowels *a*ˑ, ɛˑ, *e*ˑ, *i*ˑ, *o*ˑ, *u*ˑ; and the consonants *k*, χ, *g*, γ, *q*, ŋ, *t*, *d*, *n*, *p*, *f* (*pf*), *b*, *w*, *m*, *č*, *ǰ*, *y*, *s*, *z*, *š*, *ž*, *ts*, *l*, *r*.

There is also a series of sounds—*č̣*, *ǰ̣*, *ṣ̌*, *ẓ̌*—made with the tip of the tongue retracted, which may amount in some cases to cerebrals, in the stricter definition of the term.

Natives recognize *ḍ* (passing into medial *ṛ*), and there is a curious sound which seems to be a cerebral or retracted *y*. Natives also claim to recognize the aspirates *kh*, *th*, *ph*, *čh*, *ǰh*. In a few words there appears to be a velar *g* corresponding to *q*. Werchikwār has an additional *l*, probably cerebral. Initial *g*, *d*, *b*, γ and *w* are changed to *k*, *t*, *p*, *q* and *p* after certain prefixes.

Among the many distinctive features of grammar and construction are the following:

Nouns are divided into four categories according to whether they represent: male human beings (mh), female human beings (fh), animals of both sexes and some inanimate objects (x) or the remaining inanimate objects (y).

The principles underlying the differentiation of the x and y categories cannot at present be fully stated, but, in general, names of fruit and wood and articles made of wood are x. Names of liquids, plastic and finely divided substances, trees, metals, abstract ide and immaterial objects are y.

The following vary to a greater or lesser extent, according t the category of the noun to which they refer: (1) plural suffixes o nouns (and occasionally adjectives); (2) demonstrative pronoun and adjectives; (3) third person singular and plural of the finit tenses of verbs. Case inflection is effected by the use of suffixe and postpositions.

Agglutinative Pronouns are used as pronominal prefixes wit certain nouns and verbs. With nouns they indicate the possesso with intransitive verbs the subject, and with transitive verbs som times the direct, sometimes the indirect object, and occasionall the subject. With a large series of verbs they are used as infix after an initial *d*.

Verbs are conjugated by the use of terminal inflections adde to two bases, present and past. The imperative is founded o the past base. Transitive and causative verbs are formed fro intransitive verbs by prefixing an element *—ʌ— or *—ʌs— (*- indicates the presence of a pronominal prefix).

Numerals.—The numeral system consists of a series of numbers from 1 to 10. The numbers from 20 to 99 are based on th numbers 20 and 40, to which are added the numbers 1 to 19, whil 20 and 40 are themselves multiplied as required by a precedin number; *e.g.*, $95 = 2 \times 40 + (10 + 5)$. The element of 2 is emphasized, 2, 4, 8, 20 and 40 being all obviously related. There is special series of forms of the numerals used in counting, as mult plicators and with certain nouns of measure, etc. The number 1 and 3 are also differentiated for h as opposed to x and y, and has special forms for h, x and y.

Vocabulary.—Excluding obvious loan words taken chiefly fro Persian, Ṣhiṇa and Khowār, the vocabulary of Burushaski and th whole of its inflectional system are, so far as is known, peculiar t itself. It would probably be impossible to point out an alien amon its pronouns numerals (except *sa's* 1,000), verbs and nouns relatin to the common objects of daily life.

See D. L. R. Lorimer, *The Burushaski Language*, 3 vol. (1935–36)

(D. L. R. L.)

BURY, RICHARD DE: *see* AUNGERVILLE, RICHARD.

BURY, a municipal and county borough in Lancashire, Eng on the Irwell river and the Manchester, Bolton and Bury cana 9 mi. NNW of Manchester. Pop. (1968 est.) 65,960. Area 11. sq.mi. Together with the borough of Radcliffe and Tottington urban district it forms the parliamentary division of Bur and Radcliffe. Bury (Anglo-Saxon *burhg* or *birig*, town, castle o fortified place) was the site of a Saxon station, and a castle stoo in nearby Castlecroft. It was a member of the honour of Clither (*q.v.*) and a fee (estate) of the royal manor of Tottington, whic soon after the Norman conquest was held by the Lacys. Th church of St. Mary was mentioned in Domesday Book but th present building dates from 1872 to 1876. Under a grant mad by Edward IV to Sir Thomas Pilkington, fairs are still held o March 5, May 3 and Sept. 18, and a market, formerly held unde the same grant on Thursday, is now held on Saturday. The woole trade was established there by Flemish immigrants in the reig of Edward III, and in Elizabeth I's time this industry was of suc importance that an alnager (*see* ALNAGE) was appointed to measur and stamp the woolen cloth. But although the woolen manufactur is still carried on, the cotton trade gradually superseded it afte the early 18th century. John and Robert Kay, noted in the cotto industry as inventors of the flying shuttle and the drop box, belonged to Bury, and Robert Peel's printworks were establishe there in 1770. The cognate industries of calico printing, dyein finishing and bleaching are carried on, as are the paper and textil trades. Many light industries were established. Kay's free grammar school was founded in 1726. An important business exper ment established the Bury Co-operative society in 1856. Bury ha a technical college and an art gallery and museum. The new tow hall was opened by Queen Elizabeth II in 1954. Bury, incorporated in 1876, was made a county borough in 1888.

BURYAT AUTONOMOUS SOVIET SOCIALIST REPUBLIC (BURYATSKAYA AVTONOMNAYA SOVETSKAYA SOTSIALISTICHESKAYA RESPUBLIKA), a republic of the Russian Sovie

Federated Socialist Republic, U.S.S.R., is in eastern Siberia, ying along the eastern side of Lake Baikal (*q.v.*) with a "panhandle" extending westward beyond the southern end of the lake. Its area is 135,636 sq.mi. (351,300 sq.km.). The Buryat-Mongol Autonomous Soviet Socialist Republic was created in 1923 by the union of the Buryat-Mongol and Mongol-Buryat autonomous *oblasti*. "Mongol" was dropped from the name in July 1958.

The territory is extremely mountainous. The panhandle is occupied by the eastern Sayan fold mountains, the main ranges of which rise to more than 10,000 ft. Mt. Munku-Sardyk on the Mongolian frontier reaches 11,457 ft. and has small glaciers. The main valleys of this part are those of the north-flowing Oka and east-flowing Irkut. East of Lake Baikal lies a vast complex of mountain ranges, plateaus and tectonic basins and valleys. A series of ranges parallels the eastern shore of Lake Baikal: the Khamar-Daban, Ulan-Burgasy, Ikatsky and Barguzinsky ranges. East of these, in the northeast of the republic, is the Vitim plateau, while along the eastern border of the republic rises the Yablonovy range. The region, uplifted in very early geological times, has undergone severe folding and fracturing in every major period of earth movements. Movement still continues and earthquakes occur. In the Selenga delta, there were 21 earthquakes recorded between 1734 and 1903. The chief rivers of this eastern part are the Selenga, with its tributaries, the Dzhida and Uda, the Barguzin and the upper Angara, all of which flow into Lake Baikal, and the Vitim, with its tributaries Amalat and Muya, flowing north to the Lena. The mountains are thickly forested, taiga (mostly coniferous forest) covering half the surface area of the republic. Dahurian larch makes up half the forest and pine one-quarter. Fir and Siberian "cedar," or stone pine, occur in the south and southwest. The intermontane basins and valleys have usually a steppe or meadow vegetation. The climate is dry, mostly with under 16 in. of rain a year, except at the southern end of Baikal, where it rises to 40 in. Winters are long and very cold although Baikal has a marked moderating effect on its immediate neighbourhood. Average January temperature in Ulan-Ude is −19° F. and average July temperature 68°.

Many minerals are found in the Buryat republic. Placer gold occurs in several areas, notably the Vitim plateau, where it is also mined. Wolfram and molybdenum are mined in the Dzhida valley. Iron, often together with titanium, occurs in the Khamar-Daban and Ulan-Burgasy ranges. In the eastern Sayans are found bauxite, apatite (used for phosphate fertilizers), graphite, asbestos and mica. The graphite was exported in the 19th century to Nürnberg, Ger., but is no longer worked. Coal is mined in the Dzhida valley and lignite near Gusinoozersk.

Russians entered the area in the mid-17th century, meeting strong opposition from the Buryats. Russian forts were set up at Verkhne-Angarsk (Irkana) in 1646, Barguzin in 1648 and Verkhne Udinsk (now Ulan-Ude) in 1666. Two major Buryat revolts took place before they were finally subdued. The Russians first sought gold and furs, and colonization reached significant proportions only after the coming of the Trans-Siberian railway at the end of the 19th century. Since the time of the Russian contact, the Buryats ceased being nomadic herdsmen, adopted agriculture and became sedentary. As such they gave up their former dwelling, the felt tent, and moved into permanent wooden structures typical of peasant life throughout Siberia.

The population in 1970 (prelim.) was 812,000, most of whom were Russian. In 1959 there were 252,000 Buryats in the whole Russian S.F.S.R., forming only 0.2% of the population. The Buryats also have two national *okruga* outside the Buryat A.S.S.R., in Irkutsk and Chita (*qq.v.*) *oblasti*. In the north of the republic live a few Evenki (Tungus). Of the population 362,000, or 45%, are urban, chief towns being Ulan-Ude (*q.v.*), the capital (254,000), and the mining centres of Gusinoozersk and Zakamensk.

The major branch of agriculture remains stock raising and large herds of cattle and sheep are kept. Horse breeding is important. In the Sayans, the Buryats keep *khayniki*, a yak-cow cross. In remoter areas nomadism persists. The Evenki have reindeer herds. The chief area of cultivation is the broad depression of the Selenga valley, the most densely populated region. Spring wheat, potatoes, vegetables and some sugar beet are grown. The Buryat republic is one of the areas where considerable acreages were plowed in the 1950s under the Virgin Lands project. Timber working is steadily developing, especially northeast of Baikal, where the timber is rafted across the lake to Irkutsk, and in the Uda valley, with Ulan-Ude as the main sawmilling centre. Furs are obtained either by hunting (chiefly squirrel and sable) or from farms (silver fox and raccoon). Fishing is important on Lake Baikal. Industry, apart from mining, is largely concentrated in Ulan-Ude, with its locomotive and rolling stock building, light engineering, meat-packing, sawmilling, glass and clothing industries. Zakamensk has a wolfram-molybdenum ore-enriching plant. The republic is traversed by the Trans-Siberian railway, with a branch from Ulan-Ude to Ulan Bator in Mongolia. Roads join Ulan-Ude to Ulan Bator and Irkutsk. Another road into Mongolia, from Irkutsk, crosses the panhandle by the Irkut valley. (R. A. F.)

The northernmost of the major Mongol peoples, the Buryats are related by language ties, history, habitat and economic type to the Khalkha Mongols, or Mongols of Outer Mongolia, the Mongols of Inner Mongolia and Manchuria, and the Kalmyks (Oirats), who together form the principal Mongol peoples. The Buryats are among the smaller of these groups; they numbered about 300,000 in the 1960s.

The origins of the Buryat are not clear. The entire people is divided into a number of patrilineal clans, each with its own name. Some of these names appear in the historical treatise of the Persian author and statesman, Rashid al-Din, at the beginning of the 14th century. Part of the Buryat population is not native to the region. A plausible theory is that they were formed as an ethnic unit from various elements in the course of settlement of their present territory during the 13th–14th centuries.

In their traditional social organization they were separated into noble and common strata; in addition, they had a small number of slaves. They lived in patrilineal families grouped into kin-villages, clans, and clan-confederations. The more permanently organized confederations were ruled by princely dynasties.

By tradition they are a nomadic pastoral people whose stock consists of cattle, horses, sheep, goats and a few camels. In addition, they had a highly organized battue, or hunting surround.

In their religious life the Buryats have an intricate combination of shamanist and Buddhist traits. The eastern Buryats, under the closer influence of the Khalkha Mongols were more thoroughly Buddhist in their rite than the western. Some Buryats became Russian Orthodox Christians during tsarist times (*see* SHAMANISM: *Asia*).

See also CHITA; MONGOL: *Affiliations and Origins: Homeland;* MONGOLIA: *Anthropology;* MONGOLIAN LANGUAGE.

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BURY ST. EDMUNDS, a municipal borough and market town of West Suffolk, Eng. (of which it is the county town), lies on the left bank of the Lark, a tributary of the Great Ouse, 26 mi. N.W. of Ipswich. Pop. (1961) 21,179. At Beodricesworth, as the town was first called, Sigebert, king of the East Angles, is said to have founded a monastery about 630 which may have come to an end during the Danish invasions 865–870. The remains of St. Edmund, the East Anglian king martyred by the Danes in 869, were translated there early in the 10th century. The saint's shrine became a place of pilgrimage and from him, by the 11th century, the town took its name. About 1020 Canute founded a Benedictine abbey to serve the shrine. Canute was also probably the founder of the monastic borough and, about 1044, Edward the Confessor gave the abbots jurisdiction over West Suffolk. The town is associated with Magna Carta for, in Nov. 1214, the English barons are said to have taken oath in the abbey church to compel King John to accept their demands. By the time of Henry I the abbots had obtained grants or confirmations of a mint, a market and a fair. However, the burgesses demanded self-government and there were repeated armed revolts between 1264 and 1381. A royal charter of incorporation was granted in 1606.

The 12th-century precinct wall contains fine surviving monastic buildings including the 14th-century abbey gate and the 12th-century Norman bell tower (still in use). Two ancient parish churches were built by the abbots for the townspeople. St. James's, since 1914 the cathedral church of the diocese of St. Edmundsbury and Ipswich, is largely the work of John Wastell (early 16th century). St. Mary's (early 15th century) contains the tomb of Mary Tudor, sister of Henry VIII; angels in the nave roof represent a contemporary procession to the high altar. Moyses hall, an original Norman dwelling house, is now a museum. The grammar school was founded in 1550. A fashionable resort in the 18th century, the town retains much of its Georgian character. The town hall (*c.* 1780) is the work of Robert Adam and the fine Athenaeum ballroom is in the Adam style. A Queen Anne house called Angel Corner contains a remarkable collection of clocks. The Angel hotel was visited by Dickens and appears in *Pickwick Papers.*

The centre of an agricultural area, Bury St. Edmunds has a corn exchange, stock markets and a biweekly provision market. Formerly it had a large woolen trade. There are agricultural engineering works, a brewery, timber yards and a beet sugar factory.

Buildings of interest in the vicinity include the 16th-century Hengrave hall, 3 mi. N.W., built by Sir Thomas Kytson; Culford hall, 4½ mi. N.W., built by the 1st Marquess Cornwallis, but since much altered: and Ickworth house, 3 mi. S.W., begun by the 4tb earl of Bristol, bishop of Derry. (M. P. S.)

BUS: *see* Motor Transportation.

BUSBECQ (Busbeck), **AUGIER** (Ogier) **GHISLAIN** (Ghiselin) **DE** (1522–1592), Flemish diplomat and man of letters who, as ambassador to Constantinople, wrote informatively about Turkish life. Born at Comines in eastern Flanders, the illegitimate son of the seigneur de Boesbec, he was later legitimated. He entered the service of Ferdinand I of Austria, brother of the emperor Charles V, and in 1554 and 1556 was sent to the court of Suleiman the Magnificent, who disputed Ferdinand's claim to the throne of Hungary. On his second visit he was placed under domiciliary arrest by the sultan, but finally succeeded in framing peace terms, ratified after his return to Vienna in 1562. Ferdinand became emperor in 1558, and Busbecq held various positions at the imperial court; he spent his last years at the French court as treasurer to Elizabeth of Austria, who married Charles IX in 1570, and as ambassador for Maximilian's son, Rudolf II. He died at St. Germain, near Rouen, on Oct. 28, 1592.

Busbecq's Latin letters to Ferdinand and Rudolph from Constantinople and the French court were long admired for stylistic elegance, and were regarded as models by later ambassadors. The former especially are a valuable source for contemporary history and manners. A man of lively interests, Busbecq collected Greek manuscripts (later incorporated in the Austrian national collection), and also coins and inscriptions; and it was he who discovered the Monumentum Ancyranum (*q.v.*). As a result of meeting at Constantinople two ambassadors from the Crimea, he made, and included in his fourth letter, the first list of words from a form of Gothic still in use there (*see* Gothic Language). He also introduced into Europe plants from the Levant, among them the lilac and the tulip.

Bibliography.—Busbecq's four letters from Turkey and his letters to Rudolph II, first published in 1589 (*Legationes Turcicae epistolae quatuor*) and 1630 (*Epistolae ad Rudolphum II*), were included in the Elzevir editions of his *Opera . . .* (Leiden, 1633; Amsterdam, 1660). For an English translation, *see* C. T. Forster and F. H. Daniell, *Life and Letters of Ogier Ghiselin de Busbecq*, 2 vol. (1881); *The Turkish Letters of Ogier Ghiselin de Busbecq*, trans. from 1633 Elzevir ed., by E. S. Forster (1927; repr. 1968). *See* also E. Schröder, *Busbecqs Krimgotisches Vokabular* (1910); Royal Flemish Academy, *Augerius Ghislenius Busbequius* (1955; with bibliography). (R. F. Ls.)

BUSBY, RICHARD (1606–1695), British scholar and teacher, traditionally a great flogging headmaster, was born at Lutton in Lincolnshire on Sept. 22, 1606, and was educated at Westminster School and Christ Church, Oxford, where he graduated in 1628. For his support of the royal cause he was restored to the prebend's stall at Wells and created a prebendary of Westminster. From 1638 (confirmed in 1640) until his death he was headmaster of Westminster School. Tradition has probably exaggerated his use of the rod, though there is no doubt that Busby followed the common practice of the period. Sir Peter Lely's sketch, *Sedes Busbiana,* was presented to Busby by Charles II. At the back of the chair a birch rod figures in the coat of arms with the motto *In hoc signo vinces* ("In this sign thou shalt conquer").

Busby gained a great reputation as a classical scholar, and in 1660 the University of Oxford conferred a doctorate on him. Among his famous pupils were John Dryden, John Locke, and Christopher Wren. Busby wrote and edited many schoolbooks for the use of his scholars, mainly Greek and Latin grammars. He died on April 6, 1695. (S. J. C.)

BUSBY, the English name for a military headdress made of fur. Possibly the original sense of a "busby wig" came from association with Richard Busby, headmaster of Westminster School from 1638–95; but it is also derived from the "buzz wig," which was frizzled and bushy. In its first Hungarian form, the military busby was a cylindrical fur cap, having a bag of coloured cloth hanging from the top. The end of this bag was attached to the right shoulder as a defense against sword cuts.

In Great Britain, busbies are of two kinds: (1) the Hussar busby, cylindrical in shape, with a bag, worn by Hussars and the Royal Horse Artillery; (2) the rifle busby, a folding cap of Astrakhan fur, in shape somewhat resembling a Glengarry cap, but taller. Both have straight plumes in the front of the headdress.

The word "busby" also is used colloquially to denote the tall bear-and-raccoon-skin caps that are worn by the Foot Guards and the Fusiliers, and also the full-dress feather bonnet of the Highland Infantry. Cylindrical busbies formerly were worn by the Artillery Engineers and Rifles but are now obsolete in the regular Army

BUSCH, JULIUS HERMANN MORITZ (1821–1899) German writer known for his eyewitness accounts of Bismarck He was born at Dresden on Feb. 13, 1821, and studied theology at Leipzig. After a visit to the United States (1851–52) he traveled in Palestine, Egypt, and Greece (1856–59) and later edited the weekly journal *Die Grenzboten* with Gustav Freytag (*q.v.*). In 1864 he became a press official for the duke of Augustenburg but after 1866 entered the service of the Prussian government. In the Franco-German War he accompanied Bismarck as one of his press agents. From 1873–75 Busch was editor of the *Hannoverscher Kurier* but then became a free-lance writer and was official publicity agent in Berlin and Leipzig until 1890. He died at Leipzig, Nov. 16, 1899.

The accounts of Bismarck which gave Busch his fame or notoriety are mainly contained in *Graf Bismarck und seine Leute während des Krieges mit Frankreich,* two volumes (1878), and *Tagebuchblätter,* three volumes (1899). There is an English version of the latter, *Bismarck: Some Secret Pages of His History,* which was published a year earlier in 1898 and has independent value The English version, which Busch sold to the firm of Macmillan contains his earlier work on Bismarck plus later additions, and it includes sharp passages which had been struck out of the German edition of 1878, as well as accounts of later conversations, etc The German *Tagebuchblätter,* however, contain corrections. Both the English publication and the subsequent German one mus therefore be used. Busch was neither a historian nor a creative biographer, but he could record what he saw, though allowance must be made for the limitations of his vision.

BUSCH, WILHELM (1832–1908); German painter and poet was best known for his wise, satiric drawings, accompanied by his own short rhymes, chastising human weaknesses. He was born at Wiedensahl in Hanover on April 15, 1832, and studied at the academies in Düsseldorf, Antwerp, and Munich. In 1859 he began to contribute his picture sheets (*Bilderbogen*) to *Fliegende Blätter* the leading German comic weekly. These were followed by his humorous illustrated poems such as *Max und Moritz, Der heilige Antonius von Padua, Die fromme Helene, Hans Huckebein, Di deldum, Herr und Frau Knopp,* and many others. Busch's works were translated into many languages. By 1910 over a half million copies of *Max und Moritz* had been printed in German. Busch' work still enjoys great popularity; he is one of the most quoted writers in German-speaking countries. His picture sheets, *i.e.*

series of comic sketches telling stories without words, can be regarded as precursors of the comic strip. His style, copied by innumerable artists, was remarkable for its extreme simplicity. His pen line was able to record with a few rapid scrawls the most complicated contortions and the most transitory movement. In 1878 he retired to his native province of Hanover, taking up the life of a country squire but continuing occasionally to publish poems or pieces of prose based on the experiences of a long life. He died n Mechtshausen, Ger., on Jan. 9, 1908.

See Wilhelm Busch, *Sämtliche Werke*, 8 vol. (1943). (Hs. H.)

BÜSCHING, ANTON FRIEDRICH (1724–1793), German geographer and educationalist whose main achievement was to put geography on a scientific basis, even if this was limited to he political and statistical side. Born in Sept. 1724 at Stadthagen, Lower Saxony, he studied theology at Halle. A journey in 1749 to St. Petersburg as tutor to the family of the Danish minister made him decide to write a new kind of world geography. After a period from 1754 as professor of philosophy at Göttingen, he went again to St. Petersburg in 1761 as pastor to the Lutheran congregation. On his return to Germany he was in 1766 appointed headmaster of the famous *Gymnasium zum Grauen Kloster*, ounded by Frederick the Great, a post which he held until his death in Berlin on May 28, 1793. Through his reforms he became ts most outstanding head during the 18th century and also gave great impulse to education in Germany. The most important of his publications, which range through many subjects and number over 100, are his educational and geographical writings, notably his *Neue Erdbeschreibung* ("New Geography"). This work began to appear in 1754, but by the time of his death only the ections dealing with Europe and a part of Asia had been published. The first parts saw eight editions (Eng. trans. by P. Murdoch, vol., 1762).

His son, Johann Gustav Gottlieb Büsching (1783–1829), became professor of German archaeology at Breslau and did important pioneer work in this field.

See E. Plewe, *Stuttgarter Geogr. Studien*, 69 (1957). (K. A. S.)

BUSEMBAUM (Busenbaum), **HERMANN** (1600–1668), Jesuit theologian, was born at Nattuln, Westphalia. His celebrated book, *Medulla theologiae moralis, facili ac perspicua methodo resolvens casus conscientiae ex variis probatisque auctoribus concinnata* (1645 or 1650), saw over 200 editions before 776, was the basis of subsequent commentaries by a number of minent moralists and was used as a textbook in many seminaries. Despite contrary allegations, Busembaum was never condemned by Rome and is recognized still by Catholic moralists as a model f theological orthodoxy.

There is no textual foundation for the accusation (popular in mid-18th-century France, where in 1757 his book was publicly burned by civil authorities) that the *Medulla* condones regicide r defends the theory that a laudable purpose justifies an intrinsically evil means. Evidence of the esteem accorded Busembaum n the Society of Jesus are his appointments as provincial's assistant, rector of the college of Hildesheim and rector (twice) at Münster, where he died on Jan. 31, 1668.

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(J. J. L.)

BUSHEL: *see* Weights and Measures.

BUSHIDO, the code of moral principles that developed among he samurai (military) class of Japan, especially during and after he Kamakura period (12th century ff.), on a basis of national tradition influenced by Zen and Confucianism. The first use of he term apparently occurred during the civil war period of the 6th century; its precise content varied historically as samurai andards evolved. Its one unchanging ideal was martial spirit, ncluding athletic and military skills as well as fearless facing of he enemy in battle. Frugal living, kindness and honesty were also ighly regarded. Like Confucianism, Bushidō required filial piety; but, originating in the feudal system, it also held that the supreme honour was to serve one's lord unto death. If these obligations conflicted, the samurai was bound by loyalty to his lord despite the suffering he might cause his parents.

The final rationalization of Bushidō thought occurred during the Tokugawa period (17th century ff.), when Yamaga Sokō (1622–85) equated the samurai with the Confucian "superior man" and taught that his essential function was to exemplify virtue to the lower classes. Without disregarding the basic Confucian virtue, benevolence, Sokō emphasized the second virtue, righteousness, which he interpreted as "obligation" or "duty." This strict code of honour, affecting matters of life and death, demanded conscious choice and so fostered individual initiative while yet reasserting the obligations of loyalty and filial piety. Obedience to authority was stressed, but duty came first even if it entailed violation of statute law. In such an instance, the true samurai would prove his sincerity and expiate his crime against the government by subsequently taking his own life.

By mid-19th century, Bushidō standards had become the general ideal, and the legal abolition of the samurai class in 1871 made Bushidō even more the property of the entire nation. In the public educational system, with the emperor replacing the feudal lord as the object of loyalty and sacrifice, Bushidō became the foundation of ethical training. As such, it contributed both to the rise of Japanese nationalism and to the strengthening of wartime civilian morale up to 1945. *See* also Japan: *The People*.

(D. M. Ea.)

BUSHIRE (Bushahr; formerly Abu Shahr), a port of Iran near the head of the Persian Gulf, is situated on the northern end of a flat peninsula connected with the mainland by a four-to-six-mile-wide neck of tidal marshes. It was the seat of the former Governorship of the Persian Gulf, now included in the Persian Gulf and Ports, including the Sea of Oman *ostan*. Pop. (1966) 23,547 (more Arab than Persian). On its frontage the town shows substantial two- and three-storied houses built in the peculiar gulf style, but the remainder, and the extensive bazaars, are poorly built. The ordinary water supply is slightly brackish; a limited amount of drinking water is obtainable from a condensing plant erected by the British outside the town. The climate is that of the gulf, oppressive with the combination of heat and humidity in summer, but moderated by northwestern winds at times. Many country houses are scattered about the parklike land south of the town.

Bushire has an outer and an inner anchorage, the former with deeper water but open to the winds; port equipment is mediocre. It is the terminus of the important ancient trade route to Shiraz, Isfahan, and Teheran, which was rebuilt for motor traffic but is handicapped by several steep ascents like the famous Kotal-e Dokhtar and Kotal-e Pireh Zan (7,390 ft. [2,250 m.]). Teheran can be reached in four days. In the mid-1960s the trade of Bushire amounted to about 75,000 tons annually. An additional amount of oil products is handled. Imports include sugar, cement, and steel and largely exceed exports, which include dried fruits, gums, and raw cotton. The construction of the Trans-Iranian Railway, the headports of which are Bandar-e Shahpur and Khorramshahr, has had an adverse influence on Bushire's trade. Since the 1930s many people have left the town; others emigrate seasonally to Bahrain, Abadan, and Kuwait. Two small textile mills are located at Bushire.

Bushire dates from comparatively modern times. Its forerunner was Rishire (Rishahr), about 5 mi. to the south on a small, fairly deep bay. Portuguese maps of the 16th and 17th centuries show Rishire as the chief emporium of the Persian coast. Its ruins were used as a quarry for Bushire. For a short time it was revived by the British during World War I. Bushire was founded and destined to be the base of the Persian navy by Nadir Shah in 1736. Though his scheme came to nothing, his interest in the town had the effect of concentrating there the trade of the Persian Gulf—mainly at the expense of Bandar Abbas (*q.v.*). The British East India Company finally transferred its trading activities in Persia from Bandar Abbas to Bushire in 1759 and Bushire became increasingly important. Bushire was temporarily occupied by British forces in the course of the war with Persia in 1856–57, and again during World War I. Its role during World War II was insignificant. The British consulate general was suppressed as a consequence of the oil conflict in 1951. (H. Bo.)

BUSHMAN, a term used by early European settlers in South Africa for peoples whom their Hottentot (*q.v.*) neighbours originally called San—a name that anthropologists are now tending to revive.

Formerly, the Bushmen were supposed to be readily identifiable by physical features, language, and culture. First, by the physical reckoning, the Bushman was identified entirely from external features: light-coloured skin with a tendency to wrinkle; dark hair, tightly coiled in small spirals; small, broad heads; flattish faces and broad noses; prominent buttocks. None of these features, however, is exclusive to Bushmen; and in other, not directly observable features (such as blood-groups), Bushmen have been recently shown to be similar both to Hottentots and to Bantu. Second, some Bushman groups (*e.g.*, the Gwi), who practise the supposedly typical economy of hunting and gathering, are said to speak Hottentot languages, which have click consonants in common with those of the San but are not necessarily related to them; nor indeed is it certain how the various San language-families, of which there are at least four, are related to each other (*see* AFRICAN LANGUAGES; BUSHMAN LANGUAGES). Third, most of the surviving Bushmen have been restricted—by European settlement or by pressure from tribal Africans of other stock—to unattractive semi-arid areas, so that many of them have to work, temporarily or permanently, for wages on European farms or to continue in a longstanding kind of client relationship with the other Africans (especially the Tswana), whom they serve as hunters, cattle herders, or labourers in return for provision of food, livestock, clothing, and tobacco. Therefore they no longer fit easily into a distinct cultural category. In fact, Bushmen who can now (often doubtfully) be classified as such by physique, language, or mode of life number scarcely more than 50,000 (20,000 in southwestern Africa; about 30,000 in northern Botswana; a few thousand in Angola; and a handful in Zambia). For practical purposes, it seems preferable to reserve the term Bushmen for groups such as the Auen, Kung, and Gwi some of whom retain the "band" organization of hunters which must now be described.

A Bushman band may comprise several families (totaling some 40–60 persons among the Gwi and some 25–30 persons among the Kung). The elementary family within the band is composed of husband, wife, and their dependent children, but it is occasionally enlarged by polygynous marriage. Among the Kung and the Gwi a man may undertake "bride service" for some years, which means hunting and generally helping his parents-in-law, and, should he marry into another band, he may live with them, thus forming an extended family. Often all band members are related. Considerable interaction through trade, visiting, and particularly marriage may take place between bands; and kinship, both real and fictional, ramifies widely, thus facilitating the frequent movement of people from band to band, so that the composition of any particular band may fluctuate considerably in time. Notwithstanding these ties, Bushman bands do not permanently combine to form wider social or political groups. Each band is an autonomous unit within its own territory, and in most bands influence rather than authority may be exercised in particular situations by skilled hunters or older men—although Kung bands have hereditary custodians with some control over the use of water and vegetable foods in their territory. Nowhere are there chiefs with the power to punish wrongdoers, and individuals obtain satisfaction by self-help or, for grievous offences, by blood vengeance, though violence is much feared and seems to be uncommon. Persistent offenders who threaten the peace of the whole band are subject to withdrawal of cooperation or even expulsion from the band.

In most Bushmen bands the members camp together regularly—unless they do so for the rainy season only, dispersing as single family groups in the dry weather. Their individual shelters are flimsy, semicircular structures of branches laced with twigs and thatched with grass; their equipment is portable; their possessions few and light. Woods, reeds, animals (and, formerly, stone) are the main raw materials from which their skin clothing, carrying bags, water containers, and hunting weapons are made. For hunting they use bows and poisoned arrows, snares, throwing sticks and sometimes spears. They have, most probably, always fed on game, wild vegetables, fruits, nuts, and insects; as game becomes less plentiful, they are forced to rely increasingly on gathering or, ultimately, into abandoning their old means of subsistence altogether. The women usually build shelters, collect wild foods and firewood, draw water, and cook. The men hunt much of their time but also make utensils and skin garments.

The introduction of adolescents into adulthood is formalized. Girls are treated individually with a ritual procedure that, among the northerly groupings, includes the allegorical eland dance. Among most surviving Bushmen, boys are given training in hunting and submit to ritual scarification. These and other ceremonial activities are directed by specialists, who are also concerned with rainmaking and the magic of successful hunting; other such specialists treat physical ailments.

The religions of the Kung and the Gwi seem to be similar, in that both groups believe in two supernatural beings, one of which is the creator of the world and of living things, whereas the other has lesser powers, but is partly an agent of sickness and death. The Kung and the Gwi also believe in spirits of the dead, but do not practise the cult of ancestors familiar among the Bantu.

Bushmen were once widely distributed over southern Africa in unknown numbers. Extinct groups have left notable paintings and engravings, but these arts are not practised by their survivors, who, however, retain dancing as a major form of artistic expression.

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BUSHMAN LANGUAGES are spoken in southern Africa and belong to the same linguistic family as the Hottentot languages.

Classification.—There has been considerable confusion about the membership of these two major branches, or subfamilies, of what has in recent times come to be called the click or Macro-Khoisan language family. Nonlinguistic considerations, such as the great cultural differences between the pastoral Hottentots and the hunting and food-gathering Bushmen, have been introduced into discussions of the problem; in addition, Carl Meinhof's classification of the Hottentot languages as Hamitic, on the basis of a few very tenuous typological resemblances, further bedeviled the situation, and attempts to re-examine the matter were inhibited by his eminence and stature as an Africanist. The result has been that the Bushman and Hottentot languages have been regarded by many as genetically quite distinct, and even when the over-all relationship has been acknowledged it has been generally assumed that the languages spoken by peoples of Bushman culture constitute a category quite distinct from those spoken by peoples of Hottentot culture.

Thus in the past a subdivision of the Bushman languages into three groups, termed Northern, Central and Southern, has been generally accepted. The so-called Central Bushman languages are very closely related to the Hottentot tongues and should be classified in one linguistic branch with them.

To avoid the confusion arising from the cultural connotations of the terms Hottentot and Bushman, it is preferable to use the terms "Khoi" and "San" for the linguistic divisions. Some of the Bushman languages, *i.e.*, spoken by peoples of Bushman culture, are of Khoi type, while others are of San type. There are the following major divisions within the Macro-Khoisan family:

1. Khoi branch
   - a. Hottentot group, including Nama, !kora (almost extinct), Grikwa (extinct)
   - b. Central Bushman group, including Naron, Hie, G/wi, G//ana, /aba
2. San branch
   - a. Northern Bushman group, including //ãũ//ˀẽ, !kuŋ, !o!kuŋ
   - b. Southern Bushman group, including /auni, N/usan, ≠khomani, !xõŋ
3. Sandawe (Tanganyika)
4. Hadza (Tanganyika)

E. O. J. Westphal recognizes a greater affinity between Sandawe (*q.v.*) and the Hottentot and Central Bushman group languages, which requires the inclusion of Sandawe in the Khoi branch, and he suggests a closer relationship between Hadza and the Northern and Southern Bushman groups, which would include Hadza in the San branch. Information on the vast majority of the Macro-Khoisan languages, however, is still fragmentary, so that any attempt at internal classification remains highly tentative. Their unique phonological structures present special problems, and relatively little linguistic research has yet been carried out. Listing and classification is complicated by the existence of numerous nicknames, used, *e.g.*, by the Bantu peoples, and of orthographically variant forms of their own names as recorded by different writers. Their inaccessibility in the desert regions of the Kalahari, their nomadism and the lack of social units larger than the hunting band (seldom more than an extended family) all serve to complicate both field research and attempts to keep track of their ethnic or linguistic affiliations.

Geographic Distribution.—Following the tentative classification set out above, discussion of the Bushman languages is here confined largely to those of the San branch, but references are made to the languages of the Khoi branch wherever necessary. Geographically, the Bushman groups are distributed roughly as follows: Northern group (San) in southern Angola, northeastern areas of South-West Africa, northwestern regions of Botswana; Southern group (San) in the southwestern areas of Botswana, adjacent regions of South-West Africa and northern Cape Province; Central group (Khoi) in the central and northern regions of Botswana.

In former times, Bushman and Hottentot peoples ranged very widely in Cape Province, Orange Free State, Basutoland and Transvaal, but these are almost entirely extinct. Only the scantiest record of their languages remains and their relationship and classification are a matter of conjecture.

Phonology.—The most striking feature of the Bushman languages, as of all the Macro-Khoisan tongues, is their extensive and unique use of click sounds (*see* CLICKS). There are certain Bantu languages, notably those of the Nguni (Zulu-Xhosa) group, which have acquired these consonants as a result of contact with the Khoisan peoples. However, the plain nonclick consonants are obviously fundamental in the Bantu languages, whereas in the Khoisan languages the clicks dominate and form the basis of the consonantal phonology. They constitute a complete or near-complete, consistent and fully symmetrical series, whereas the nonclick consonants are often haphazard and asymmetrical in their pattern distribution. The clicks also occur much more frequently than the other consonants, most word roots having an initial click consonant. These features indicate that the clicks are the original consonants of these languages and that many of the nonclick consonants may be later acquisitions or developments.

Six positional types of clicks occur, but no one language is known to employ more than five of them. Most of the languages have four types, usually represented by / (dental), ≠ (alveolar), ! (palatal), // (alveolar-lateral). In addition, most of the Southern group languages have a labial click, ⨀, while a retroflex click, ///, has been reported for one language, !khũ, of the Northern group. Each of the clicks may be voiceless, voiced or nasalized, and further combinations may occur with glottalized, aspirated and velar fricative releases. The following table illustrates the series of basic clicks and combinatory clusters occurring in //ãũ//ˀẽ (Northern group):

	Dental	Alveolar	Palatal	Lateral
Voiceless	/	≠	!	//
Voiced	g/	g≠	g!	g//
Nasalized	n/	n≠	n!	n//
Glottalized	/ˀ	≠ˀ	!ˀ	//ˀ
Aspirated	/h	≠h	!h	//h
Voiceless velarized	/x	≠x	!x	//x
Voiced velarized	g/γ	g≠γ	g!γ	g//γ
Aspirated velarized	/hx	≠hx	!hx	//hx
Nasalized aspirated	n/h	n≠h	n!h	n//h

The nonclick consonants are characterized by the absence in most of the languages of a voiceless labial stop, *p*, although there is usually a voiced labial stop, *b*. The bilabial fricative, *β*, is common but the dentilabials, *f* and *v*, have not been recorded, and the lateral *l* is rare, whereas a flapped *r* or *d* occurs regularly. The glottal catch, ˀ, has consonantal function in all the languages, and velarized and glottalized release of stop consonants is common. The following nonclick consonants, including some clusters, have been recorded for //ãũ//ˀẽ:

Labial	Dental	Alveolar	Prepalatal	Velar	Glottal
	t	ts	tš	k	ˀ
b	d	dz		g	
	tˀ	tsˀ			
		tsh	tšh	kh	
	dh	dzh			
		tsx		kxˀ	
	dγ				
		tshx	tšhx	khx	
		s	š	x	h
		z	ž		
m	n			ŋ	
		r		w	

There are usually at least six vowel phonemes, *i*, *e*, *a*, *o*, *u*, and central ə, all of which may be nasalized, *e.g.*, *ã*, or occur with contrast of long : short. Vowel clusters (diphthongs) are common. For many of the languages pharyngalization or "pressing" of vowels has been reported, but it is not clear precisely what the function of this feature is.

Syllabic structures may consist of a single vowel (V) or consonant (C), or sequences of as many as four clustered consonants with one or two vowels. Syllables of the type CVC also occur, usually with nasal consonants in final position, and monosyllabic words consisting of click consonant plus syllabic nasal are common. Root words are mostly monosyllabic, and forms with three or more syllables are obvious compounds in most cases. All Bushman languages are tone languages and as many as five tonal levels or glides have been reported, but it is doubtful whether more than three of these are phonemically distinctive.

The following examples illustrate some of these syllabic and tonal features, the syllables being separated by hyphens and the tones distinguished by acute accent (high), grave accent (low) and unmarked (mid).

m-ba	"my father"	*≠wi*	"caracal"
ˀa-ba	"your father"	*≠xwí*	"hair," "feathers"
à-ba	"his father"	*≠hxwí*	"tail of animal"
m	"eat"	*/xí*	"foot," "paw," "toe"
/m	"sun," n.	*g/γí*	"scorpion"
n/ðm	"spring hare"		
to-ḿ	"approach," v.	*≠a*	"plain," n.
m-ḿ	"suck," as an infant	*≠ã*	"await," v.

Morphology.—There is considerable variation in the morphological structures of the Bushman languages. Those of the Central group (Khoi), like the Hottentot languages, have a fairly extensive range of suffixal inflections of substantives to express number, gender and case. They commonly have three categories of grammatical number: singular, dual and plural. There are three genders or classes of nouns: masculine, feminine and common. However, strong, tall or slender objects are treated as masculine, and weak, short or round ones as feminine, so that the classification extends beyond strict distinctions of sex. The so-called case inflections are actually postpositional particles or enclitics, expressing temporal, locative, associative, instrumental and possessive relationships, but sometimes variant forms of the gender suffixes are required with these. The possessor precedes the thing possessed. Examples from Naron:

	Masculine	Feminine	Common
Sing.	*kweba* "man"	*kwesa* "woman"	*kwe* "person"
Dual	*kwetšəra* "two men"	*kwešəra* "two women"	*kwekhara* "two persons"
Plural	*kwe//kwa* "men"	*kweši* "women"	*kwene* "people"

Masculine sing.	*kwe-ba*	"a man"
	kwe-m-di	. . . "a man's . . ."
	kwe-m kwe	"with a man"

These languages have an extensive series of pronouns representing the three persons, numbers and genders. Adjectives may either precede or follow the nouns which they qualify and some are inflected suffixally while others are invariable. In verb conjunction various tense particles or auxiliaries are employed, usually preceding the verb itself. In most accounts these auxiliaries have been recorded as separate words, but further investigation may reveal some or all of them to be affixal. In all the languages, particles and inflectional elements rarely incorporate click consonants, which occur almost exclusively in word roots.

By contrast with the Central group (Khoi) languages, those of the Northern and Southern groups (San) have no system of gender inflections or distinctions, except sometimes in pronouns. To specify the sex of an animal, for example, its name is associated with a word meaning "male" or "female," or perhaps "man" or "woman." There are only two categories of grammatical number, singular and plural, though the distinction is not at all regularly observed. In the Northern group, a type of plural can be formed by suffixing *-sì*, which appears to be none other than the third person plural pronoun meaning "they." With some forms having a collective or quantitative significance, *-sì* occurs regularly; *e.g.*, in //ãũ//ˀẽ, *msì* "food"; *wāāsì* "all," "everyone"; *tsisì* "clothing," but in general no distinction between singular and plural is made unless to emphasize specifically the plurality of the objects referred to, whereupon *-sì* is suffixed. Thus: *gumi* "cattle" (one or more); *g/wi* "spotted hyena," "spotted hyenas"; *n!um* "stone," "stones"; *ʔəri* "guinea fowl" (one or more). However, there are a few instances in this language where a number distinction is regularly observed either by the use of two entirely different words or by a difference of tone: *!hwāā* "a man"; *n//ae* "men"; *žu* "a person"; *žú* "people."

In the Southern group, distinctions of number are commonly not expressed, but the use with nouns of pronominal forms meaning "this one" and "they" does occur, *e.g.*, in ≠khomani, while reduplication of the noun is used to express the plural in /xam and sometimes elsewhere. Adjectives usually precede nouns in the Northern group, but follow them in the Southern group. In all the San languages the word denoting the possessor precedes that signifying the thing possessed. In the Northern group no possessive particle occurs; in the Southern group it is usually *-ka*. Verb-tense distinctions are achieved mainly by the use of auxiliaries preceding the verb itself, as in the Central group. The sentence order in the San languages is subject-verb-object; in the Central group (Khoi) it is usually subject-object-verb.

In general, five distribution classes of words (parts of speech) may be recognized for Bushman languages—nouns, pronouns, adjectives, verbs and particles—but, except for the nouns in the Central group and some pronouns, there are no intrinsic features by which words can be identified as belonging to one or another of these categories. For example, a word can be identified as a verb only by establishing its potentiality for association with tense particles in verbal constructions; except in the languages where gender and number affixes are a regular feature, nouns can be identified only by their potentiality for association with a plural or possessive suffix, etc., or in specific syntactic sequences with verbs. However, there are probably many instances of word roots with dual potentialities; *e.g.*, in //ãũ//ˀẽ the root */ĩ* is either a verb, meaning "die," or a noun, meaning "death" (*cf.* English "cut," verb, noun or adjective).

Vocabulary.—As may be expected, the Bushman languages are rich in terms for the things of everyday life, including animal and plant life, hunting and food-gathering, weapons and veld lore. Obviously they lack terms for the technical devices and philosophical abstractions of western civilization. Numerals occur only for "one" and "two" or sometimes for "three," any greater number generally being designated "many." Having no domestic animals or many other possessions, there is no need for counting, and the tendency is to specify each object individually. This manifests itself in other ways; for example, the //ãũ//ˀẽ do not appear to have any generic terms for "snake" or "game animal," but each distinctive species of snake or other animal has its own name. Furthermore, when designating parts of wholes or associated things, specifying compounds are extensively used in a fashion which appears redundant to speakers of European languages: *žu-/xí* "person-foot," *dzu-/xí* "ostrich-foot," instead of simply */xí* "foot"; *daa-šuwa* "fire smoke," *šoro-šúwá* "tobacco smoke," rather than *šuwa* "smoke." However, many other such formations have parallels in European languages, as *g≠γwà-n/ĩ* "kneecap," lit. "knee-head"; *≠úm-!háá* "thigh" or "calf," lit. "leg-meat." In contrast with this specificity, there are intriguing instances of the reverse: */xí* "foot" or "toe"; *g≠ɔ̃ú* "hand" or "finger"; *≠xwí* "feather," "hair," "wool" or "whisker[s]"; *≠hwí* "string," "twine," or the plant used for making twine; *ku* "breast," "nipple," "teat," "udder" or "milk."

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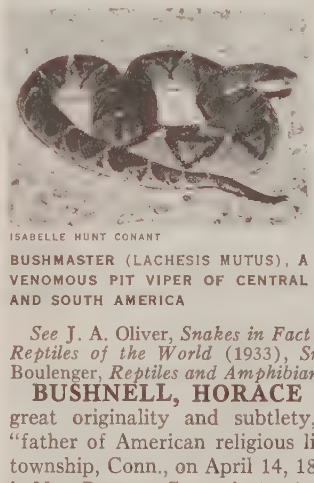
BUSHMASTER (*Lachesis mutus*), a member of the venomous pit viper family, Crotalidae, that occurs from Costa Rica and Trinidad to eastern Brazil Since it is confined to humid forest regions, it is seldom encountered. It is a handsome snake with a row of dark rhombs on a dull reddish or yellowish background The scales are tuberculate, giving it a rough appearance. It is unique among the American pit vipers because it lays eggs; it is also the longest, reported to attain 12 ft. Rodents constitute the principle food. The species does very poorly in captivity.



ISABELLE HUNT CONANT

BUSHMASTER (LACHESIS MUTUS), A VENOMOUS PIT VIPER OF CENTRAL AND SOUTH AMERICA

See J. A. Oliver, *Snakes in Fact and Fiction* (1958); R. L. Ditmars, *Reptiles of the World* (1933), *Snakes of the World* (1931); E. G. Boulenger, *Reptiles and Amphibians* (1914). (Jo. R. B.)

BUSHNELL, HORACE (1802–1876), U.S. theologian of great originality and subtlety, sometimes referred to as the "father of American religious liberalism," was born in Litchfield township, Conn., on April 14, 1802. The family moved to a farm in New Preston, Conn., in 1805. Bushnell joined the local Congregational church in 1821 and in 1823 entered Yale college, planning to become a minister. These plans changed, however; after graduation in 1827 he taught school for a time, served as associate editor of the *New York Journal of Commerce*, then returned to Yale to study law (tutoring in the college at the same time). Following a decisive religious experience in 1831, he entered the Yale theological department. In 1833 he was ordained minister of the North Congregational church in Hartford, Conn., where he served with distinction until 1859 when ill health forced his resignation. Thereafter he devoted himself chiefly to writing on theological subjects. Bushnell stood between the orthodox tradition of Puritan New England and the new romantic impulses represented by Ralph Waldo Emerson, Samuel Taylor Coleridge and, above all, Friedrich Schleiermacher (*q.v.*). Yet he was more than a mediator; his own contributions were large and long-lasting.

Bushnell's first major publication, *Christian Nurture* (1847;

nd ed., 1861), was probably also his most influential. Though oncerned chiefly with baptism, the family and education, it was lso a thorough critique of the great emphasis placed on the con- ersion experience by revivalism. Stressing the churchlike quality nd redemptive role of the family, as well as the familylike quality f the church, Bushnell insisted that a child of Christian parents hould never know when he had not been a Christian. *God in hrist* (1849) consisted of a dissertation on language and three ddresses dealing with the divinity of Christ, the atonement and roblems of dogma and spirit in the reviving of religion. The issertation on language expressed a persistent Bushnellian theme, mphasizing the social, symbolic and evocative nature of language, specially when it deals with religious faith and the mysteries of od. This controversial volume was amplified and defended in *hrist in Theology* (1851), with special attention being given to ne metaphoric aspects of theological language and to an "instru- iental" view of the Trinity. In *Nature and the Supernatural* 1858) he defined "nature" as that realm of being which is gov- rned by law, the "supernatural" as that which is not in the train f cause and effect but which acts upon the chain from without. eeing both as constituting the one "system of God," he sought defend from skeptical attack the Christian position on sin, iracle, incarnation, revelation and Christ's divinity. *The Vi- rious Sacrifice* (1866) and *Forgiveness and Law* (1874) provide iore complete statements on his moral view of the atonement and is deepening understanding of God's sacrificial love. He died Hartford on Feb. 17, 1876.

Bushnell's thought was bitterly attacked by conservatives, and 1852 North church withdrew from the local consociation in order preclude an ecclesiastical heresy trial. Nevertheless his thought as so coherent, his argumentation so plausible and his manner expression so persuasive that his interpretation of Christianity orked a powerful influence on the course of liberal theology in merica. He remains a major figure in the country's intellectual story. He is perhaps best remembered for his perceptions of ie social dimension of the person, faith and sin, and of the organic, ntextual character of human groups (such as the family, the ngregation or the nation). In a time of cultural fragmentation id intellectual ferment he profoundly illuminated the spiritual, oral and philosophical significance of these social relationships.

Most of Bushnell's works were reissued after his death, includ- g six volumes of sermons and essays: *Sermons for the New Life* 858), *Christ and His Salvation* (1864), *Work and Play* (1864), *oral Uses of Dark Things* (1868), *Sermons on Living Subjects* 872) and *Building Eras in Religion* (posthumously edited). *irit in Man: Sermons and Selections* (1903) contains previously ipublished papers and a bibliography by Henry B. Learned. *ristian Nurture*, ed. by L. A. Weigle, was reissued in 1916. ishnell's moderate and cautious views on social issues were set rth in *A Discourse on the Slavery Question* (1839); *The Census d Slavery* (1860); and *Women's Suffrage, the Reform Against ature* (1869). An essay on "Science and Religion" (1868) shows resistance to Darwinian evolutionary theory.

Bibliography.—On Bushnell's life and thought *see* the biographies Mary Bushnell Cheney, a devoted and scholarly daughter (1880; d ed., 1903); Theodore T. Munger (1899); and Barbara M. Cross 958). (S. E. A.)

BUSHRANGERS were men who lived, during the 19th ntury, in the Australian bush on the proceeds of robberies. ey traveled on horseback, raiding highways, country towns and lated dwellings and then disappearing into the bush country. At nes there may have been considerable economic and social stification for this activity: the first bushrangers were convicts o escaped from the small early settlements and often from the rsh discipline of the lash and from unfair treatment by those authority. The early bushrangers became such a problem that Bushranging act was passed in New South Wales in 1830 and nained in force until convict bushrangers had practically dis- peared at the date of gold discoveries in 1851. These, however, vided new incentive for highway and bank robberies, and, in 25 years which followed, bushrangers gained fame and noto- ty. The late 1860s and 1870s saw some renewed causes, if not justifications, of their activities. Most of the usable land had been taken up, and the exhaustion of alluvial gold meant that hundreds of thousands of men were forced to seek land or employment under unfavourable conditions. Legislation was enacted which reflected both the power of the wealthy and the impotence of the poor. The resultant contest for land brought unfairness, corruption and unscrupulousness. These circumstances encouraged crime, and sympathy for the bushrangers was often as widespread as was the feeling of social grievance.

The members of the Kelly gang were really the last of the bushrangers. They lived in northeastern Victoria and graduated to bushranging from cattle stealing, which, with a concomitant hatred of the police, was more general than many cared to admit. However, Ned Kelly (*q.v.*) and his gang were hardened criminals with no more honour than desperate men can afford. There are little or no grounds for beliefs about wrongful suspicions and arrests (assumed to excuse the Kellys) or for claims that they respected women and had the willing support of the people. Yet the contest between the Kellys and the police seems to have been treated as if the bushrangers were in the right and as if the authority of the police was to be denied. The arrest of Ned Kelly and the killing of his companions at Glenrowan in June 1880 was, however, a great relief to farmers and townspeople in Victoria and New South Wales. (J. F. C.)

BUSH WREN, the name given to a family of birds (Acanthisittidae) confined to the highland forests of New Zealand. There are four species of these tiny, wrenlike forms, related to the tyrant flycatchers (*see* Flycatcher).

BUSINESS CODES, a term applied to principles or standards of fair and ethical practice observed or agreed upon by particular industries or business groups. After the decade preceding World War I businessmen became increasingly concerned with the ethical aspects of their activities and with the inability of common law and statutes to prevent some members of most industries from cheating consumers and using unfair methods of competition against their competitors. Business codes are more or less systematic attempts to translate the ethics of the majority into standards of conduct enjoined upon all. During the 20th century this crystallizing and universalizing of business ethics has had its most notable development in the United States. (For European experience *see* Cartel.)

Nature of Business Codes.—The salient fact about business codes is that they are the product of a consensus among the businessmen concerned and the result of agreements on the part of those who will be governed by the codes. They are not imposed from without, but spring from within the group whose interests they are designed to advance. The interests of this relatively small group of businessmen overlap, in part, the interests of society in general; in part, also, the two sets of interests are inconsistent. The community of interest may be utilized to make business codes effective instruments of social control. The conflict of interest, on the other hand, can turn business codes into vehicles of private aggrandizement and public exploitation. A particular business code may socialize extreme manifestations of the ruggedly individualistic competitive spirit by proscribing unfair methods of competition, or it may develop, formalize and perpetuate restraints of trade. In fact, most business codes combine these social and selfish elements. They are useful instruments of social control, but they require public supervision to ensure that they shall be adequately socialized in purpose and effect.

Except where they have become law, business codes depend for their effectiveness upon moral suasion and group pressure. These sanctions are applied to those who refuse to subscribe to the code as well as to those who accept it, but they are not sufficiently severe to compel determined individualists to conform to the standards of the majority of the trade. The result is that the practical force of a business code tends to weaken just at the point where the code is most needed. A code may be effective where compliance with its standards is willing and unanimous, but it tends to break down where compliance must be compelled.

The term "business code" usually connotes a written document in which the standards of a given industry are set forth in systematic fashion. In a looser sense, however, every trade or business may be said to have its own code of ethics, even if that code is nothing more than the inarticulate body of conventions, prejudices and convictions which some particular group adopts as the common basis of its conduct. The unwritten code of every business is simply its prevailing morality.

Written business codes, ordinarily drafted under the auspices of trade associations, imply inadequacy of the prevailing morality as a sound basis for the activities of the trade. These formal codes typically proscribe such competitive practices as fraud, disparagement of a competitor's goods, sales below cost, enticement of a competitor's customers or employees, industrial espionage and the like. The fact that such practices are specifically prohibited is some evidence that the prevailing morality has permitted them to flourish. The code often is a statement of ideals, not a description of practice. It tends to raise levels of conduct by stating unattained goals as rules, but it also tends to fall into contempt if practice falls short of principle. If the code persuades the public that an industry's practices are substantially in accord with its principles, it may obscure the need for corrective measures and produce unmerited good will. A good business code is not, from the viewpoint of the trade as a whole, entirely selfish, but recognizes, in addition to obligations of members of the trade to one another, their obligations to customers, suppliers and employees, and to the general public and the government. In practice most business codes have combined good features with bad. They have emphasized rights at the expense of duties and have been designed primarily to benefit the trade and protect it against regulation from without. However, they also have tended to raise prevailing standards of business practice and to educate the trade to observe the higher standards stated.

Professional Codes *v.* Business Codes.—Codes of business ethics originated in the learned professions, and today their highest development is to be found in the codes of ethics governing such professions as law and medicine. These professional codes are the result of circumstances peculiar to the learned professions, but the professional character of business management may in time come to be accepted as the product of analogous circumstances. The learned professions are bound together in a common discipline which creates a spirit of fraternity, scholarship and public service. The professional practitioner does not deal at arm's length with his patient or client; the business principle of *caveat emptor* cannot apply where experts sell their services to laymen. The customer is a client or a patient, not an opponent in the game of trade. Some gratuitous services to clients and patients are contemplated; in principle the profession is devoted to public service, and financial gain presumably is secondary. Professional codes recognize duties to the cause of learning, to clients or patients and the public, as well as to colleagues.

Business codes do not rest upon the same intellectual and philanthropic basis. Business typically calls for skill, not learning, and the objective is profit, not service. Nevertheless, the development of business codes suggests an awakening professional attitude among many businessmen. This attitude is a product of corporate enterprise, which has divided the classic functions of entrepreneurship between investors and managers.

In the modern corporation the salaried manager is both a fiduciary and a skilled specialist. Under these circumstances a professional attitude is likely to develop, and indeed "business statesmanship" is the accepted ideal.

Self-government in Business.—The functional specialization of salaried corporate managers provided the initial impetus toward the self-regulation of business through codes of ethics. As loyalty to function succeeded loyalty to firm or industry, purchasing agents, advertising managers, credit managers and others began to organize themselves into associations and to adopt codes of ethics modeled upon those of medical and legal practitioners. Considerations essentially professional in character began to displace unqualified acceptance of the profit motive, as modern financial institutions and practices converted profits into salaries and dividends and so dulled the profit motive in a new generation which was not accustomed to thinking of pecuniary advancement in terms of capital gains.

Codes of ethics encompassing whole industries followed naturally from the early tendencies of functional specialists toward professional organization. After World War I the trade-association movement developed rapidly, and the activities of the trade associations directed toward formulation of industry-wide codes of fair competition were greatly stimulated by the Federal Trade commission (*q.v.*). During the period 1919–25 misrepresentation of quality, commercial bribery and similar practices were widespread in U.S. business; competition forced the low standards of the unethical minority upon all who wished to survive. The Federal Trade commission arranged informal meetings of representatives of affected firms at which proposed standards of ethical conduct and definitions of unfair practices were drafted. The commission submitted these proposals to the industry and used them for the promotion of ethical standards of business conduct and as a guide in the selection of defendants for prosecution under the Clayton Anti-trust act and Federal Trade Commission act. After 1925 these meetings were formalized and further developed as "trade practice conferences" through which the Federal Trade commission co-operated with business in the development of codes of business ethics on a much broader scale.

The codes formulated through the trade practice conferences were supported by the moral and legal power of the Federal Trade commission and were taken much more seriously by violators than the earlier codes which could be enforced only by such extralegal sanctions as the trade associations themselves were able to impose. The co-operative attitude of the commission, the enforceability of codes drafted under its supervision, and the erroneous notion that the commission's blessing amounted to a suspension of the antitrust laws encouraged the formulation of increasingly broad codes which had the effect of eliminating competition while purporting to make competition fair. Costing systems tending to encourage price uniformity, uniform terms of sale, basing-point systems, perpetuation by artificial means of traditional marketing institutions and channels, prohibitions of sales below cost and the like began to be required by the codes. The self-regulation which the business community was so eager to practise threatened to develop into cartelization, and in 1930, after the department of justice questioned the legality of some of these code provisions, the Federal Trade commission drastically modified the trade practice conference procedure. Business confidence in the government-supervised code device was badly shaken and the popularity of the trade-practice conferences declined. Agitation for alteration of the antitrust laws took the place of the conferences, but business pressure for self-regulation did not produce results until the National Industrial Recovery act (NIRA) became law in 1933.

This abortive experiment in industrial self-government lasted only two years; in 1935 the United States supreme court held it to be an unconstitutional delegation of the legislative power of congress. During the life of the NIRA the antitrust laws were suspended to permit trade associations and other industry representatives to draft comprehensive codes of fair trade practice which would have the force of law upon their approval by the president. These codes regulated the wages and hours of labour in such a way as to "spread the work" and maintain consumer purchasing power during the economic depression which the law was designed to ameliorate. They also commonly allowed co-operative industrial price fixing and production control and generally tended toward rapid and extensive cartelization of business and almost total abandonment of the competitive ideal which theretofore had characterized U.S. economic policy. Insoluble conflicts of interest developed, and the impracticability of the plan had become quite apparent by the time the supreme court ended it.

After the demise of the NIRA public policy toward business regulation gradually reverted to the traditional competitive basis with restraint of trade and monopoly controlled by the antitrust laws; business codes designed to regulate unfair methods of competition still were encouraged within the limitations of the antitrust laws. The Federal Trade commission's trade practice conferences were continued on a modest scale for the purpose of maintaining competition on a satisfactory plane, and the commission's power to control unfair methods of competition directly was strengthened through supplementary legislation. Trade associations continued to assist the commission to discover and prosecute violations of law and to encourage ethical standards of competition on the part of members of their trades.

Industrial self-government had a full and fair trial in the United States and was found to be a practicable policy only within narrow imits and for specialized purposes. It was a useful technique for the efficient and economical accomplishment of certain desirable purposes, but it failed to eliminate unfair competition and threatened competition itself. Self-regulation was found practicable under U.S. conditions only within the basically competitive framework established by the antitrust laws and subject to such direct regulation of business practice as might be required under particular circumstances. Experience during World War II and the postwar transition period supported this conclusion: self-regulatory business codes proved useful for certain purposes, but direct control of a quite drastic sort was essential to the achievement of national objectives.

Business Codes as Law.—The trade practice conference device ends to give business codes the force of law. In a broader sense, t may be said that, though the law controls business, business makes the law. The standards and practices of the business community tend in time to become formalized as rules of law. The ommon law of commerce, including but not limited to the law merchant, and the statutory codifications and extensions of this aw, are but the crystallization and restatement of business experience: law is the broadest business code.

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(C. W. Gm.)

BUSINESS CYCLE, a general fluctuation in the economy of country that relies chiefly on private enterprise to organize the roduction and distribution of goods. Such a fluctuation is characterized by expansions that occur at approximately the same time in nearly all aspects of economic life—the earning and spending of income, industrial production, employment, trade (both domestic and foreign), security market activity and the prices of oth commodities and securities—followed by similarly general ontractions.

In simplest terms it is an alternation of prosperity and depression, or recession. Some branches of activity whose long-term rate of growth is very rapid continue to expand during general ontractions, but usually at a reduced pace. The rise in unemployment that accompanies depressions is the gravest social evil of business cycles.

In Great Britain and the United States, business cycles have succeeded one another in a virtually continuous round since at least the end of the 18th century. In other countries, evidences of cyclical fluctuation begin with their industrialization at various times in the 19th century. In the United States, business cycles characteristically have required between three and five years to run their course. Few have been shorter; a few somewhat longer. In European countries, cycles have been somewhat longer on the average and their duration less regular than in the United States.

Most business contractions are mild, but some have been very serious. The table below shows how different has been the impact of contraction. Even mild contractions, however, hit some branches of industry hard. The durable goods industries are a notable example. In such sectors, many workers lose their jobs even when the economy at large is little disturbed.

Among the serious contractions, the depression that began in 1929 was the worst economic catastrophe of modern times. In the United States, which was among the hardest hit of all countries, total output declined over 30% between 1929 and 1932. In the latter year, 25% of all workers were unemployed, and even in 1940, although employment had risen by 9,000,000, over 8,000,000, amounting to nearly 15% of an increased labour force, were still unable to find jobs.

Minor Cycles.—Because their characteristics are somewhat different, economists distinguish business cycles with mild and short contractions from those that include severe or protracted depressions. In the first group, often called minor cycles or recessions, almost the entire decline in output during contractions can be traced to a reduction in consumers' purchases of automobiles, furniture and the like (consumer durables), in business purchases of machinery and equipment (producer durables), and, most of all, to a decline in the volume of goods which business firms add to their stocks or inventories (inventory investment). Although in the United States these categories make up no more than 15% of total output on the average of good years and bad, they usually account for 80% or more of the declines in output during minor contractions.

The decline of inventory investment alone accounts for a major share of the total decline during minor contractions. The goods added to stocks normally make up far less than 1% of total output. Near the peaks of minor cycles, however, it will often happen that 3% or more of total output is intended for building up stocks. Near the troughs, on the other hand, businessmen will be content to fill 3% or more of their sales by drawing down inventories. The difference implies a drop of 6% or more in production which is very large compared with the total decline of output. In minor contractions, therefore, well over half the decline in total output typically results from a change-over from building up inventories in the boom to selling them off in the downswing.

The successive expansions and contractions of income, production and employment have a cumulative character which derives in the first place from the interaction of changes in incomes and changes in consumer expenditures. Economists call this interaction the multiplier process. An increase in incomes, however earned, encourages a larger volume of consumer expenditures. The consequent increase in sales leads to increased production and, if there are unemployed, more men are put to work. The level of income earned thus rises still more and drives the process on to second and higher rounds. In contractions, the process is reversed.

The multiplier process tends to be self-limiting because consumer expenditures usually rise

Measures of the Size of Cyclical Contractions in the U.S., 1920–1958

(Arranged Approximately in Increasing Order of Severity)

	Percentage change from business cycle peak to trough*							
	1926–1927	1953–1954	1948–1949	1923–1924	1957–1958	1937–1938	1920–1921	1929–1933
1. Gross national product (in constant dollars)§	+1.1	−3.0†	−1.4†	+1.9	−4.0†	−4.6	−5.3	−28.4
2. Personal income (in current dollars)	+0.8†	−0.1	−3.2	+0.1†	−0.2	−11.2	−21.9†‡	−49.7
3. Industrial production (incl. utilities)	−5.7	−8.4	−6.8	−15.5	−13.4	−30.4	−28.1	−49.4
4. Production of durable goods	−10.9	−15.1	−13.0	−19.9	−20.8	−48.0	−48.8	−73.5
5. Nonfarm employment	−3.8	−3.4	−4.1	−12.3	−4.4	−10.0	−29.9	−30.7
6. Retail sales	0.0	−0.8	−0.3	−1.9	−3.4	−14.1	−4.3	−43.5
7. Corporate profits after tax†	−26.2	−14.8	−21.8	−46.5	−24.0	−69.8	−104.1	−135.6
8. Wholesale prices excl. farm products and food	−6.5	−0.3	−4.9	−8.6	−0.3	−5.4	−36.5	−27.9
9. Consumer prices	−1.5	+0.1	−2.0	+0.2	+2.5	−1.6	−8.2	−26.5

*Based on three-month averages centred on business cycle peak and trough months, except as noted. †Based on changes between e following business cycle peak and trough quarters: P, III 1926; T, IV 1927; P, II 1953; T, III 1954; P, IV 1948; T, IV 1949; II 1923; T, III 1924; P, III 1957; T, II 1958; P, I 1920; T, III 1921; P, II 1937; T, II 1938; P, III 1929; T, I 1933. ‡Percentage ange computed on basis of estimated peak in 1920. Estimated on annual basis. §Based on annual averages for the following busiss cycle peak and trough years: P, 1926; T, 1927; P, 1923; T, 1924; P, 1920; T, 1921; P, 1937, T, 1938; P, 1929; T, 1932.

or decline by much less than the change in the community's total income, the difference representing a change in the sums taken by taxation, retained by corporations out of profits or saved by consumers. The stimulus which any single change in income flow gives to the consumer goods industries is, therefore, transmitted with steadily diminishing force and tends to die out. The forces of expansion or contraction, however, gain renewed strength from coincident changes in inventory investment and business purchases of durable equipment; but it is also through these categories of investment that the forces which tend to reverse the direction of the business tides usually act.

Consider, first, inventory investment. Business firms seek to maintain a fairly constant ratio between inventories and sales or output. The volume of goods available for sale at any time, however, reflects the level of production decided upon, or the level of orders placed, sometime earlier. Consequently, at the beginning of expansion, an upturn in demand usually finds the current flow of production inadequate. Since business firms satisfy at least part of the increment in demand by drawing down inventories, the desired balance between inventories and sales is temporarily upset. This gives a strong stimulus to business firms to place larger orders or to expand production, partly to meet the increased volume of sales, partly to replenish inventories and partly to accumulate stocks to accommodate the higher level of sales. At first, the attempts to build up stocks are partially self-defeating. For the multiplier process set in motion by the expansion in employment also enlarges income and sales. For a time, therefore, stocks remain unduly low; the pressure to expand employment persists and helps to drive the economy to higher levels. After a time, however, the rise of demand slackens and manufacturers and distributors gradually overcome their inventory deficiencies. This may stop the expansion or actually depress business. Purchases and orders are now required only to meet the current level of sales, whereas formerly they also included amounts destined to be added to stocks. This difference is sometimes large enough to cause cuts in employment and the process then goes into reverse. In any event, it retards the growth of incomes and so makes the economy more vulnerable to a downturn initiated by other causes. When orders and sales do fall, business finds it cannot dispose of all it has produced. Stocks pile up, and the attempt to liquidate unwanted inventories combines with the multiplier process to drive the economy downward.

The inventory-adjustment and multiplier processes, however, do not work alone. Business expansion also activates investment in plant and equipment. The expansion of demand makes production capacity in many lines inadequate. It also causes profits to rise rapidly and widely. This strengthens the faith of businessmen in the future. It encourages old firms to carry out expansion plans and new firms to enter business. The increase in profits also encourages capital expenditure by facilitating financing; profits retained by business can be used for capital expenditure; and high profits create a favourable market for securities in which large corporations find it easy to float stock. At the same time, the rise in profits improves the credit standing of most firms and encourages banks and others to lend more freely.

As with inventory investment, the expansion of expenditures on durable capital is gradually checked. With intensified activity, prices of labour and materials rise. This tends to raise production costs, lower profit margins and discourage some firms from making investments. Other firms are put off by higher prices of machinery and buildings. Still others find that the demand for additional financing has driven up interest rates and made credit harder to obtain. In some industries, the pressure to expand capacity is reduced by the completion of plant and equipment ordered earlier in the boom, while in others the same thing occurs when the rate of growth of demand has slowed down. These developments sometimes actually can bring about a downturn in capital goods production. But even if its expansion is merely checked, the economy becomes more vulnerable to recession stemming from the inventory-adjustment process. When a downturn starts, business investment in durables is reduced, thus aggravating the general contraction.

In addition to the factors already considered, foreign trade plays a part in the cyclical process. It is especially important for countries like Great Britain that export a large portion of their output and import a large portion of the goods they fabricate or consume. Dependence on a market for exports involves such countries in the rising or declining fortunes of their foreign customers. When countries which are heavy importers suffer a contraction of income they naturally reduce their purchases abroad.

The process by which contractions gather force, slow down and finally give way to expansions is similar to that by which expansions first gain strength and later weaken. No contraction, however, is the exact mirror image of expansion. The chief reason is that expansions swim with the tide of long-term economic growth while contractions must breast it. Moreover, no full cycle is the identical twin of any other. Wars and civil disorder, speculative movements, the changing economic policies of governments, the accidents of harvests and the vagaries of foreign demand act to disturb the course of cyclical fluctuations in many unpredictable ways. Thus the mechanism as well as the observable features of business cycles change from occasion to occasion, a fact which has so far thwarted attempts at accurate business forecasting.

Major Depression.—Neither the characteristics nor the causes of the more serious contractions are as well established as those of the minor contractions. Some deep depressions seem to be of the class to which the minor movements belong. Others, however, display certain distinctive features which suggest that they constitute a separate class of disturbances. The latter are not only more than normally deep, they also last longer than minor recessions. Depressions may be of extended duration either in the sense that business activity declines without interruption for several years or in the sense that recoveries, if they occur, fail to bring the economy back to full employment levels or do so only briefly.

Long, severe contractions occurred in the United States in the years 1837–43, 1873–78, 1882–85, 1892–96 and 1929–32. Severe, short contractions occurred in 1857–58, 1907–08, 1920–21 and 1937–38. The minor contractions in each country have tended to run to some extent independently of business cycles in other countries but the severe depressions have usually been nearly world-wide in scope.

Apart from widespread unemployment, the distinctive features of depressions that were long as well as severe were serious declines or protracted cessations of growth in construction activity, declines in population growth and labour force growth, and great reductions in international capital movements. In the United States and in many other countries, financial panics, involving a collapse of security prices, the failure of commercial and investment banks, and the suspension of payments against bank deposits, were also characteristic of these episodes, as well as of some of the shorter severe depressions. (*See* PANIC.)

Two sorts of explanations have been offered for these occurrences. They are sometimes attributed simply to accidental combinations of unfavourable circumstances. In this view, each serious depression has its own particular origins. Among the causes suggested are inadequacy in the rate of growth of the money supply, hoarding and scarcity of credit brought on by financial panics, overinvestment in industry or real estate, and fortuitous declines in the investment opportunities afforded by technological advance or population growth. Another view holds that protracted depressions are the systematic outcome of a cyclical or quasi-cyclical process—a long wave in economic growth. These waves are attributed by some to the great swings observed in urban building activity, or in urban building activity in association with a similar fluctuation in the construction of transport facilities. The theoretical and empirical links in these proposed cyclical chains, however, are not yet clearly established. The significance of the long wave theory of serious depressions is, therefore, still uncertain.

Stabilizing Influences in Modern Economics.—In recent decades the evolution of economic life and certain changes in institutional arrangements and governmental policies have combined to reduce the vulnerability of economic activity to serious contractions. Examples from the United States will serve to illustrate a class of developments experienced in many countries.

One set of changes has served to weaken the impact of the mul- iplier process; the chain of reactions remains but the responses re less strong. Thus when business falls off, the incomes of the nemployed are partially protected by the payment of unemploy- ent insurance benefits. Secondly, the incomes of business in- estors are better cushioned against sharp declines in profits ecause corporations keep dividend payments far more stable than eir profits. Thirdly, taxes on corporate and personal income, hich take a much larger share of all incomes, work in the same irection. When earnings decline during business contractions, come taxes decline also. Thus both corporate and personal in- omes after taxes decline less than earnings before taxes. As a esult, corporations are better able to maintain dividends and apital expenditures in the face of a decline in profits, and house- olds are better able to maintain consumption expenditures. The esult is a net gain for economic stability, for a larger portion of e shock of declining earnings is assumed by government, espe- ially the federal government, which can better sustain expendi- re when revenues decline than can private individuals or corpo- tions.

The United States is also better armed against financial panic an it used to be, not only through the federal reserve system q.v.), which can enlarge bank reserves at need, but still more rough the Federal Deposit Insurance corporation, which provides government guaranty of bank deposits. A large-scale run on anks and, therefore, a breakdown of the banking system, is no nger a practical possibility in the United States.

The U.S. Employment act of 1946 declared that it is ". . . the ontinuing policy and responsibility of the Federal Government use all practicable means . . . to promote maximum employment, roduction and purchasing power. . . ." To meet this responsibility, e government, acting in part through the federal reserve system, as tried since 1946 to stabilize private expenditures or to offset eir fluctuations by a variety of measures. These efforts have cluded control of the money supply, of rates of interest and rms of lending, especially on residential mortgages, acceleration retardation of government expenditures and changes in tax tes. The success of these measures in helping to cope with the mparatively short and mild recessions of the post-World War II riod is a matter of some dispute. It seems clear, however, that e U.S. government, like many other governments, is prepared to unter the danger of severe depression, should it arise, by large creases in government expenditures, by tax cuts and by measures increase the money supply and reduce the cost of finance.

Not all the changes of recent decades are potentially stabilizing. particular, the fluctuations of military expenditures under the essures of the "cold war" may be a disturbing factor of con- derable importance. On balance, however, the developments etched above give promise that business contractions in the ture will be less violent, at least on the average, than they have en in the past. While intervals of retarded growth and, there- re, of undesirably high unemployment rates may yet be experi- ced, it seems much less likely that serious depression should be ffered for protracted periods.

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BUSINESS LAW, also called commercial law or mercantile w, is the body of law that governs commercial transactions and siness organizations. Business law is studied at universities and colleges or schools of business administration. The latter in- tutions approach business law as an essential element in the professional training of business executives (whereas the law schools are primarily concerned with the training of practising lawyers), and often stress the connection of this branch of law with the economic, financial, managerial and sociological aspects of business.

Anglo-American business law traces its origins to the law merchant (*q.v.*), which was finally incorporated by Lord Mansfield, English chief justice, into the common law during the 18th century. Many important treatises on commercial law were published in that and the following century of which those of the French jurist R. J. Pothier (1699–1772), *Traité des obligations* (1761) and *Traité du contrat de vente* (1762); of the English lawyer Lord Blackburn (1813–96) on the *Contract of Sale* (1845) and of Judah P. Benjamin (1811–84) on the *Law of Sale of Personal Property* (1868) may be mentioned. Benjamin was an American lawyer who became a member of the Confederate government during the American Civil War and at the end of the war took refuge in England where he was admitted to the bar and published his famous treatise. In many countries business law or some branches of that subject are codified.

As an academic specialty business law developed after World War I as an integral feature of the modern U.S. school of business. In Europe and Great Britain periodicals specializing in business law provide a forum of discussion for those interested in the development and progress of this branch of law; the oldest of these periodicals is the German *Zeitschrift für das Gesamte Handelsrecht und Konkursrecht*, founded by Levin Goldschmidt in 1858; others are the French *Revue Trimestrielle de Droit Commercial*, the Italian *Revista di Diretto Commerciale* and the British *Journal of Business Law*. The American Business Law association includes most of the leading U.S. authorities on the subject and devotes itself to the advancement of business law through regional and national meetings and scholarly publications.

Business law includes two chief subdivisions: business transactions and business organization. The cornerstone of business transactions is the law of contracts (*see* Contract), which deals with legally enforcible business agreements and the rules governing their negotiation, interpretation and performance. The fundamental principles of contract law are applied to such specialized topics as sales of goods, commercial paper (promissory notes, bills of exchange, checks, bonds and shares, etc.), debtor-creditor relations and insurance. (*See* Sale of Goods; Commercial Paper; Investment Paper; Debtor and Creditor Law.)

The law of business organization, as distinguished from the law of business transactions, pertains to the various legal forms in which capital may be organized for the purpose of conducting business transactions. Chief among these are the sole proprietorship, the partnership and the limited liability company or corporation. The principles of the law of agency, which establish rules enabling a person or business organization to act through agents or servants, underlie the entire field and, second only to contracts, constitute a primary element of business law. *See* Company; Corporation; Partnership; Agency.

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BUSIRI, AL- (Sharaf al-Din Muhammad al-Busiri) (*c.* 1212–*c.* 1294), Arabic poet, of Berber extraction, won fame with his poem *al-Burdah* ("The Mantle"). He was born in Egypt and died in Alexandria, but lived for many years in Jerusalem and Arabia. His famous poem was written in Mecca and is in praise of the prophet Muhammad, who cured the poet of paralysis by appearing to him in a dream and wrapping him in a mantle. Even in the poet's lifetime the poem was regarded as sacred. Its verses are used as amulets; it is employed in the lamentations for the dead; it has been frequently edited and made the basis for other poems; and new poems have been made by interpolating four or six lines after each line of the original.

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BUSIRIS, in Greek legend, an Egyptian king, son of Poseidon and Lyssianassa. After Egypt had been afflicted for nine years with famine, Phrasius, a seer of Cyprus, arrived in Egypt and announced that the end of the famine would not take place until a foreigner was yearly sacrificed to Zeus. Busiris began by sacrificing the prophet and continued the custom by offering a foreigner on the altar of the god. It is here that Busiris enters into the circle of the myths of Hercules, who had arrived in Egypt from Libya and was seized and bound ready to be killed and offered at the altar of Zeus in Memphis. Hercules burst his bonds and, seizing his club, slew Busiris with his son Amphidamas and his herald Chalbes. This exploit is often represented on vase paintings from the 6th century b.c. and onward, and the legend is referred to by Herodotus and later writers.

Although some of the Greek writers made Busiris an Egyptian king and a successor of Menes, about the 60th of the series and the builder of Thebes, those better informed by the Egyptians rejected him altogether. Various esoteric explanations were given of the myth, and the name not found as a king was recognized as that of the tomb of Osiris. Busiris is here probably an earlier and less accurate Grecism than Osiris for the name of the Egyptian god Usire. All shrines of Osiris were called *P-usiri* (Busiris), but the principal city of the name was in the centre of the Delta, capital of the ninth (Busirite) nome of lower Egypt. The name Busiris in the legend may have been caught up merely at random by the early Greeks, or they may have vaguely connected their legend with the Egyptian myth of the slaying of Osiris (as king of Egypt) by his mighty brother Set, who was in certain aspects a patron of foreigners. Phrasius, Chalbes and Epaphus (for the grandfather of Busiris) are all explicable as Grecized Egyptian names, but other names in the legend are purely Greek.

The sacrifice of foreign prisoners before a god, a regular scene on temple walls, is perhaps only symbolic for the later days of Egyptian history, but foreign intruders must often have suffered at the hands of the Egyptians, in spite of the generally mild character of the latter. (F. Ll. G.; X.)

BUSKEN HUET, CONRAD (1826–1886), the greatest, and also one of the liveliest, Dutch literary critics of his time, was born at The Hague, Dec. 30, 1826, of an old French Protestant family. He studied theology at Leiden and became pastor of the Walloon chapel at Haarlem, but resigned because of his modernist views. He turned to literary criticism, and from 1862 to 1865 was an editor of the influential literary magazine, *De Gids*. After many disappointments, he left Holland for the Dutch East Indies where he worked as a journalist, and for the last years of his life lived in Paris, where he died, June 1, 1886.

As a critic, Busken Huet took C. A. Sainte-Beuve and Georg Brandes as his guides, and sought to bring Dutch literature into closer touch with other European cultures. He wrote brilliantly about the Dutch classics, about the minor Dutch poets, and about both the classic and modern literature of other countries. He castigated some of the Dutch writers of his own time severely for their narrowness and dullness. Busken Huet collected his most important critical writings in 25 volumes entitled *Litterarische Fantasiën en Kritieken:* they are still read with enjoyment for their style and acute perception. His history of Dutch culture in the 17th century, *Het land van Rembrand* (1882–84), remains a classic.

See C. G. N. de Vooys, *Busken Huet* (1949). (J. C. B. C.)

BUSKERUD, a *fylke* (county) in south central Norway, extends 130 mi. northwestward from Oslo fiord to the mountains of Hardangervidda in the centre of the country. Area 5,719 sq.mi.; pop. (1960) 166,368. Caledonian rocks in thrust masses form high peaks (Hallingskarv, 6,342 ft.) over a plateau of altered Cambro-Silurian schist (3,250 ft.) giving summer pastures for the valley farms. The schist is deposited on Pre-Cambrian bedrock into which the deep forested valleys of Hallingdal and Numedal are cut. In the eastern part of the *fylke* the schist lowland of Ringerike forms a basin containing a lake, Tyri fiord which is drained by the Drammen (Dramselva) river to Oslo fiord. The lowland districts contain 75% of the population. Drammen (administrative headquarters of the *fylke*) on Drammen fiord and Honefoss in Ringerike are industrial and commercial towns; several pulp and paper mills are located along the Drammen river. At Kongsberg (pop. [1960] 9,678) silver mines were worked from 1624 to 1957. The eastern lowlands are agricultural districts, fruit, vegetables and corn being grown. The Oslo-Bergen railway follows Hallingdal; the Oslo-Stavanger railway goes via Drammen and Kongsberg with a branch line through Numedal. (L. H. Hg.)

BUSON (Yosa or Taniguchi Buson) (1716–1784), Japanese poet and painter, the foremost *haiku* poet of his day and, next to Matsuo Bashō (*q.v.*), the most renowned of all time, was born in a hamlet near Osaka. Although his father was a wealthy landholder, Buson inherited none of the family's riches and went to seek his fortune in Edo (modern Tokyo) instead. Turning to poetry, he traveled extensively in northeastern Japan and studied under, among others, Hayano Hajin, whom he loved as a father and eulogized in *Hokuju Rōsen wo itonamu* (1745; "Elegy to Hokuju Rōsen"). In 1751 he settled down in Kyōto as a professional painter. Except for the years 1754–57, which he spent in Yosa, Tango province (now Kyōto prefecture), Buson mostly remained in Kyōto, enjoying brief excursions to nearby scenic spots and gradually gaining a reputation as painter and poet. He died Jan. 17, 1784.

Buson's fame rose particularly after 1772; therefore, as was the case with his great predecessor Bashō, his last decade proved most significant for his art. Along with other *haiku* poets of the time, Buson urged revival of the Bashō tradition. "Use the colloquial language to transcend colloquialism," he urged, and he declared that in *haiku* "One must talk poetry." To Buson this required intimacy with Chinese and Japanese classics, rich experience, and an accurate ear. Consequently, in his longer, experimental verse he sometimes employed Chinese. Often, moreover, his verses do not scan in the usual pattern of five, seven, and five syllables. One of his most highly acclaimed verses, *Botan chitte/uchi-kasanarinu/ni-sam-pen* ("Fallen peonies/piled one on top another: /two or three petals"), for example, shows his keenness of eye. Buson's reputation diminished in the early 19th century but rose once again in the early 20th when Masaoka Shiki declared that Buson exceeded even Bashō in mastery of visual imagery. (L. M. Zo.)

BUSONI, FERRUCCIO BENVENUTO (1866–1924), Italian musician who attained fame as a pianist of brilliance and intellectual power, but was also an important composer. The son of an Italian clarinetist and a pianist of German descent, Busoni was born at Empoli, Tuscany, April 1, 1866. Taught by his mother, he appeared as a child prodigy and later completed his studies in Vienna and Leipzig. In 1888 he became professor of pianoforte at Helsingfors (Helsinki), and from there he moved to Moscow and later to the United States. From 1894 to 1914 he lived in Berlin, conducting a series of orchestral concerts containing music by his contemporaries and making concert tours devoted mainly to Bach, Beethoven, and Liszt. During World War I he retired to Zürich, conscious of the pull between his Italian nationality and his affinity with German music. This dichotomy affected him also as a composer, his music being compounded of romantic fervour controlled by an austere intellect and Latin brilliance and clarity. His most ambitious work was the unfinished opera *Doktor Faust*, based not on Goethe but on earlier versions of the Faust legend. It was completed by his pupil, Philipp Jarnach, and performed in Dresden (1925). Two other short operas, *Arlecchino* and *Turandot*, composed at Zürich, attempted to revive the *commedia dell' arte* in modern form. Busoni's pianoforte works include an immense *Concerto* with choral finale, six sonatinas, which contain the essence of his musical thought, and the great *Fantasia Contrappuntistica* on an unfinished fugue by Bach (two versions, 1910; one version, 1912; fourth version for two pianos, 1921), which sums up his lifelong experience of Bach's music. In 1920 he returned to Berlin where he died on July 27, 1924.

Bibliography.—F. Busoni, *Entwurf eine neuen Ästhetik der nkunst* (1907), *Briefe an seine Frau* (1935; Eng. trans. by R. Ley, *tters to His Wife,* 1938); E. J. Dent, *Ferrucio Busoni* (1933). (Dy. H.)

BUSS, FRANCES MARY (1827–1894), founder of the orth London Collegiate School for Girls and associate of Doro-ea Beale (*q.v.*) in her work for girls' secondary education, was orn in London in 1827. She attended a school in Camden Town, ondon, and, after teaching there for a short time, taught with r mother in a school in Kentish Town. In 1848 she attended ctures with Miss Beale at Queen's College for Ladies, also teach-g in her mother's school. This was moved to Camden street d in 1850 became the North London Collegiate School for dies. After its recognition as a public school for girls (1871), e word "Ladies" in the title became "Girls." This school served a model for the high schools of the Girls' Public Day School ust.

Miss Buss appeared before the Schools Inquiry commission in 65 and testified to the need for girls' secondary schools. With e assistance of funds from the Brewers' and Clothworkers' com-nies, she was able to move the North London Collegiate school other premises, and to open the Camden Girls' school in 1871.

She believed in a sound intellectual training for girls and en-uraged them to take examinations, supporting the foundation women's colleges at the universities and the improvement of achers' training. She founded the Association of Headmistresses 1874 and was its first president (1874–94), being succeeded Miss Beale. Miss Buss died in London on Dec. 24, 1894.

See Annie E. Ridley, *Frances Mary Buss and Her Work for Educa-n,* 2nd ed. (1896). (S. J. C.)

BUSSY, ROGER DE RABUTIN, Comte de (called ussy-Rabutin) (1618–1693), French soldier and writer, a mem-r of the Académie Française but known chiefly for his urbane d malicious *Histoire amoureuse des Gaules,* was born at Epiry in urgundy on April 13, 1618. An army officer from the age of 16, served quite diligently in many campaigns. In 1644 he pur-ased the lieutenant-colonelcy of the light cavalry commanded by e duc d'Enghien (Louis II de Bourbon, prince de Condé in 1646); d in 1645 he succeeded his father as king's lieutenant of the vernais province. In the period of the Fronde, when Condé s arrested (1650), Bussy joined the rebels demanding his re-se; but on his release Condé, for personal reasons, made Bussy sign his lieutenant-colonelcy (1651). Bussy then offered his rvices to the government for the final war against Condé and e Spaniards. His new commanding officer, Turenne, found him much given to frivolous versification. Bussy, however, bought e rank of lieutenant-colonel general of the light cavalry of ance in 1653.

Meanwhile Bussy had been acquiring a worldly reputation. In 41 he was imprisoned in the Bastille for five months because his giment had misbehaved while he was absent with a lady; in 48, after his first wife's death (1646), he tried to abduct a rich dow, to whose family he had eventually to pay damages; after second marriage (1650), he still pursued other ladies, with rying success; and in Holy Week 1659 he attended a party at issy which was later supposed to have been an outrageous orgy. art from all this, he was accepted as a critic by Parisian literary ciety; and finally he was persuaded to put five of his scandalous ries about court ladies into writing. These stories constitute authentic *Histoire amoureuse des Gaules,* manuscript copies which were being circulated in 1663. Then, in 1664, Louis XIV d Bussy's short *Maximes d'amour* (in verse) with approval; d early in 1665 Bussy became a member of the Académie Fran-se. Within a few weeks of this a secretly printed text of the *stoire amoureuse* was published, without Bussy's consent.

This provoked extreme indignation. Bussy was sent to the stille for 13 months and then exiled to his Burgundian estates. ere he remained for the rest of his life, save for rare intervals en he could show himself in Paris or at Versailles. His enemies de his situation worse by satirizing the royal family in spurious plements to the *Histoire amoureuse;* and Bussy's former as-iation with Nicolas Fouquet, the disgraced finance minister, was not forgotten. Bussy in exile devoted himself to family affairs, to a voluminous correspondence and to writing his memoirs. He died at Autun on April 9, 1693, in a Christian spirit.

The *Histoire amoureuse* is a masterpiece of elegant and witty narrative, reflecting the piquant grace of a well-informed courtier's intimate conversation. The letters of Bussy bear comparison with those of his cousin Mme de Sévigné, to whom many of them are addressed. His memoirs are uneven, in parts vivacious, in parts focused on military detail or official communications.

Bibliography.—*Histoire amoureuse des Gaules,* ed. by G. Mongrédien, 2 vol. (1930); *Mémoires,* ed. by L. Lalanne, 2 vol. (1857); *Correspondance,* ed. by L. Lalanne, 6 vol. (1858–59). (J. G. R.-S.)

BUSTAMANTE Y SIRVÉN, ANTONIO SÁNCHEZ DE: *see* Sánchez de Bustamante y Sirvén, Antonio.

BUSTARD, the common name for medium to large game birds of the family Otididae, constituting the suborder Otides in the order Gruiformes, typified by the cranes and rails. The family comprises about 11 genera and 23 species, confined to the old world. The best known is the great bustard, *Otis tarda,* largest European land bird, males reaching as much as 32 lb., with four-foot length and eight-foot wingspread. It is found in grain fields and open steppes from central and southern Europe to central Asia and Manchuria. Both sexes are similar in colour, being grayish barred with black and brown above, whitish below; the male is stouter, and has whitish bristly feathers at the base of the bill. Being wary, the great bustard is difficult to approach, running swiftly when endangered. On land it assumes a stately gait; on the wing, it displays a relatively slow but powerful and sustained flight. The spring courtship ceremonies are characteristic: the cock's head is bent back almost touching the uplifted tail, the white quill feathers of the forearm are exposed and the throat pouch is inflated. Two or three eggs, olive blotched with brown, are laid in a shallow excavation sheltered by low vegetation.

ERIC HOSKING

GREAT BUSTARD (OTIS TARDA)

The little bustard, *Otis tetrax,* ranges from western Europe and Morocco to Afghanistan. The bustards of south Africa are known as paauw, the largest being the great paauw, *Choriotis kori; C. arabs* is found in Morocco and northern tropical Africa south of the Sahara; *C. australis,* in Australia, where it is called turkey; and *C. nigripes,* in northwest India. The family also includes the following: *Spheotides indica,* common over India; *Houbaropsis bengalensis,* occurring from eastern India to Indochina; *Chlamydotis undulata,* of the deserts and high plateaus of north Africa and southwest Asia; and a number of species (belonging to the genera *Neotis, Eupodotis, Lophotis* and *Lissotis*) common in desert, savanna and thornbrush country over Africa south of the Sahara. (G. F. Ss.; X.)

BUSTELLI, FRANZ ANTON (1723–1763), modeler of porcelain figurines for the factory of Nymphenburg (near Munich, Bavaria), was born at Locarno, Switz., in 1723. Nothing is known of his early life or training. Bustelli worked for Nymphenburg from 1754 to 1763, when he died. His characteristically graceful models became recognized as the most excellent porcelain sculpture of the rococo. Bustelli respected the limitations of the material even in his detailed works. Their rich colours on the milky white porcelain of Nymphenburg grant them unrivaled charm. Bustelli's most famous subjects are Harlequins, Columbines, Chinese, cupid-like children, and groups such as the "Tea Party." Bustelli figurines of the period are very rare and valuable; his models are still reproduced by the factory in Nymphenburg.

See G. W. Ware, *German and Austrian Porcelain* (1952). (Hs. H.)

BUTADES of Sicyon (fl. *c.* 600 B.C.?), wrongly called Dibutades, the first Greek modeler in clay. The story is that his daughter, who loved a youth at Corinth, where they lived, drew upon the wall the outline of his shadow, and that upon this outline her father modeled a face of the youth in clay and baked the model along with the clay tiles which it was his trade to make. This model was preserved in Corinth until Mummius sacked that town. He is also said to have invented a mixture of clay and ruddle, or to have introduced the use of a special kind of red clay.

BUTADIENE is a hydrocarbon of industrial importance as the major constituent of synthetic rubber. It was first produced commercially by Germany during World War I from acetylene. Before World War II the only U.S. production was a minor quantity obtained as a by-product. When natural rubber imports were stopped by the war an emergency program was undertaken in 1942 which resulted in construction of production capacity of approximately 1,000,000 tons per year by 1945. This corresponded to almost twice the prewar consumption of rubber. The plants were government owned and for raw materials used ethyl alcohol for 40% of the production and butenes from petroleum and natural gas for the remainder.

With the resumption of natural rubber importation into the United States in 1946, excess butadiene capacity was held in stand-by condition and the most efficient plants were operated under government contracts. In 1954–55 the government plants were sold to private industry and an expansion program was initiated to increase production from petroleum and natural gas Production from alcohol is generally not attractive except in emergencies because of higher production costs. Although new chemical uses were being developed, synthetic rubber continued to consume approximately 90% of the U.S. butadiene production.

At atmospheric conditions butadiene exists as a colourless gas but is condensed to a liquid either by cooling to −4.4° C. (24° F.) or by compressing to 2.8 atm. at 25° C. (77° F.). The gas is 1.86 times heavier than air, while the liquid has a specific gravity of 0.627 at 15.5° C. (60° F.). Butadiene has the chemical structure $CH_2{:}CHCH{:}CH_2$ and is the lowest member of the conjugated diolefin series. It is the high chemical activity of the conjugated diolefin structure that is responsible for the importance of butadiene in chemical synthesis. Under suitable conditions, particularly in the presence of an oxidizing catalyst, butadiene molecules combine with each other or with other highly reactive compounds such as styrene or acrylonitrile to form plastic or solid polymers of high molecular weights. (*See* Rubber.)

Many other additional compounds are readily formed. The chemical activity of butadiene leads to difficulties in its manufacture and handling. At elevated temperatures and pressures it dimerizes to 4-vinylcyclohexene, which is a stable liquid boiling at 127° C. In the presence of air or other sources of oxygen, butadiene peroxides are formed which catalyze polymerization to plastic or solid materials. Such peroxidized solids may decompose with explosive violence and their formation in storage is prevented either by exclusion of oxygen or by the use of suitable oxidation inhibitors. (K. M. W.)

BUTANE belongs to the series of paraffinic hydrocarbons found in natural gas and in crude petroleum; it is formed in large quantities in the cracking of oil to produce gasoline. It occurs in two isomeric forms: *n*-butane and isobutane. The chemical formula of butane is C_4H_{10}.

The butanes present in natural gas are separated from the large quantities of lower-boiling constituents such as methane and ethane. The butanes thus obtained and freed from lower-boiling gases have a sufficiently low vapour pressure (2–4 atm.) at ordinary temperatures to enable them to be shipped safely in tank cars or in cylinders. The production of liquefied butanes separated from natural gasoline in the United States in the early 1960s was over 1,000,000,000 gal. of *n*-butane and over 300,000,000 gal. of isobutane. The amount of butanes consumed in the United States in the early 1960s in motor fuels was over 900,000,000 gal.

Butanes present in the refinery gases are usually admixed with large proportions of butenes; the latter, being more reactive, are converted to high-octane gasoline or to chemical derivatives. The butanes remaining from this reaction are either added to gasoline to increase its volatility or used as raw material for the manufacture of aviation gasoline.

Butanes can be separated into iso- and *n*-butane by means of fractional distillation. The former boils at −11.7° C. and freezes at −159.6° C.; the latter boils at −0.5° C. and freezes at −138.3° C. *n*-Butane can be transformed commercially to isobutane. Isobutane reacts with olefins in the presence of hydrogen fluoride or sulfuric acid to form an alkylate which is a constituent of high-octane gasoline. This reaction was responsible for the production in the early 1960s of more than 10,000,000 gal. of octanes.

Butene (C_4H_8), also called butylene, belongs to the series of olefinic hydrocarbons. It occurs in four isomeric forms as shown in the table.

Name	Freezing point °C.	Boiling point °C.
1-Butene	−185.3	−6.3
cis-2-Butene	−138.9	3.7
trans-2-Butene	−105.5	0.9
Isobutylene (methylpropene)	−140.3	−6.9

The first three isomers are classified as normal butenes.

Butenes are formed during the cracking of oil to produce gasoline; they can also be prepared commercially by the catalytic dehydrogenation of butanes. Butenes undergo all the characteristic reactions of olefins. The major part of the butenes is utilized for the production of octanes, which are important constituents of aviation gasoline. This is done either by causing the butenes to react with isobutane or by polymerizing butenes to form octenes (C_8H_{16}), which on hydrogenation yield octanes (C_8H_{18}). Butenes, on treatment with water in the presence of catalysts, are transformed to secondary and tertiary butyl alcohols, which are important commercial solvents. *n*-Butenes on dehydrogenation form butadiene, which is the main starting material for the manufacture of synthetic rubber. Isobutylene, on treatment with catalysts and minor amounts of diolefins at temperatures below −40° C., polymerizes to a spongelike material called butyl rubber, which is used for the production of high-grade tire tubings. (H. Ps.)

BUTE, JOHN STUART, 3rd Earl of (1713–1792), British politician, the "dearest friend" of George III, whose accession caused him to be thrust briefly into political prominence, was born in Edinburgh on May 25, 1713, son of James, 2nd earl, and of Lady Anne Campbell, daughter of the 1st duke of Argyll. He was educated at Eton and succeeded to the earldom (created in the peerage of Scotland for his grandfather, Sir James Stuart, in 1703) on his father's death in 1723. He married Mary, daughter of Edward and Lady Mary Wortley Montagu, in 1736, and after her father's death (1761) Bute controlled his wife's large fortune. He was elected a representative peer for Scotland in 1737, but not in the following parliaments, and appears not to have spoken in debate. In 1738 he was made a knight of the Thistle. For several years he lived in retirement in Bute, engaged in agricultural and botanical pursuits, and from the quiet obscurity for which his talents and character entirely fitted him he was drawn by a mere accident. He had resided in England since the rebellion of 1745. In 1747, a downpour of rain having prevented the departure of Frederick, prince of Wales, from the Egham races, Bute was summoned to his tent to make up a whist party; he immediately gained the favour of the prince and princess, became the leading personage at their court at Leicester house and in 1750 was appointed by Frederick a lord of his bedchamber. After Frederick's death in 1751 his influence in the household increased. Bute became the constant companion and confidant of Frederick's son George, heir apparent, over whom he exerted a strong personal influence. He took part in the negotiations between Leicester house and William Pitt, directed against the duke of Newcastle, in 1755 and in the conferences between Pitt and Newcastle in 1757 which led to their taking office together.

On the accession of George III in 1760, Bute became a privy councilor, groom of the stole and first gentleman of the bedchamber, and though without a seat in parliament or in the cabinet he was the only man who enjoyed the king's complete confidence. George III immediately proceeded in his attempt to accomplish his long-projected plans, the conclusion of the peace with France, and the ejection from power of his grandfather's ministers. His policy was followed with skill and caution. Great care was shown not to alienate the old ministers in a body, which would have raised up under Pitt's leadership a formidable party of resistance, but advantage was taken of disagreements between them concerning the war, of personal jealousies and of the reluctance of the old statesmen who had served the crown for a generation to identify themselves with active opposition to the king's wishes. They were all discarded singly and isolated, after violent disagreements, from the rest of the ministers. Bute succeeded Lord Holderness as secretary of state for the northern department on March 25, 1761, and Pitt resigned in October on the refusal of the government to declare war against Spain.

On Nov. 3, 1761, Bute appeared in the house of lords, where he had not been seen for 20 years, in his new capacity as first minister. Though he had succeeded in disarming all organized opposiion in parliament, the hostility displayed against him in the nation, arising from his Scottish nationality, his character as the king's favourite, his peace policy and the resignation of the popular hero Pitt, was overwhelming. He was the object of numerous attacks and lampoons. He dared not show himself in the streets without the protection of prize fighters, while the jack boot (a pun on his name) and the petticoat (representing George's mother, he princess of Wales) were continually being burned by the mob or hanged upon the gallows. On Nov. 9, while proceeding to the Guildhall, he narrowly escaped falling into the hands of the popuace, who smashed his coach, and he was treated with studied coldess at the banquet. In Jan. 1762 he was compelled to declare war against Spain, though now without the advantages which the arlier decision urged by Pitt could have secured, and he supported he war, but with no zeal and no definite aim beyond the obtainng of a peace at any price and as soon as possible.

In May 1762 Bute succeeded the duke of Newcastle as first lord f the treasury. In his eagerness for peace he conducted on his wn responsibility secret negotiations for peace with France hrough the comte de Viry, the Sardinian minister, and the preiminary treaty was signed on Nov. 3 at Fontainebleau. A parliamentary majority was secured with the aid of Henry Fox, who ecame leader of the house of commons. The definitive peace of Paris was signed on Feb. 10, 1763, and a wholesale proscription f the duke of Newcastle's party was begun, in which even inignificant adherents incurred the vengeance of the court. Later, Bute roused further hostility by his cider tax, an ill-advised measure producing only £75,000 a year, imposing special burdens upon he farmers and landed interest in the cider counties, and extremely npopular because it extended the detested system of taxation by xcise, regarded as an infringement of popular liberties. At length, nable to contend any longer against the general animosity displayed against him, fearing for the consequences to the monarchy, larmed at the virulent attacks of the *North Briton* and suffering rom ill-health, Bute resigned on April 8, 1763.

He still for a time retained influence with the king, but George renville (whom he recommended as his successor) insisted on ossessing the king's whole confidence, and on the failure of Bute n Aug. 1763 to procure his dismissal and to substitute a ministry d by Pitt and the duke of Bedford Grenville demanded and obined Bute's withdrawal from the court. He resigned accordngly the office of privy purse and took leave of George III on ept. 28. He still corresponded with the king and returned to ondon in 1764, but in May 1765, after the duke of Cumberland's ailure to form an administration, Grenville exacted the promise rom the king which was kept faithfully that Bute should have no hare and should give no advice whatever in public business and btained the dismissal of Bute's brother from his post of lord rivy seal in Scotland. Bute continued to visit the princess of Wales, but on the king's arrival always retired by a back staircase. e spoke against the government on the American question in Feb. 1766 and in March against the repeal of the Stamp act. In 1768 and 1774 he was again elected a representative peer for Scotland but took no further part in politics, refusing, in 1778, to have anything to do with the abortive attempt to effect an alliance between himself and Pitt, now earl of Chatham.

He traveled in Italy and determined on "retiring from the world before it retires from me." He died in London on March 10, 1792, and was buried at Rothesay in Bute. Thrust into high office and great influence at a critical moment in British history, Bute proved to have little grasp of realities. He loved the theatrical and lacked the ability or balance of judgment to overcome political animosities by wise government.

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(I. R. C.)

BUTE, the most important, though not the largest, of the islands constituting Buteshire (*q.v.*) in the Firth of Clyde, Scot., about 18 mi. S.W. of Greenock and 40 mi. by water from Glasgow. Pop. (1951) 12,547. It is bounded on the northeast, north and northwest by the picturesque Kyles of Bute, the narrow winding strait which separates the island from Argyllshire; on the east by the Firth of Clyde, and on the south and southwest by the Sound of Bute, about 6 mi. wide, which divides it from Arran. Its area is 47 sq.mi., its length 15½ mi., and its breadth from 4½ to 1 mi.

Its highest point, Kames hill, in the north, is 875 ft. This part of the island is composed mainly of the metamorphic rocks of the eastern Highlands, mica schists, interrupted by a belt of clay slate; the south of the island consists mainly of Upper Old Red Sandstone, with many intrusive igneous rocks.

The name of the island is variously derived from the Erse, *both*, a "cell," in allusion to St. Brendan's foundation there in the 6th century, and from the Gaelic *Ey Bhiod*, "the island of corn," in reference to its fertility. Stone monuments, barrows, cairns and cists, with the remains of ancient chapels, attest its early settlements. Bute was probably first colonized by the vanguard of Scots who came over from Ireland.

Because of its pleasant scenery, sandy bays, mild climate and lower rainfall than occurs over much of the western coast, added to its fertile soil and proximity to the Clyde estuary, the island is relatively populous and a residential and holiday resort for the Scottish industrial belt and other centres of population in the British Isles. Mount Stuart, a modern Gothic mansion, is a seat of the marquess of Bute. About two-thirds of the island is arable, the main crops being oats, turnips and swedes and, in the southern part of the island, early potatoes. Many burns (streams) drain the island, and there are six lochs among which the biggest, Loch Fad, about 1 mi. S. of Rothesay and stretching south-southwest for 2½ mi., was the source of the power used in the Rothesay cotton-spinning mill, the first of the kind erected in Scotland. The island is well served by steamers, including a vehicular ferry, from Wemyss Bay to the chief port and old royal burgh of Rothesay (*q.v.*).

There is also a vehicular ferry across the Kyles of Bute from Colintraive to Rhubodach (Rudhabodack), enabling heavy goods to be conveyed by road.

See J. K. Hewison, *Isle of Bute in the Olden Time*, two volumes (1894–95). (A. H. Wd.)

BUTENANDT, ADOLF FRIEDRICH JOHANN (1903–), German biochemist who shared the 1939 Nobel prize in chemistry with Leopold Ruzicka. He was given the award for his work on sex hormones but was forbidden by the German (Nazi) government to accept. Born at Bremerhaven-Lehe, March 24, 1903, Butenandt studied chemistry at Göttingen and graduated there in 1927. As a *Privatdocent* he worked in the laboratory of A. Windaus, winner of the 1928 Nobel chemistry prize for research in sterol chemistry. In 1929, almost simultaneously with E. A. Doisy in the U.S., Butenandt isolated estrone, one of the hormones responsible for sexual development and function in females. In 1931 he isolated and identified androsterone, one of the male sex hormones, and in 1934 progesterone, a hormone produced by the corpus luteum that plays an important part in the female reproductive cycle.

He carried out much research on the chemistry and interrelationships of the sex hormones and on the possible carcinogenic properties of some of these substances. The large-scale production of cortisone stemmed largely from Butenandt's work on hormones.

Butenandt was professor of chemistry at Danzig (1933–36), director of the Kaiser Wilhelm institute of biochemistry in Berlin (1936–45), director at the Max Planck Institute for Biochemistry, Tübingen, Ger. (1945–56) and director of the Max Planck Institute for Biochemistry, Munich (from 1956). (W. J. Bp.)

BUTES, the name of three figures in Greek mythology and legend.

1. Butes, a son of Boreas. Having killed his brother Lycurgus, he was compelled to flee from Thrace to Naxos, where he lived by piracy. On one expedition he captured Coronis, a handmaiden of Dionysus, whom he took as his wife; but Dionysus drove him mad, so that he jumped into a well and perished.

2. Butes, son of Pandion of Athens, brother of Procne, Philomela and Erechtheus (*q.v.*). He married his niece Chthonia, but when her father, Erechtheus, was compelled by the Delphic oracle to sacrifice one of his daughters in order to repel the attack of Eumolpus and the Eleusinians, Chthonia was killed and her sisters committed suicide. Butes was priest of Athena and Poseidon, and in historical times an altar dedicated to him was to be seen in the Erechtheum.

3. Butes, the Argonaut who succumbed to the lure of the Sirens. Jumping from the ship and swimming toward their island, he was saved by Aphrodite, who bore him to Sicily where he became by her the father of Eryx. (T. V. B.)

BUTESHIRE, an insular county of southwestern Scotland, consists of the islands of Bute, Arran, Great Cumbrae, Little Cumbrae, Holy Island (not to be confused with Lindisfarne), Pladda and Inchmarnock, all lying in the Firth of Clyde between Ayrshire on the east and Argyllshire on the west and north. Land area 218.3 sq.mi.

Physical Features.—The Highland boundary fault passes through Bute where the Old Red Sandstone in the south abuts sharply upon the higher schists in the north of the island (highest point 911 ft.). In Arran, although the fault cannot be traced, the same contrast exists between the southern part and the northern part, which is the only mountainous area in the county, rising to 2,867 ft. Arran has a large variety of rock formations and is regularly visited by students of geology. The climate of Buteshire is temperate; snow is infrequent and seldom lies for more than a few days except in the mountains of Arran. The soil, mostly light and fertile loam near the shore, generally turns toward clay inland which can nevertheless yield excellent crops when properly drained. Fauna include red deer, roe deer, weasels, stoats and others. An area of land in Glen Diomhan, a steep-sided post glacial gorge in Arran extending to 24 ac., is a nature reserve.

History.—Excavations have revealed evidence of human habitation from the Neolithic period and at Dunagoil, Bute, there is a fine vitrified fort of the Iron Age. There are remains of numerous chapels of the early Christian period. St. Blane, who was born on Bute (6th century), built a chapel near Dunagoil where a ruined church still stands. Rothesay castle, Bute, which goes back to Viking times and was used as a royal residence by Robert II and Robert III of Scotland, was burned down in 1685 and is now an ancient monument, as is Lochranza castle on Arran. Brodick castle, where Robert the Bruce lived for a time before the battle of Bannockburn and which was once the residence of the duchess of Montrose, is now administered by the National Trust for Scotland.

Population and Administration.—The population of Buteshire in 1961 was 15,129. There are two small burghs: Rothesay (7,656) (*q.v.*), the county town, and Millport (1,592), on Great Cumbrae. Buteshire unites with North Ayrshire to return one member to parliament. Ayrshire and Buteshire form a sheriffdom, courts being held weekly in Rothesay and when required in Lamlash, Arran. Police courts are held in Rothesay and in Millport, Great Cumbrae, and justices of the peace sit occasionally in Rothesay and Lamlash. There is a district council for each of the three main island groups: Arran, Bute and the Cumbraes.

Industries and Communications.—Agriculture and the tourist trade are the main industries in the county, although fishing is of some importance. The staple crops are oats, hay, turnips and potatoes, while cattle and sheep are reared and milk is sent from Bute and Arran to the mainland. Many people from the industrial belt of Scotland and the industrial towns of northern England spend their vacations in Buteshire. There is regular steamship communication for passengers and cars between the county ports of Rothesay, Millport and Brodick and the mainland ports of Wemyss Bay, Gourock and Fairlie (or Ardrossan). There is also a regular ferry service for vehicular and passenger traffic across the Kyles of Bute between Rhubodach, Bute, and Colintraive, Argyll. *See* also Arran; Bute; Cumbraes, The.

See J. E. Reid, *History of the County of Bute* (1864). (A. H. Wd.)

BUTLER, the name of a family famous in the history of Ireland. The Butlers alone, among the families of the Norman conquerors, could rival the Geraldines, their neighbours, kinsfolk and often their mortal enemies, and until 1688 the effective government of Ireland was usually in the hands of one of the two families (*See* Ireland: *History*).

The Butlers are descended from Theobald Walter (d. *c.* 1206), whose office of hereditary chief butler (or botiller) of Ireland gave the family its name. Theobald, a nephew of Ranulf de Glanville, Henry II's justiciar, rose in the king's service through his uncle's influence, although he never attained the eminence of his brother, Hubert Walter, archbishop of Canterbury. He may have accompanied Henry II to Ireland in 1171, and certainly went there with the king's son John in 1185. His services on that expedition were rewarded with large grants of land, in Ormonde (now part of County Tipperary) and elsewhere. He made his Irish home at Arklow, where he founded a monastery. The date of his appointment as chief butler to the lord of Ireland is uncertain, but after the Irish expedition he spent most of the rest of his life in England in John's service (from 1194 to 1199 he was sheriff of Lancashire, where he also had large estates). Toward the end of his life he returned to Ireland.

His descendants steadily increased the family's influence in Ireland, adding to their possessions by judicious marriages. Edmund (d. 1321), 6th butler, was justiciar of Ireland during Edward Bruce's Scottish invasion of 1315 and was afterward granted the castle and manors of Carrick, Macgriffyn and Roscrea with the title of earl of Carrick, which, however, he apparently never used. His son James (*c.* 1305–38) married in 1327 Eleanor de Bohun, a granddaughter of Edward I. The marriage further increased the power and prestige of the Butlers, and because of it James was created earl of Ormonde in 1328.

From the time of the 1st earl, the Ormondes served in the chief offices of the government of Ireland as deputies, lords lieutenant, lords keeper and lords justice. They fought in the king's wars both at home, against the native Irish, and overseas, and unlike their enemies, the Geraldines, they remained loyal to the English crown. James (1331–82), 2nd earl (the Noble Earl), was four times governor of Ireland. His son James (d. 1405), 3rd earl, increased the territorial influence of the Butlers, in particular acquiring the castle of Kilkenny, which became the family seat. James (*c.* 1392–1452), 4th earl (the White Earl), was famous not only as a warrior, but as a scholar and antiquarian. He won his spurs in France with Henry V and then fought for him in Ireland. His best known battle was at the red moor of Athy in 1420 against the wild O'Mores, when, according to legend, the sun stood still for three hours until the English had won.

James (1420–61), 5th earl, son of the White Earl, lived mainly in England, and was given an English peerage as earl of Wiltshire in 1449. He took an active part in the Wars of the Roses on the Lancastrian side, both in politics, after his appointment as high treasurer in 1455, and in the field. But he was taken prisoner by the Yorkists after the battle of Towton in 1461, and shortly aftervard was executed at Newcastle. On his death the earldom of Viltshire became extinct and his Irish title and estates were foreited by the act of attainder (1462) against him and his two rothers. However, Edward IV recognized the 5th earl's brother OHN (d. 1478) as 6th earl of Ormonde some time before the atainder against him was annulled in 1475. John was a famous cholar, and spoke every European language. Edward admired im greatly and employed him as ambassador to several foreign ourts. He was succeeded by his brother Thomas (d. 1515), 7th arl, who also remained at court in England, and was sent as amassador to France and to Burgundy. He died in 1515 without nale issue. His daughter, Margaret, married Sir William Boleyn, nd their younger son, Thomas, was the father of Anne Boleyn.

While the earls of Ormonde lived in England, the influence of he family in Ireland had declined, especially as it had no recogized head there. But Sir Piers Butler (*c.* 1467–1539), 8th earl the Red Earl), cousin of the 7th earl, claimed the title in 1515, eized the estates and revived the Butler influence. He fought for he English against the rebel Irish lords, especially the Kildare eraldines, and in 1522, styled as the pretended earl of Ormonde, e was made lord deputy of Ireland. In 1528, renouncing his claim o the earldom of Ormonde, he was made earl of Ossory, and Sir homas Boleyn was made earl of Ormonde. Then in 1538, Piers as given the earldom of Ormonde as a new creation. However, is son and successor, James (*c.* 1496–1546), 9th earl (the Lame), rd treasurer of Ireland since 1532, who had been made Viscount hurles in 1536, was confirmed in the possession and precedence f the ancient earldom by act of parliament in 1544. James died, oisoned, at Ely house, London, on Oct. 28, 1546. Another son of iers, Richard, was in 1550 created Viscount Mountgarret, a title hich is still held in the Butler family.

James's son Thomas (1531–1614), 10th earl (the Black Earl), as brought up a Protestant at the English court after his father's eath. He returned to Ireland in 1554 and was appointed lord easurer there in 1559. In the rebellions of the Irish he threw his reat influence on the English side, but he was equally zealous prosecuting his private feud with the Desmond Geraldines. he earl of Desmond finally rose in open revolt in Dec. 1579, and rmonde was appointed military governor of Munster in 1580 put down the rebellion. He was able to pacify Munster after esmond's death in 1583. Appointed lieutenant governor in 1597, suppressed the rebellion of the O'Neills and the Burkes. His phew, Walter Butler of Kilcash (1569–1633), 11th earl, who ad fought with him in Ireland, succeeded to the title, but his claim the estates was disputed by Sir Robert Preston, the husband of e 10th earl's daughter Elizabeth. Refusing to submit to the arbiation of James I, Walter was imprisoned in 1617 and deprived of e palatinate rights in Tipperary which had been held by the fam- for three centuries. However, after his release in 1625 he revered most of his estates. His grandson and successor, James *ee* Ormonde, James Butler, 1st Duke of), the most famous of the Butlers, regained the rest of the Ormonde estates by marage with his cousin Elizabeth Preston.

James's son Thomas (1634–1680), earl of Ossory, "the terror of reign nations and the glory of his own," who served Charles II, ed before his father, who was succeeded by his grandson (*see* rmonde, James Butler, 2nd Duke of).

The Ormonde estates and titles were forfeit by the 2nd duke's tainder in 1715, but his brother Charles (1671–1758) was alwed to buy back the estates in 1721. A supporter of William III, arles had been given an Irish title as earl of Arran in 1693, and English one as Lord Butler of Weston in 1694. On his death ese titles became extinct, as did the dukedom and marquessate Ormonde. The earldom was claimed by descendants in Ireland the brother of the 1st duke, but the attainder was only reversed the Irish parliament in 1791, when John Butler (1740–95), th earl, was confirmed as earl of Ormonde and Ossory and Viunt Thurles. John's son Walter (1770–1820), 18th earl, gained English title as Lord Butler of Lanthony in 1801, and was made rquess of Ormonde in 1816, but these titles died with him. He d one of the ancient privileges of the Butlers, the right to the isage of wines in Ireland, to the English government for £216,000. His brother James (1774–1838), 19th earl, was made Baron Ormonde of Lanthony in 1821, and the Ormonde marquessate was revived for him in 1825. These titles were retained by his descendants, down to James Arthur Norman (1893–1971) and James Hubert Theobald Charles (1899–), 7th marquess, who succeeded his cousin.

Other branches of the Butler family also gained honours and titles, although the Ormonde lines were the most distinguished. A descendant of the 1st earl of Ormonde's brother was made Viscount Ikerrin in 1629, and one of his successors was made earl of Carrick also, in 1748. Sir Thomas Butler of Chaier, or Chaier-down-Eske, a descendant in an illegitimate branch of the family, was made Baron Caher in 1543. The title fell into abeyance on the death of the 2nd baron in 1561, but was revived in 1583, after the surrender of their rights by the heirs general, for Sir Theobald Butler (d. 1596). It became extinct in 1858 on the death of Richard Butler, 13th baron and 2nd viscount Caher, and 2nd earl of Glengall. A descendant of the 3rd earl of Ormonde, Count Walter Butler (d. 1634) gained fame and a title on the continent. A dragoon officer in the Thirty Years' War, he served for a time under Albrecht von Wallenstein, but in 1634, distrusting him and doubting his loyalty, he planned and carried out Wallenstein's murder. In memory of his services, the imperial title of Butler von Clonebough, *genannt* Haimhausen, count of the Holy Roman empire, was revived in 1681 for a kinsman.

BUTLER, ALBAN (1710–1773), English Roman Catholic hagiologist, author of the celebrated *Lives of the Saints*, was born in Northampton on Oct. 24, 1710. He was educated at the English college, Douai, France, where after ordination in 1734 he held successively the chairs of philosophy and divinity. In 1749 he returned to England but later became president of the English college at St. Omer, France, where he died on May 15, 1773. Butler's chief book, *The Lives of the Fathers, Martyrs, and Other Principal Saints*, 4 vol. (1756–59), a sound critical work of its period, which went through many editions, was drastically revised by H. Thurston and D. Attwater (*Butler's Lives of the Saints*, 4 vol., 1956), to bring it up to date in both content and treatment.

See C. Butler, *An Account of Alban Butler* (1800); J. Gillow, *Bibliographical Dictionary of English Catholics*, vol. i (1885).

BUTLER, BENJAMIN FRANKLIN (1818–1893), U.S. lawyer, soldier and politician, was born at Deerfield, N.H., on Nov. 5, 1818. He was educated at Waterville (later Colby) college, Waterville, Me., was admitted to the Massachusetts bar in 1840 and soon became a prominent lawyer in Lowell, Mass. An active Democrat, he served in the Massachusetts house of representatives in 1853 and in the state senate in 1859, distinguishing himself as a champion of the rights of labour and of naturalized citizens. In 1860 he attended the Democratic national convention at Charleston, S.C., but withdrew from it and joined the prosouthern faction that nominated John C. Breckinridge.

When the Civil War broke out, Butler strongly supported the Union. As a brigadier general of the Massachusetts militia, he commanded the troops that occupied Baltimore, and, in May 1861, was promoted to the rank of major general in command of Ft. Monroe, Va. There he refused to return fugitive slaves on the ground that they constituted "contraband of war," an interpretation which was later upheld by his government. He lost the engagement at Big Bethel in June, 1861, but achieved a success two months later when he captured the forts guarding Hatteras inlet.

Early in 1862, Butler took command of the land forces which accompanied Farragut's expedition against New Orleans. The city fell late in April, and from May to December Butler ruled it with an iron hand. He executed a citizen who had torn down the U.S. flag, undertook sanitary measures to prevent an outbreak of yellow fever, and confiscated the property of Confederate sympathizers. In order to end the indignities inflicted upon his soldiers, he published his famous order no. 28 in which he threatened to regard any female molesting his troops "as a woman of the town plying her avocation." Partially because of difficulties arising from his relations with foreign consuls, he was recalled in Dec. 1862.

As commander of the army of the James in 1864, Butler permitted himself to be bottled up at Bermuda Hundred, Va., and was generally unsuccessful in operations before Richmond and Petersburg. After the failure of an expedition against Ft. Fisher, N.C., he was relieved of command in Jan. 1865.

From 1867 to 1875 and again from 1877 to 1879, Butler served in the house of representatives as a Republican. An outspoken proponent of radical reconstruction and a manager of the impeachment trial of Andrew Johnson, he became one of President Grant's chief supporters in congress after 1868. But because of his sympathy with the inflationary greenback movement, he lost the confidence of prominent members of his party. In 1878 he broke with the Republicans, and, after two unsuccessful attempts, was elected governor of Massachusetts as a Democrat in 1882. Defeated for a second term, he bitterly opposed Cleveland's nomination for the presidency. In 1884 he became the standard bearer of the People's party, which included remnants of the Greenback Labor party and the Anti-Monopoly party, but failed to win a single electoral vote.

An able lawyer, Butler was often accused of corruption, but the charges against him were never proven. His flamboyant advocacy of the rights of workers, women and Negroes called attention to the necessity of many reforms, and he performed a valuable service by rallying the Democrats to the national cause in 1861. He died at Washington, D.C., on Jan. 11, 1893.

Bibliography.—H. L. Trefousse, *Ben Butler: The South Called Him Beast* (1957); R. S. Holzman, *Stormy Ben Butler* (1954); *The Autobiography and Personal Reminiscences of Major-General B. F. Butler: Butler's Book* (1893); and *The Private and Official Correspondence of Gen. Benjamin F. Butler During the Civil War*, 5 vol. (1917).

(H. L. T.)

BUTLER, HENRY MONTAGU (1833–1918), famous headmaster of Harrow school and master of Trinity college, Cambridge, was born at Gayton, Northamptonshire, on July 2, 1833, the son of George Butler, dean of Peterborough and a former headmaster of Harrow. H. M. Butler was headmaster from 1859 to 1885. At first he was opposed by an old-fashioned staff, but through his tact and firmness, public spirit and devotion to the school he overcame their opposition. During his term of office the report of the Clarendon commission was issued; many of the reforms recommended by the commission were already being tried out by Butler.

A brother-in-law of Sir Francis Galton, he was in sympathy with the scientific thought of the period, and science was officially recognized as a subject in the school curriculum. When E. E. Bowen was appointed to the staff, Butler supported him in the creation in 1869 of a modern side, or division, with the proviso that only boys with a satisfactory record in classics should be admitted. He also encouraged the traditions of the school. He was a great lover of music, and during his headship the cycle of Harrow school songs written by Bowen was completed. In 1885 Butler became dean of Gloucester, but this did not diminish his interest in Harrow, and in 1901 he was elected a governor of the school.

While master of Trinity college (1886–1918), Butler formed a link between religious bodies of different types and showed great interest in classes for working men. It was at Cambridge that he met Albert Mansbridge, the founder of the Workers' Educational association. Butler also began the annual reunion of Trinity scholars and was vice-chancellor of the university for the year 1889–90. He died at Cambridge on Jan. 14, 1918.

Bibliography.—H. M. Butler, *Public School Sermons* (1899), *Some Leisure Hours of a Long Life* (1914); E. Graham, *The Harrow Life of Henry Montagu Butler* (1920); J. R. M. Butler, *Henry Montagu Butler: Master of Trinity College, Cambridge, 1886–1918* (1925).

(S. J. C.)

BUTLER, JOSEPH (1692–1752), English bishop of Durham and moral philosopher, was born on May 18, 1692, at Wantage, Berkshire, of Presbyterian parentage. As a boy he was sent to the dissenting academy of Samuel Jones at Gloucester and later to Tewkesbury. While there Butler became dissatisfied with Presbyterianism and resolved to join the Church of England. In 1715 he entered Oriel college, Oxford, and after taking his degree, three years later, was ordained deacon and priest. In 1736, after several previous posts, Butler was appointed clerk of the closet to Queen Caroline. In 1737 the queen died. Her recommendation of Butler to the favour of her husband led to his appointment in 1738 to the bishopric of Bristol. Two years later Butler was presented to the deanery of St. Paul's and in 1746 was made clerk of the closet to the king. In 1750 he accepted the see of Durham. He died on June 16, 1752, at Bath, and was buried in Bristol cathedral. According to his wishes, all his manuscripts were burned after his death. Butler never married.

Butler's reputation rests chiefly upon two printed works, the *Fifteen Sermons* (1726) and the *Analogy of Religion* (1736). In the former he set forth his moral philosophy, arguing the case for ethics primarily from reason rather than from revelation and basing his arguments upon the nature of man and of the world rather than upon the divine imperative. The *sermons,* although written earlier than the *Analogy,* did not come into their own as a classic in ethical theory until a century or so after the author's death. The *Analogy of Religion, Natural and Revealed, to the Constitution and Course of Nature,* by contrast, did much to shape the history of the Christian apologetics during the 19th century. It is aimed at deism and proposes to defend the doctrine of immortality and the need for revelation against deistic rationalism. In support of both these tenets Butler argues that a sound use of reason does not contradict but at the least supports faith in divine revelation and in human immortality.

Of the many editions of the *Analogy* the best are those by W. Fitzgerald (1860), containing a valuable biography; by W. E. Gladstone (1896), the second volume containing the *Sermons* as well; and by J. H. Bernard (1900), which also includes the *Sermons.*

Bibliography.—C. D. Broad, *Five Types of Ethical Theory* (1930); E. C. Mossner, *Bishop Butler and the Age of Reason* (1936); Austin Duncan-Jones, *Butler's Moral Philosophy* (1952).

(J. J. Pn.)

BUTLER, JOSEPHINE ELIZABETH (1828–1906), English social reformer, chiefly remembered for her efforts to combat prostitution, was born at Milfield Hill, Northumberland, on April 13, 1828. She was the daughter of John Grey, an agriculturist, and was of Huguenot descent through her mother Hannah Annett. After her marriage (1852) to George Butler, later canon of Winchester, she settled in Liverpool (1866) where she began to work for the rehabilitation of prostitutes. She became involved at an early stage in the campaign against the Contagious Diseases acts, which had been passed in 1864, 1866 and 1869 to prevent the spread of venereal diseases in garrison towns and naval stations. These acts permitted the arrest of suspected women by special police, required compulsory medical examination by justices' order and detention in hospital if found affected. In 1869 Mrs. Butler organized the Ladies National Association for Repeal, and the "Protest of the Ladies," which, signed by notable women including Florence Nightingale and Harriet Martineau, was published in the London *Daily News* and initiated the abolitionist crusade. Urging that the acts deprived the most defenseless class of its constitutional rights and failed as public health measures, Mrs. Butler agitated for their repeal by numerous publications (notably *The Constitution Violated,* 1871), by appealing directly to working men, by intervention in elections and by organizing debates in parliament. A royal commission (1870–71) and a select committee of the house of commons (1879–82) were obtained to investigate their operation. The acts were suspended in 1883 and repealed in 1886. Mrs. Butler told the story of the campaign in *Personal Reminiscences of a Great Crusade* (1896).

She also influenced European governments against licensed brothels and state regulation of prostitution. Victor Hugo, Mazzini and Garibaldi were among her continental, and William Lloyd Garrison among her American, supporters. She founded the International Abolitionist federation, which held its first world congress in Geneva (1877). She revealed the licensed brothel as the market for the white-slave traffic and sale of children for infamous purposes.

An early suffragist, Mrs. Butler worked also for equal educational and economic opportunities for women. She died at Wooler, Northumberland, on Dec. 30, 1906.

Bibliography.—W. T. Stead, *The Maiden Tribute of Modern Babylon* (1885); Benjamin Scott, *A State Iniquity* (1890); M. G. Fawcett and E. M. Turner, *Josephine Butler* (1927).

(A. H. M.; A. Bri.)

BUTLER, NICHOLAS MURRAY (1862–1947), U.S. ducator, publicist and Nobel laureate, was born at Elizabeth, N.J., n April 2, 1862. He was educated at Columbia college, where, nder the influence of Pres. F. A. P. Barnard (*q.v.*), he decided prepare himself for a professional career in education. After ompleting his undergraduate work in 1882 he continued at Colum- ia as a graduate fellow in philosophy, taking the Ph.D. degree in 384. A year in Berlin and Paris completed his formal education.

At the age of 23 Butler embarked upon an active career destined put him in touch with the leading educators and statesmen of s time. He was appointed an assistant in philosophy at Colum- ia in 1885 and rose to a full professorship within five years. In 890 he became the first dean of the faculty of philosophy, and 1901 he acceded to the presidency of the university, a post he eld until his retirement in 1945. Under his leadership Columbia ew from a provincial college into a cosmopolitan university of orld renown.

As a young man Butler boldly criticized the schools and colleges his day. He attacked antiquated pedagogical methods and arply assailed what he called "the old dogma of formal educa- on." As president of the Industrial Education association, he ayed a central role in the founding of the New York College for e Training of Teachers, subsequently Teachers college, Colum- a university. Later, however, he turned his criticism against dagogical reform itself, steadfastly defending the "great tradi- on" in education and lashing out against vocationalism and be- viourism as the "new barbarism."

For more than a half-century Butler was active in the Republi- n party, serving frequently as a delegate to its national conven- ons. He was also a vigorous advocate of improved international derstanding, sharing with Jane Addams the Nobel peace prize r 1931. Butler died on Dec. 7, 1947, in New York city.

His *Across the Busy Years*, two volumes (1939–40), contains bibliography of his published works.

See Edward C. Elliott (ed.), *The Rise of a University*, vol. ii (1937). (L. A. C.)

BUTLER, SAMUEL (1612–1680), English poet, satirist d author of *Hudibras*, son of a Worcestershire farmer, was bap- ed at Strensham, in that county, on Feb. 8, 1612. Educated the King's school, Worcester, he obtained employment as a rk with a Mr. Jeffereys and later in the household of the count- s of Kent at Wrest, Bedfordshire, where he had access to a e library and met the great scholar John Selden, whose secretary is said to have been for a time. He then passed into the serv- of Sir Samuel Luke of Cople Hoo, a rigid Presbyterian, a lonel in the parliamentary army and scoutmaster-general for dfordshire. In his service Butler must have had abundant op- rtunities of studying at firsthand the motley collection of cranks, atics and scallywags who attached themselves to the Puritan ny, and whose antics were to form the subject of his famous em. At the Restoration he obtained a post as secretary to chard Vaughan, earl of Carbery, lord president of Wales, who de him steward of Ludlow castle, an office which he held from n. 1661 till Jan. 1662. At this time he is said to have married woman with "a competent fortune" which was however dissi- ted by "being put out on ill securities."

The first part of *Hudibras* appeared anonymously in an edition ted 1663, which was apparently on sale at the end of 1662. muel Pepys bought a copy on Dec. 21, but could find no wit in silly an abuse of the Presbyter knight going to the warrs." wever he repeatedly testifies to its immense popularity and re is no doubt that it had a very great success. Charles II ighted in it and it was said that

> He never Eat nor Drank nor Slept
> But *Hudibras* still near him kept.

spurious second part appeared within the year and this ap- ently determined the poet to bring out the authentic second t, licensed on Nov. 7, 1663, and published in 1664. The first parts were reprinted together in 1674 with "The Heroical istle of Hudibras to Sidrophel." In 1677 an injunction was ued by the king to protect Butler's rights against piratical nters, and in 1678 a third (and last) part of *Hudibras* was published. According to John Aubrey, the biographer, when the first part of *Hudibras* appeared, the king and the lord chancellor Clarendon sent for Butler and "promised him great matters" but these promises do not seem to have materialized, though Charles is said to have given him £300. In the latter part of his life he seems to have been attached to the suite of George Villiers, 2nd duke of Buckingham, whom he probably accompanied on an embassy to France in 1670, and he is said to have been a member of the team which helped the duke in the composition of *The Rehearsal* (1671) and to have acted as his secretary when he was chancellor of Cambridge university. Butler died Sept. 25, 1680, and was buried in the churchyard of St. Paul's, Covent Garden. There seems little doubt that he died a poor and disappointed man, who, at the end of an apparently successful literary career, in the words of his contemporary, John Oldham, "found nothing left but poverty and praise." Aubrey, who knew Butler well, describes him as "of a middle stature, strong sett, high coloured, a head of sorrell hair, a severe and sound judgment: a good fellowe."

Hudibras is the most memorable burlesque poem in the English language. Its hero is a Presbyterian knight who goes "a-colonelling" with his squire Ralpho, an Independent. They constantly squabble over religious questions and in a series of grotesque adventures are shown up as ignorant and wrongheaded, cowardly and dishonest. Butler derived his story from Cervantes and the burlesque method (making everything as "low" and undignified as possible) from Scarron. However, his brilliant handling of the octosyllabic metre, his witty, clattering rhymes, his delight in strange words and out-of-the-way learning, resembling in some respects both Rabelais and James Joyce, and his enormous zest and vigour produce effects which are entirely original. The story and characters in *Hudibras* are of little importance. Its strength lies in the fact that it is the first English satire to make a notable and successful attack not on personalities but on ideas. Butler's real enemies are not so much the Puritans as fanaticism, pretentiousness, pedantry and hypocrisy. His famous description of the militant Presbyterians is an unforgettable deflation of the spirit of religious intolerance:

> Such as do build their Faith upon
> The holy Text of *Pike* and *Gun;*
> Decide all Controversies by
> Infallible *Artillery;*
> And prove their Doctrine Orthodox
> By Apostolick *Blows* and *Knocks:*
> Call Fire and Sword and Desolation
> *A godly-thorough-Reformation,* . . .

His description of the doctrine of the Inner Light is a fine example of "metaphysical wit" harnessed to serve the new skeptical rationalism of the age of Newton and Locke:

> 'Tis a Dark-Lanthorn of the Spirit,
> Which none see by but those that bear it:
> A Light that falls down from on high
> For Spiritual Trades to couzen by:
> An *Ignis Fatuus* that bewitches
> And leads Men into Pools and Ditches . . .

There is lyrical beauty as well as burlesque in *Hudibras* and the description of the rising of the moon is as fine as anything of the kind in Andrew Marvell or Thomas Carew:

> The *Moon* pull'd off her veil of Light,
> That hides her face by day from sight,
> (Mysterious Veil, of brightness made,
> That's both her lustre, and her shade).

The pictures of low life in the poem are, perhaps, the most notable things of the kind in English poetry between John Skelton and George Crabbe, with both of whom Butler has a certain affinity.

He attacked pretentiousness and pedantry wherever he found it. In "The Elephant in the Moon" (1676) he mocked the solemnities of the scientists of the newly founded Royal society and in "Repartees between Puss and Cat at a Caterwalling" the absurdities of the rhyming heroic tragedies. His ode *To the Happy Memory of the Most Renowned Du Val* (1671) is an amusing skit on the fashionable "pindaric" odes. Other poems are ascribed to him in an edition of his *Posthumous Works in Verse and Prose,* three volumes (1715–17), but some are undoubtedly spurious. Butler's papers, now in the British museum, London (Add. Mss. 32, 625–626), passed at his death into the hands of his friend William Longueville and were left untouched till Robert Thyer edited from them *Genuine Remains in Verse and Prose of Mr. Samuel Butler*, two volumes (1759). This collection included more than a hundred prose "Characters," which show Butler as a master of vigorous, incisive, racy prose and an artist in the Theophrastian "character" not inferior to John Earle or the contributors to Sir Thomas Overbury's famous collection. The study of "A Duke of Bucks" is a satiric analysis of the character of the 2nd duke of Buckingham which does not suffer much even by comparison with Dryden's famous "Zimri" in *Absalom and Achitophel.*

BIBLIOGRAPHY.—The best modern edition is the *Collected Works*, ed. by A. R. Waller and R. Lamar, 3 vol. (1905–28); *Poetical Works*, ed. by R. B. Johnson, 2 vol. (1893) contains important bibliographical information. Editions of *Hudibras*, besides those mentioned above, appeared in 1704 (containing the first *Life* of Butler), in 1726 (illustrated by Hogarth), in 1744 (2 vol., ed. by Zachary Grey, with a copious and learned commentary) and a new edition by J. S. Wilders (1961). *The Poetical Remains* (1827) were based on Thyer's *Genuine Remains.*

See also Zachary Grey, *Critical, Historical and Explanatory Notes Upon Hudibras* (1752); J. Veldkamp, *S. Butler* (1924); E. A. Richards, *Hudibras in the Burlesque Tradition* (1937); I. Jack, *Augustan Satire, Intention and Idiom in English Poetry, 1660–1750* (1952).

(V. DE S. P.)

BUTLER, SAMUEL (1835–1902), English satirist, novelist, essayist and critic, one of the most original and many-sided writers of the late Victorian age. The son of the Rev. Thomas Butler, and grandson of Dr. Samuel Butler, headmaster of Shrewsbury school and later bishop of Lichfield, he was born at Langar rectory, Nottinghamshire, on Dec. 4, 1835. After six years at Shrewsbury he went to St. John's college, Cambridge, where in 1858 he was bracketed 12th in the classical tripos. His father wished him to be a clergyman and he actually went as far as to do a little slumming in a London parish by way of preparation for Holy Orders. But the whole current of his highly independent and heretical nature was carrying him away from everything his father stood for: home, church and Christianity itself—or what Christianity had appeared to mean at Langar rectory. After an unpleasant altercation with his father he left Cambridge and the church and all home prospects, and emigrated to New Zealand, where (with funds advanced by his father) he set up a sheep run in the Canterbury settlement.

When Darwin's *Origin of Species* came into his hands, soon after his arrival in New Zealand, it took him by storm; he became "one of Mr. Darwin's many enthusiastic admirers," and a year or two later he told a friend that he had renounced Christianity altogether. Yet, as it proved, Christianity had by no means finished with Butler. For the next 25 years it was upon religion and evolution that his attention was mainly fixed. At first he welcomed Darwinism because it enabled him to do without God (or rather, without his father's God). Later, having found a God of his own, he rejected Darwinism itself because it left Him out. Naturally, therefore, he antagonized both the church and the orthodox Darwinians, and spent his life in a lonely, "Ishmaelitish" situation. To the New Zealand *Press* he contributed several articles on Darwinian topics, of which two—"Darwin Among the Machines" (1863) and "*Lucubratio Ebria*" (1865)—were later worked up in *Erewhon.* Both show him already grappling with the central problem of his later thought: the relationship between mechanism and life. In "Darwin Among the Machines" he tries out the consequences of regarding machines as living organisms competing with man in the struggle for existence, and so likely to win that they must at once be destroyed. In the "*Lucubratio*" he takes the opposite view, that machines are extracorporeal limbs, and that the more of these a man can tack on to himself the more highly evolved an organism he will be.

Having doubled his capital in New Zealand, Butler returned to England (1864) and took the apartment in Clifford's Inn which was to be his home for the rest of his life. In 1865 his *Evidences for the Resurrection of Jesus Christ . . . . Critically Examined* appeared anonymously. For a few years he studied painting at Heatherley's art school, and tried to convince himself that this was his vocation. Until 1876 he exhibited occasionally at the Royal Academy. One of his oil paintings, "Mr. Heatherley's Holiday" (1874), is in the Tate gallery, London, and his "Family Prayers," in which the ethos of Langar rectory is satirically conveyed, is at St. John's college, Cambridge. Later he tried his hand (in collaboration with H. Festing Jones) at musical composition, publishing *Gavottes, Minuets, Fugues, and Other Short Pieces for the Piano* (1885), and *Narcissus*, a comic cantata in the style of Handel—whom he rated high above all other composers—in 1888; *Ulysses: an Oratorio* appeared in 1904. It was typical of Butler to use his native gifts and mother wit in such exploits and even in literature, his rightful territory, much of his work is that of the shrewd amateur who sets out alone to sling pebbles small but lethal, at various Goliaths of the Establishment. "I have never," he once said, "written on any subject unless I believed that the authorities on it were hopelessly wrong." Hence his assault on the citadels of orthodox Darwinism and orthodox Christianity; hence, later, his attempt to prove that the *Odyssey* was written in Sicily by a woman (*The Authoress of the Odyssey*, 1897), and his new interpretation of Shakespeare's sonnets (*Shakespeare's Sonnets Reconsidered and in Part Rearranged*, 1899).

Erewhon (1872) made whatever reputation Butler enjoyed in his lifetime as a writer; it was the only one of his many books on which he made any profit worth mentioning, and he only made £69 3*s*. 10*d*. on that. Yet it was received by many as the best thing of its kind since *Gulliver's Travels*—that is to say, as a satire on contemporary life and thought conveyed by the time-honoured convention of travel in an imaginary country. The opening chapters, based upon Butler's recollections of the Upper Rangitata mountains, are in an excellent narrative style, and the description of the hollow statues at the top of the pass, vibrating in the wind with unearthly chords, makes a highly effective transition to the strange land beyond. The landscape and people of Erewhon are idealized from northern Italy; its institutions are partly Utopian and partly satiric inversions of our own. Butler's two main themes, religion and evolution, appear respectively in the "Musical Banks" (Churches) and in the chapters called "Some Erewhonian Trials" and "The Book of the Machines." The Erewhonians have long ago abolished machines as dangerous competitors in the struggle for existence, and by punishing disease as a crime they have produced a race of great physical beauty and strength.

The Fair Haven (1873) is an ironical defense of Christianity which, under the guise of orthodox zeal, nevertheless undermines its miraculous foundations. Butler was dogged all through life by the sense of having been bamboozled by those who should have been his betters; he had been taken in by his parents and their religion; he was taken in again by his friend Charles Pauli who returned neither the money nor the friendship he accepted from Butler for years, and by the companies of another friend Henry Hoare (in which he invested and lost money); life itself and the world, sometimes seemed to him a hollow sham. Was Darwin himself, his saviour from Langar, now to prove a fraud as well? This was the suspicion that dawned upon him while writing *Life and Habit* (1878), and envenomed the series of evolutionary books that followed: *Evolution, Old and New* (1879) *Unconscious Memory* (1880) and *Luck or Cunning* (1887). Darwin had not really explained evolution at all, because he had not accounted for the variations on which Natural Selection worked Where Darwin saw only chance, Butler saw the Lamarckian effort on the part of creatures to respond to felt needs. He conceived creatures as acquiring necessary habits (and organs to perform them) and transmitting these to their offspring as unconscious memories. He thus restored teleology to a world from which purpose had been excluded by Darwin; but instead of attributing the purpose to God he placed it within the creatures themselves as the Life Force.

Many regard *The Way of All Flesh* (published 1903, the year after Butler's death) as his masterpiece. It certainly contains much of the quintessence of Butlerism (though the *Notebooks* of which H. Festing Jones published a selection in 1912, are necessary to supplement it). This largely autobiographical novel tells ith ruthless wit, realism and lack of sentiment, the story of Buter's escape from the suffocating moral atmosphere of his home ircle. Ernest Pontifex stands for his early self and Overton or his maturity; Theobald and Christina are his parents. owneley and Alethea represent "nice" people (Alethea was parally modeled on his friend and critic Miss Savage)—people who love God" in Butler's special sense of having "good health, good oks, good sense, experience, and a fair balance of cash in hand." he book was influential at the beginning of the anti-Victorian rection, and Butler was saluted by G. B. Shaw as "the greatest nglish writer of the latter half of the nineteenth century." He ied in London, on June 18, 1902.

Other works of Butler, not mentioned above, include *Alps and anctuaries of Piedmont* (1882); *Ex Voto: An Account of the acro Monte or New Jerusalem at Varallo-Sesia* (1888); *The Life nd Letters of Dr. Samuel Butler*, 2 vol. (1896); *Erewhon Revised* (1901); *God the Known and God the Unknown* (1909); *The umour of Homer, and Other Essays* (1913).

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BUTLER, a city of Pennsylvania, U.S., the seat of Butler unty, is about 30 mi. N. of Pittsburgh. It is built on a site ice owned by Robert Morris, American Revolutionary War ancier, and is named for Gen. Richard Butler. It was founded 1800, incorporated as a borough in 1803 and made a city in 1917. Oil, natural gas, limestone, coal and iron are plentiful in the cinity. Manufacture of steel, chemical, glass, food, lumber, etal, mine and paper products together with extensive agriculre give diversified employment to the region. For comparative pulation figures *see* table in Pennsylvania: *Population*.

(C. C. G.)

BUTLEROV, ALEXANDER MIKHAILOVICH (1828–86), Russian chemist, best known for his studies of organic mpounds, was born Aug. 25, 1828, near Kazan. With a Moscow ctorate (1854) he joined the Kazan university faculty. In 1868 transferred to St. Petersburg. Butlerov studied with E. Mitschlich, F. A. Kekulé, C. A. Wurtz, A. W. Von Hofmann and W. Williamson. His contributions included the first synthetic gar and tertiary alcohol, proof of the impossibility of free methene, formaldehyde polymerization and special studies in conction with hexamethylenetetramine, zinc alkyls, pinacolone and meric hydrocarbons. Giving full credit to Kekulé, he introduced e word "structure" into organic chemistry in a text on structural eory. He was an honorary member of many scientific societies, d was one of the first honorary members of the American Chemil society. He died Aug. 5, 1886, in Biarritz. (V. Bw.)

BUTO, the Greek form of ancient Egyptian P-Udjo (older m Per-Wedjoyet), "house of (the goddess) Udjo," is the name several towns in Egypt, the most important being the modern ll al-Farain in the northwestern delta. Stephen of Byzantium ongly applies the name of the town, Buto, to the goddess herf; by all other Greek authors she is identified with Leto and led by this name. The town, where the cult of the goddess had origin, was the capital of a lower Egyptian kingdom in pretoric times, and retained some religious importance even after unification of the country, as did the goddess, who remained utelary deity of lower (northern) Egypt. She was usually deted as a cobra (uraeus) twined round a papyrus stem, or as a t of the diadem on the head of the Pharaoh, whom she proted against enemies. According to a later tradition she was se to the infant god Horus whom Isis bore on the floating nd of Chemmis near Buto, and saved Horus from his treacheruncle, the god Setekh. It was this myth that reminded the eeks of the story of Leto and Apollo on Delos and led to the ntification of Udjo with Leto (*q.v.*).

The temple and oracle at Buto were much admired by Herodotus 155). (J. Cy.)

BUTT, DAME CLARA ELLEN (1872–1936), English contralto known for her performances of ballads and oratorios. Born at Southwick, Sussex, Feb. 1, 1872, she was a pupil of Daniel Rootham and J. H. Blower in England, of V. A. Duvernoy and J. Bouhy in Paris and of Etelka Gerster in Berlin. She made her debut in 1892 in London as Ursula in Sir Arthur Sullivan's cantata *The Golden Legend*. She possessed a powerful contralto voice and a commanding personality and was admired especially in the oratorios of Handel and Mendelssohn. She also became popular as a ballad singer in Britain and abroad, notably in Sir Edward Elgar's "Land of Hope and Glory," written at her suggestion, and Samuel Liddle's "Abide with Me." Elgar wrote for her his song cycle *Sea Pictures*, and she inspired the part of the angel in his *Dream of Gerontius*. In 1900 she married the baritone Robert Kennerley Rumford, with whom she gave joint recitals. In 1919 she made one of her few appearances in opera, taking the title role in the production at Covent Garden of Gluck's *Orfeo*, conducted by Sir Thomas Beecham. In 1920 she was created a dame of the British empire for her services to music in World War I. She died at North Stoke, Oxfordshire, Jan. 23, 1936.

See W. Ponder, *Clara Butt* (1928).

BUTT, ISAAC (1813–1879), Irish lawyer and Nationalist leader, who inaugurated the Home Rule movement, was born at Glenfin, Donegal, on Sept. 6, 1813, the son of the rector of Stranorlar. He was educated at Trinity college, Dublin, where in 1833 he helped to found the *Dublin University Magazine*, and in 1836 was appointed professor of political economy. He was called to the Irish bar in 1838 and was made a queen's counsel in 1844. Butt was a staunch supporter of the union between Great Britain and Ireland, and his eloquence, knowledge of economic affairs and great legal abilities made him one of the most influential opponents of Daniel O'Connell (*q.v.*). But his faith in the system of a joint legislature for Great Britain and Ireland was shaken by the government's failure to take effective action in the face of the great Irish famine of the 1840s.

Butt had for years urged a radical reform of the Irish system of land tenure which at that time gave no security to tenants and enabled landlords to increase rents exorbitantly by subdividing the uneconomic small holdings. Experience of the famine convinced him that even the most urgent Irish needs received little attention at Westminster and that some form of native parliament in Ireland was indispensable. In 1848 he undertook the defense of the leaders of the Young Ireland movement when they were charged with high treason as a result of their abortive insurrection that year. Later, between 1865 and 1869, he became the chief defending counsel for the Fenian leaders.

Butt was elected Liberal-Conservative member of parliament for Youghal in 1852 and retained the seat until 1865. During this time his views became increasingly liberal. In May 1870 he propounded a policy calling for a national parliament for Ireland (subordinate to the imperial parliament at Westminster) and formed the Home Government association. He was, if not the originator of the term "Home Rule," the first to make it an effective political slogan (*see* Ireland: *History*). When, in 1871, he was again elected to parliament—on this occasion for Limerick—he found he could count upon the support of 57 Home Rule members in the house of commons. The national agitation revived quickly under his leadership, but the movement soon found a more dynamic and younger leader in Charles Stewart Parnell, who began to organize systematic obstruction of parliamentary business at Westminster. Butt disapproved of the obstructionists' provocative and disruptive methods, but with his influence declining and in failing health, he was unable to control them and was soon displaced in favour of Parnell. He died in Dublin on May 5, 1879.

See T. de Vere White, *The Road of Excess* (1946). (D. G.)

BUTTE, a city of Montana, U.S., on the western slope of the continental divide; the seat of Silver Bow county. Butte early became known as "the richest hill on earth." Placer gold discovered in 1864 produced $1,500,000 by 1869. Silver was first successfully treated in 1875. Its production declined markedly after the price dropped in 1893. Copper production in Butte began in

1882 and by 1900 represented 50% of the nation's output. Zinc has almost equaled the value of copper in annual output. Lead and manganese were other important products.

The city was laid out in 1866 and incorporated in 1879. It grew slowly until the railroads reached it in the 1880s. Butte's early history was closely linked with the "war of the copper kings," William A. Clark, Marcus Daly and F. Augustus Heinze (*see* MONTANA: *History and Government*). The decline in mining and increased use of machinery caused a population decrease after 1940 (for comparative population figures *see* table in MONTANA: *Population*). In an effort to relieve the chronic instability of the economy the Anaconda Copper Mining company in 1952 adopted a 20-year plan, the Greater Butte project, followed in 1955 by the beginning of open-pit operations in the Berkeley mine. Butte's strong labour organizations have been nationally important.

Butte's Memorial hospital is widely used in the area. The Montana School of Mines, now Montana College of Mineral Science and Technology, opened in Butte in 1900. Diversified industries include a packing plant, a large stock sales yard and an elemental phosphorus plant. To the west of the city is Big Butte, a sharp conical peak from which the city takes its name. (M. G. BU.)

BUTTE (BUTE) (Fr. *butte*, "a hillock or rising ground"), a flat-topped hill surrounded by a steep escarpment from which a slope descends to the plain. The term is sometimes used for an elevation higher than a hill but not high enough for a mountain. The butte capped by a horizontal platform of hard rock is characteristic of the arid plateau region of the western United States. *See* also MESA.

BUTTER. As the term is used most commonly, butter is the yellowish or whitish fat of cow's milk as flocculated or solidified by churning. The commercial product contains not less than 80% and as much as 85% milk fat, 12% to 16% water, about 2% salt (mostly added) and about 1% milk curd. The fat consists of glycerides of perhaps eight acids, among them oleic, stearic, palmitic and butyric. The recognized high food value of butter depends predominantly on high food energy, approximately 716 cal. per 100 grams, plus high vitamin A value of about 3,300 international units (annual average) per 100 grams and substantial amounts of vitamin D. Protein is low, as are vitamins other than A and D, but about 20 mg. of calcium and 16 mg. of phosphorus are present per 100 grams. The colour of butter is caused by the carotene and other fat-soluble pigments in the fat globules of milk.

When or where man first learned to concentrate this small portion of milk and to utilize it as a semistorable and high energy food is unknown, but presumably it was in the prehistoric stages of animal husbandry. Certainly it has long been used and relished by man as a spread and as a cooking fat. Butter is the favourite edible fat of the peoples of northern Europe, North America and Oceania and some other places to which Europeans have migrated in numbers. Much of the production is restricted to those areas, but some other areas, particularly India, make considerable use of it. Much of Indian consumption is of a semifluid, clarified form called ghee.

In all, about one-third of the world's milk production is devoted to buttermaking. Estimated world butter production in the late 1960s was nearly 11,000,000,000 lb. annually. The Soviet Union was the world's largest producer with an annual output of nearly 2,600,000,000 lb., followed by the United States with a production of about 1,250,000,000 lb.; West Germany with 1,140,000,000 lb.; France, 1,130,000,000 lb.; New Zealand, 580,000,000 lb.; and Australia, 470,000,000 lb.

In the United States butter was first made on farms. The pioneers who went west to take up grain farming soon realized the value of cattle in the maintenance of soil productivity and built up sizable herds as quickly as possible. When this led to the production of butter in excess of the farm family's requirements, the surplus was disposed of either to neighbours for cash or to the village store in exchange for necessary commodities.

Enterprising persons saw an opportunity for commercializing buttermaking. The first creamery established in the United States was built by R. S. Woodhull of Campbell Hall, Orange county, New York, in 1856. Other creameries sprang up in various sections of New York and gradually moved westward to the Great Lakes and beyond.

The change of butter from a farm to a factory commodity is mirrored in the statistics of the United States department of agriculture. In the year 1850 the United States produced 313,345,566 lb. of butter, all farm-made. In 1910 the country's output was 1,706,000,000 lb., 60% of which was made in commercial plants. By the late 1960s production of farm butter had declined to less than 20,000,000 lb. annually.

The first creameries purchased whole milk from the farmers and separated it by letting the milk stand until the cream rose to the top. Then either the cream was skimmed from the top or the skim milk was drawn from the bottom. With the introduction of a farm-sized mechanical separator in 1890, however, the farmer was able to market his butterfat in the form of cream rather than as whole milk. The development of the Babcock test by S. M. Babcock in the same year enabled the creamery to give the farmer a cash return on the actual fat delivered rather than on the amount of whole milk.

The first neighbourhood factory handled only a few hundred pounds of butter a day; by the early 1960s the small creamery had an average annual output of about 250,000 lb. of butter marketed through the city wholesale dealer or jobber. In a few cases a number of small creameries organized a co-operative marketing agency. A few single factories had an annual production of approximately 15,000,000 lb., and a few companies with a series of 15 or 20 creameries were manufacturing more than 60,000,000 lb. of butter in a year.

Milk as it comes from the cow ranges from a low of approximately 3% to a high of about 6% butterfat. Good butter production must begin with the milk cow—her health and her diet affect even the final flavour of the butter (*see* DAIRY INDUSTRY). The care the milk receives, particularly as to noncontamination with bacteria or odours and rapid cooling after milking, is most important.

Butter is made as follows: As quickly as the milk is separated the cream is cooled. The cream is delivered to the creamery where it is graded according to at least two classes, sweet and sour.

If sour, the acidity is standardized to about 0.25% lactic acid by the use of a carbonate or a lime. Then it is pasteurized, and if ripened cream butter is to be made a pure culture of *Streptococcus lactis* is introduced to start the desirable souring process. If sweet cream butter is to be made no starter is added. The best storage butter is made from unripened or sweet cream. After pasteurization and ripening the cream is held overnight and then is churned, washed, salted and worked in the combined churn and worker. The market requirements determine the amount of colour and salt that are used.

The butter is compressed in bulk containers and then or later is cut into rectangular blocks of 1 lb. or ¼ lb. weight and packaged for retailing. Various continuous-process methods, by means of which butter can be produced in a continuous flow rather than in batches, were under development in the early 1960s.

In the early 1920s congress authorized the U.S. department of agriculture to set up a federal butter-grading and inspection service that would enable buttermakers and dealers to have an inspector examine commercial lots of butter and issue official certificates of grade.

Such grading did not become compulsory, however. The grade is based on aroma, taste, body or texture, colour and salt. The grades, based on a scoring of all factors, range from a high of 93 score through the much more usual and very acceptable 92 score, to 90 to 89, to cooking-grade butter. Grading has been particularly well developed and high quality obtained in countries such as Denmark and New Zealand, which serve an export market. In England and Wales, the voluntary grading scheme operated by the National Association of Creamery Proprietors received 100% support of the producers.

About one-fourth of U.S. milk production ordinarily is used for butter. Eighty per cent of U.S. butter is manufactured in he west north central and east north central regions, with Minneota, Iowa and Wisconsin the leading states. From more than ,800 manufacturing plants it is sold mostly as produced to central arket wholesalers, butter marketing co-operatives, chain stores, rge dairy corporations and meat packers. These primary reeivers distribute nearly half through their own outlets. Nearly 0% of the butter tends to bypass the wholesale "open markets" f Chicago and New York city. Spot markets are found in those ities as part of the mercantile exchanges, as are butter future arkets. Those of Chicago are more active.

Butter was rationed in most major consuming countries during Vorld War II and in some of them even into the early 1950s. In art this was because of the general food situation, but in the Inited States, in spite of increased milk production, a larger share f the total was consumed as whole milk and used for manufacuring. Military procurement rose to 312,000,000 lb. in 1944 and xports to 107,000,000 lb. in 1943. Competition with margarine ecame more severe as laws were relaxed in the postwar period. ivilian consumption per capita declined from more than 17 lb. er year prewar to 5.6 lb. in 1968. In 1966 New Zealand had the orld's highest per capita consumption of butter of 43.0 lb., folwed by Finland with 40.3 lb.

During the years 1933–41 the U.S. government engaged in utter price-stabilization programs, purchasing about 270,000,000 . From late 1942 until mid-1946 ceiling prices were in effect butter, with a subsidy of five cents per pound. Butterfat came nder the provisions of the Steagall amendment and so was suprted at 90% of parity for two years after the official ending of stilities. After 1949 the Commodity Credit corporation suprted milk and butter prices through offers to purchase butter d other manufactured dairy products. In the late 1960s a large utter surplus accumulated in Western Europe. The EEC in 1968 xed common export subsidy rates and resolved to dispose of the eater part of 350,000 tons of excess stocks, partly by gifts to eveloping countries.

International trade in butter in 1967 set a post-World War II cord; New Zealand exported 210,000 tons, or 32% of the world tal; Denmark was second with 104,000 tons. The United Kingom was by far the major importing country, taking about 38,000 tons in 1967. *See* also BUTTERFAT; MILK.

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BUTTERCUP: *see* RANUNCULUS.

BUTTERFAT, the fatty constituent of cows' milk. But, which is a solid emulsion containing fat, water, curd, milk gar, and inorganic salts, is melted and allowed to settle; the ar butterfat rises to the top and is separated by decantation. does not become rancid as readily as butter, for the albumius curd and the water present in the latter favour the growth of organisms which promote rancidity. Butterfat is manufacred chiefly in India and Egypt; before World War I it was also epared in Siberia (whence it was exported to Turkey) and to a s extent in Germany (*Schmelzbutter*). In India, where it is epared in large quantities, butterfat is known as ghee; it is mmonly mixed with the milk fat of the buffalo, while in Egypt chief adulterants are the milk fats of sheep and goats. In the ter country the fat is termed *samna.*

Butterfat occupies a unique position among the natural animal s because it contains considerable amounts of the glycerides the water-soluble fatty acids—butyric, caproic, caprylic, and pric acids. The Reichert-Meissel (Reichert-Wollny) value, ich is a measure of the amount of these acids, is a valuable characteristic in butterfat analysis. Especially characteristic is the presence of butyric acid, which is absent from coconut and palm-kernel oils, from which butterfat is distinguished also by its smaller content of lauric acid. *See* also BUTTER; OILS, FATS AND WAXES.

BUTTERFIELD, WILLIAM (1814–1900), English architect, was born in London on Sept. 7, 1814. Articled first to a Westminster builder, he later spent three years with a Worcester architect, acquiring a taste for Gothic. In 1843 he became connected with the Cambridge Camden society, a High Anglican group who wished ecclesiastical architecture to conform to the Oxford reformers' liturgy.

Butterfield, who built nearly 100 churches, provided the desired settings, but built in an astringent manner using red brick, roughly sawn timber and a harsh, abrupt disposition of masses, qualities linking him with the Pre-Raphaelites. His most ornate church is All Saints', Margaret street, London (1849–55); others include St. Matthias', Stoke Newington (1851–53), and St. Alban's, Holborn (1859–63), in London; a church at Babbacombe, Devon (1867–74), and in 1891–92, St. Augustine's, Bournemouth, Hampshire. His few secular works include Keble college, Oxford, mostly complete by 1870; its variegated brick banding is characteristic of all Butterfield's works.

He died in London on Feb. 23, 1900.

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BUTTERFISH or DOLLARFISH (*Poronotus triacanthus*), a deep-bodied, spiny-rayed fish with a long dorsal and anal fins and a forked tail, caught along the Atlantic coast of North America from Nova Scotia to Florida. The delicate flavour is especially well developed when the fish is fried in butter until lightly browned. Its maximum length is about 12 inches. Because of its bright, silvery, rounded appearance it is sometimes called the dollarfish.

Spawning occurs off-shore in deep water during the summer. The adults then congregate in loose schools over mud bottom in shallow water. The eggs hatch in about two days and the young often gather under jellyfish.

The name butterfish is also applied to various other fishes of the Stromateidae family and to species of blenny. (C. HU.)

BUTTERFLY AND MOTH. Among the most colourful of insects, butterflies and moths are also among the most numerous. The order Lepidoptera, with perhaps 100,000 named species, is second in size only to the beetles (Coleoptera). "Lepidoptera," from the Greek, refers to the scale-covered wings characteristic of the group. During development Lepidoptera undergo complete metamorphosis. Their larvae, called caterpillars, have chewing mouthparts and feed chiefly on plants, while the adults have a tubular proboscis used for sucking liquids. The great majority of the species are moths. Skippers appear to occupy a place intermediate between moths and butterflies. The butterflies, however, have appealed to human imagination since the days of Greek mythology, symbolizing fragile and ephemeral beauty. References to butterflies abound in literature. They have been depicted in many paintings, have inspired the designs of jewelry, ornaments, and textiles, and even occur on many postage stamps and in heraldic devices.

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I. GENERAL BACKGROUND

1. Number and Diversity.—In addition to the estimated 100,000 species already named, many thousands await discovery, particularly in the tropics. Lepidoptera occur abundantly in all continents except Antarctica and live successfully in every possible land environment. A few live, as larvae, in fresh water. In wing expanse Lepidoptera range from 4 mm. in the midget moths (Nepticulidae) to nearly 300 mm. in *Coscinoscera,* a giant silkworm moth, and *Troides,* a swallowtail butterfly. Most adult moths are nocturnal, while butterflies are diurnal. Nearly all feed, as larvae, on plants and plant materials. Many adults do not feed, but the majority suck nectar and water. Many adults are conspicuous, displaying garish colour and striking pattern, while others are virtually invisible against the background of their natural environment. The variety among caterpillars is equally wide, with some bearing knobs and tufts of bright colour, such as certain saturniid moth larvae, and others resembling twigs and leaves —the measuring worm larvae of the Geometridae.

2. Importance.—Abundant and omnipresent, lepidopterans are of primary importance ecologically as consumers of plant materials. In turn they are eaten by vast numbers of secondary consumers, ranging from other insects to land and freshwater vertebrates. In the past, as today, they must have strongly influenced the evolution of the plants that they feed upon and that they pollinate, the other animals that they compete with, and the predators and scavengers that feed upon them and their excreta

Many of the most destructive agricultural, forest, and househol pests are caterpillars. Some like the army worms (*Pseudaleti unipuncta*) and cutworms (*Agrotis, Mamestra*), take a grea yearly toll of wheat and other important grains. Many attac fruit crops, like the codling moth and oriental fruit moth (*Laspeyresia*), while others feed on cabbage and related plants, like th cabbage butterflies (*Pieris*). Gypsy moth larvae (*Lymantria*) an cankerworms (*Palaeacrita, Alsophila*) are among the many caterpillars that disfigure forest and shade trees. Pyralid moths hav larvae that attack stored food, especially cereals and flour, and th clothes moth caterpillars (Tineidae) destroy furs and fabrics especially wools and silks.

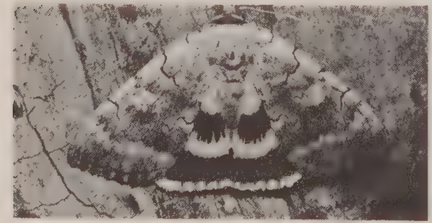
Few Lepidoptera are directly beneficial to man. Nearly all sil is obtained from the domesticated silkworm (*Bombyx mori*), native of Asia. Some other silks such as shantung and tussa are produced locally, using various Asiatic giant silkworm moth (Saturniidae). The larvae and sometimes the adults of a fe species are used as food. The caterpillars of a skipper (*Rhopalocampta libeon*) are collected in large quantities in the Cong and are eaten locally. In Mexico the caterpillars of giant skipper (Megathymidae), known as *gusanos de maguey,* are eaten locall and canned and exported for consumption as hors d'oeuvres.

The South American cactus moth (*Cactoblastis cactorum*) ha been valuable in ridding Australia of prickly pear cacti, freein many waste acres for agriculture. Doubtless, also, man benefit from much unrecognized weed destruction by caterpillars, as wel as from a great deal of pollination of flowers by adults.

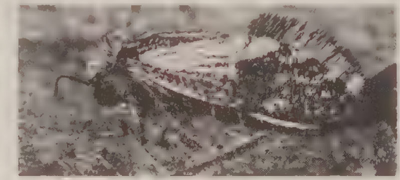
Many Lepidoptera have been of value in biological research Using the gypsy moth (*Lymantria dispar*), R. Goldschmidt di pioneer work in genetics and distribution. S. Fukuda and C. M Williams discovered much about the endocrine controls of insec development using the domesticated silkworm and saturniids. Important research on the genetics of polymorphism and mimicr has been done by P. M. Sheppard and others on the Africa swallowtail butterfly (*Papilio dardanus*). E. B. Ford and other have found out a great deal about population genetics whil studying the English scarlet tiger moth (*Panaxia dominula*

HERMANN EISENBEISS FROM PHOTO RESEARCHERS

An orange tip butterfly (*Anthocaris cardamines*)


A. B. KLOTS

An underwing moth (*Catocala concumbens*)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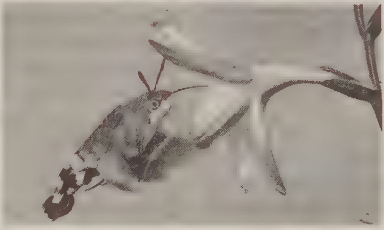
Eriocrania auricyanea, a primitive moth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Hummingbird hawk moth (*Macroglossa stellatarum*)

STEPHEN DALTON FROM NATIONAL AUDUBON SOCIETY

Purple emperor butterfly (*Apatura iris*)

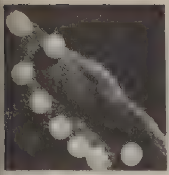
E. S. ROSS

A skipper (*Paratrytone melane*)

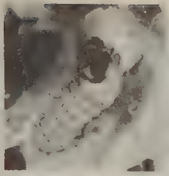
HERMANN EISENBEISS FROM PHOTO RESEARCHERS

Palaeochrysophanus hippothoe, an iridescent butterfly

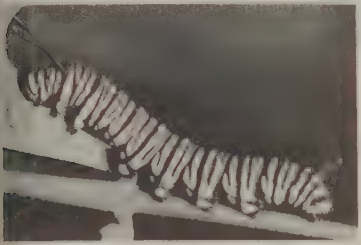
COLOURFUL AND UNUSUAL ADULTS



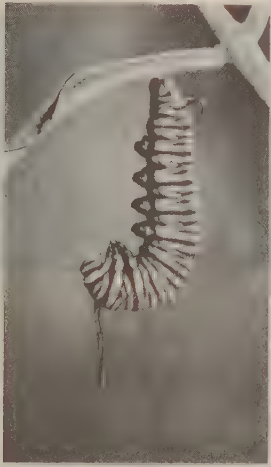
gg on leaf of milk-eed plant



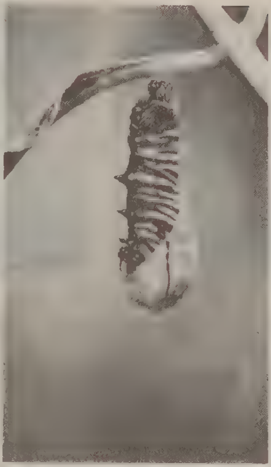
Newly hatched larva eating its egg case



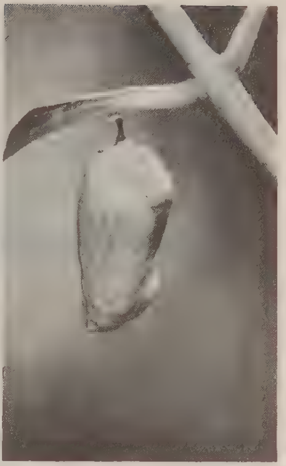
Caterpillar feeding on milkweed leaf



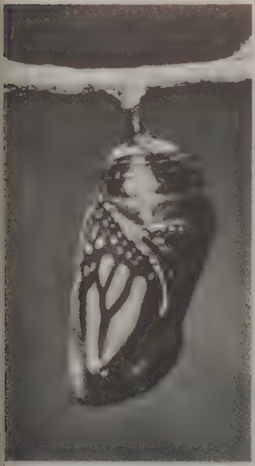
Caterpillar attaches to stem at beginning of pupation



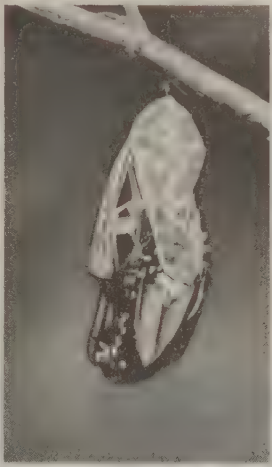
Larval skin splits and sloughs off exposing the chrysalis



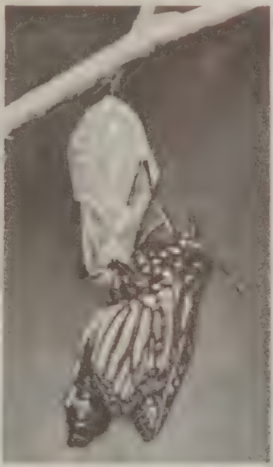
Early opaque chrysalis completely exposed



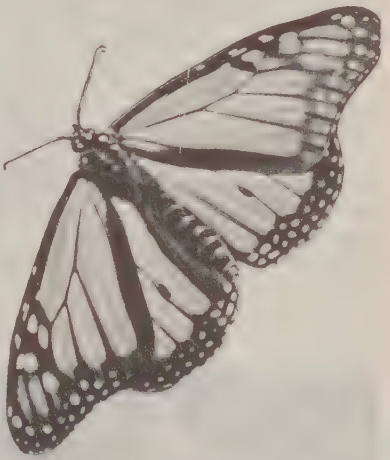
ter transparent chrysalis show-g adult wings within



Butterfly begins to emerge from chrysalis



Fully emerged adult rests and unfolds its wings



Adult with wings fully expanded

P, SECOND FROM LEFT) EILEEN TANSON FROM NATIONAL AUDUBON SOCIETY, (OTHERS) W. CLIFFORD HEALY FROM NATIONAL AUDUBON SOCIETY

LIFE CYCLE OF THE MONARCH BUTTERFLY (DANAUS PLEXIPPUS)

. B. D. Kettlewell, in exhaustive work on the effects of indus- al pollution and other factors on melanism in British moths, rticularly on the peppered moth (*Biston betularia*), has shown e genetic and ecologic mechanisms of rapid evolutionary changes ee MELANISM).

II. LIFE CYCLE AND DEVELOPMENT

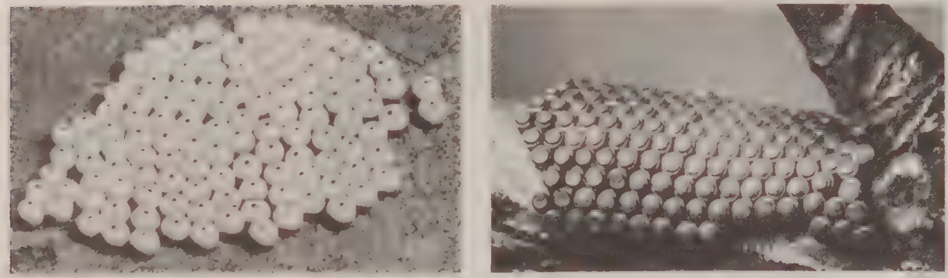
The Lepidopteran life cycle is of the advanced, or holometab- ous, type, with complete or indirect metamorphosis, consisting four distinct stages: egg, larva (caterpillar), pupa, and adult. uring development, growth and differentiation are controlled by teracting hormones secreted by the paired prothoracic glands, e corpora allata, and other parts of the brain. The prothoracic and hormone is necessary for larval molting, metamorphosis to e pupa, and formation of adult characteristics. Metamorphosis inhibited by a juvenile hormone secreted by the corpora allata til late in larval development. Neurosecretory cells in the pal brain secrete a hormone necessary for adult differentiation d for breaking the pupal resting stage (diapause); it acts by mulating the secretion of the prothoracic glands.

1. Egg.—The egg is enclosed in a protective shell, the chorion, rough which a group of tiny canals, collectively called the icropyle, permit the entrance of sperm. Most eggs are more less spherical, but some (*e.g.*, in Eucleidae, Lycaenidae) are tremely flat and others (*e.g.*, in Pieridae) are long and fusiform. The surface may be almost smooth, granular, or more or less elaborately sculptured.

Eggs are usually laid singly or a few at a time, but may be deposited in a mass. Such a mass may be covered by hardened secretions of the female's accessory glands and by much of its abdominal vestiture. Usually the eggs are laid on or near a suitable food plant, but some species (*e.g.*, Hepialidae) scatter them during flight. Embryonic development takes place in the egg. In species that hibernate or aestivate in the egg, this stage may last for many months.

2. Larval Stage.—Upon hatching, the wormlike larva begins its search for food. In fact, the larva does little more than eat, grow larger, and molt. The head bears a pair of very short antennae and a cluster of very small, simple eyes (ocelli or stemmata). The paired jaws (mandibles) are short and powerful. Behind them is a pair of small first maxillae, each with a very small sensory palpus; and behind these is the labium-hypopharynx, bearing the labial palpi and a median, tubular spinneret through which silk is extruded.

Each of the three thoracic segments (pro-, meso-, and metathorax) bears a pair of short, segmented legs. The following 10 segments constitute the abdomen. Segments 3, 4, 5, 6, and 10 each bear a pair of fleshy prolegs; each proleg has a curved row or two of minute hooklets (crochets) and a more or less eversible, soft bottom, or planta. The prothoracic segment and abdominal seg-



A. B. KLOTS

EGG CLUSTERS: (LEFT) YELLOW-NECKED APPLEWORM MOTH (DATANA MINISTRA) (RIGHT) FALL CANKERWORM MOTH (ALSOPHILA POMETARIA)

ments 1–8 each have a pair of respiratory apertures (spiracles or stigmata).

The larval covering bears a number of bristles and hairs (primary setae) that are very important in classification. Larvae that live and feed under cover, such as borers, burrowers, and miners, are mostly plain looking. Those that live and feed in the open show a great diversity of colour, pattern, shape, and ornamentation. Many have wartlike projections (verrucae) that may bear tufts of setae or spiny projections; or they may have prominent hornlike projections (*e.g.*, Saturniidae, Sphingidae).

In some families the number of the prolegs has become reduced during evolution. In the measuring worms (Geometridae) those of segments 3, 4, and 5 are missing; and in some noctuids one or two pairs have been lost. In the Drepanidae and many Notodontidae the last pair has become reduced and functionless; in the puss moth caterpillars (*Cerura*) this pair has evolved into long, eversible, defensive whiplashes (stemmatopoda). The larvae of specialized leaf miners (*e.g.*, Gracillariidae, Lyonetiidae) are usually extremely flat and may lack some or all of the prolegs. Their mandibles may project forward and act as shears.

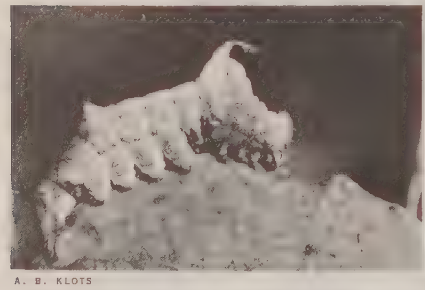
Growth rates of larvae differ greatly. Some of the very small leaf miners complete larval development in a week, while very large wood-boring larvae (*e.g.* Cossidae) require two or more years. Some arctic butterflies (*Oeneis*) spend two winters as larvae. The average number of molts (ecdyses) is perhaps five sometimes with one more in males than in females, but some leaf miners have only two. Starved clothes moth larvae (*Tineola* have been known to have a dozen molts, sometimes accompanied by a decrease in body size.

Internally larvae are relatively simple, the very large digestive tract being the most prominent structure. The paired silk glands opening at the head end are often very large internally, perhaps extending far back into the abdomen. The ovaries and testes which began to develop in embryonic life, grow and develop considerably in the larva. In many larvae special glands secrete protective substances, repellent or toxic, such as formic acid, which the larva extrudes when disturbed.

Larvae detect little more than differences of light and darkness Organs of taste and smell, with delicate nerve endings in the palpi and antennae, are more acute. Therefore, food discrimination is keen, and many larvae will starve rather than eat abnormal foods Reactions to touch consist of either suddenly dropping on a rapidly secreted silk thread, if the larva is small, or coiling up, or violently thrashing about.

A day or so before pupation many larvae stop eating, and after a period of wandering, spin a cocoon or enter the ground to pupate.

3. Pupation.—Most moth larvae prepare cocoons, although a great many pupate in the soil. Some cocoons are spun underground or in surface litter, and others are fastened to twigs or



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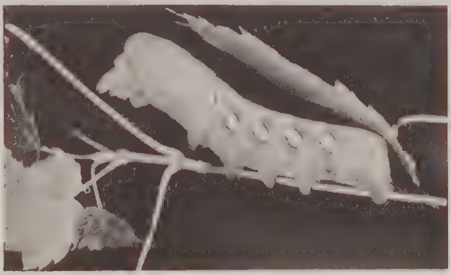
Reddish prominent moth (*Schizura semirufescens*)



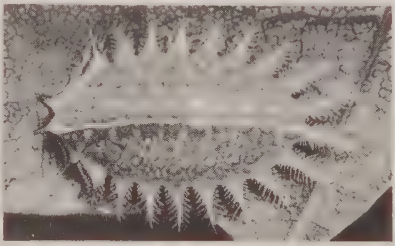
LOUIS QUITT FROM PHOTO RESEARCHERS

Pandorus sphinx moth (*Pholus pandorus*)

ROHMER H. BEARD FROM NATIONAL AUDUBON SOCIETY

Two lined prominent moth (*Heterocamp* *bilineata*)

VARIOUS CATERPILLARS



Slug moth (*Sisyrosea textula*)

A. B. KLOTS

LYNWOOD M. CHACE FROM NATIONAL AUDUBON SOCIETY

Spicebush swallowtail butterfly (*Papilio troilus*)

European puss moth (*Cerura vinula*)

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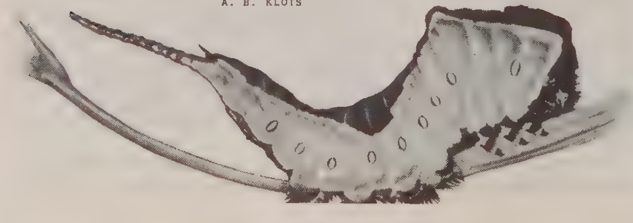
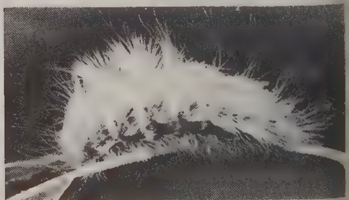




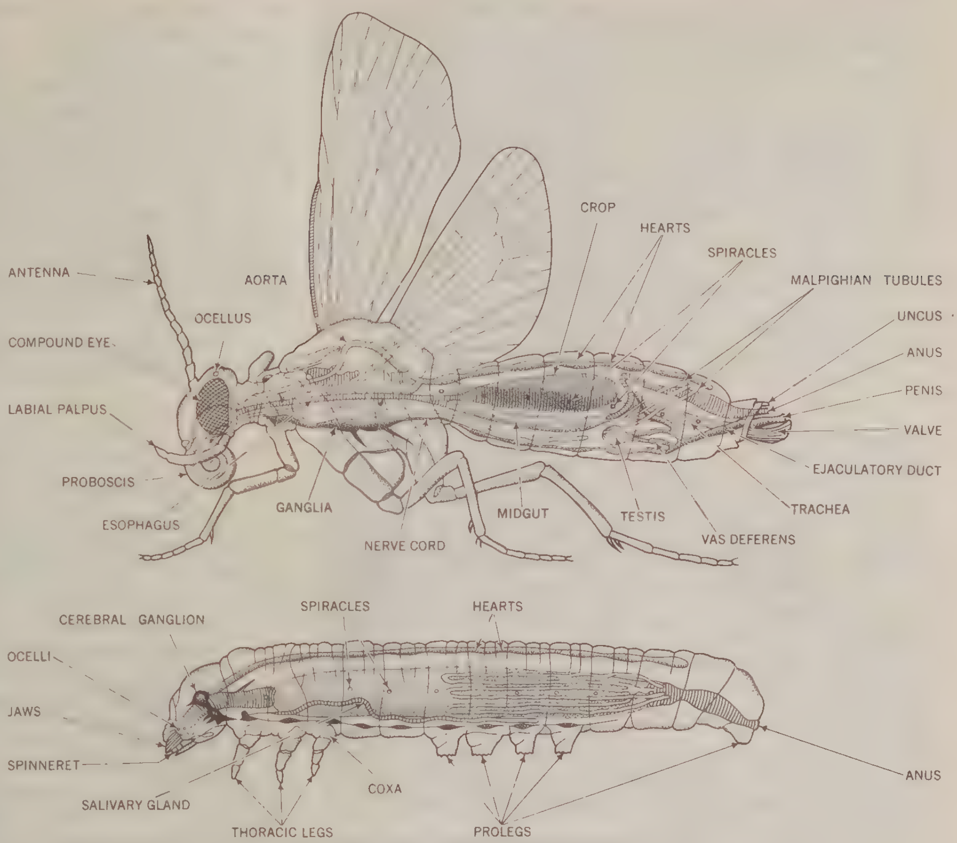
A. B. KLOTS

Lacey's flannel moth (*Lagoa laceyi*)

eaves of bushes and trees. Most eaf miners spin cocoons in the unnels they burrow in leaves. Cocoons are commonly of silk lone, but may also incorporate arval hairs, waste products, larval secretions, chewed wood pulp, rash, or leaves. There may be pecial escape valves facilitating mergence of the moth, as in he Megalopygidae.

Skipper larvae make a flimsy ocoon in the larval nest. Of he true butterflies, only the atyrs (Satyrinae) and parnasians (Papilionidae) make any ort of cocoon. In most butterlies the naked pupa (called a hrysalis) is suspended by hooking itself into a pad of silk. Some (*e.g.*, Pieridae, Papilionidae) serete a silk girdle about the body lso.

Most Lepidopteran pupae are btect; *i.e.*, have the appendages mmovably fixed to the body. In ome rather primitive groups the upae are incomplete, having the ppendages partially movable. n the very primitive Microperigidae and Eriocraniidae the upae are exarate, having the apendages freely movable, and also ecticous, having functional manibles. Obtect pupae can wriggle wo or more abdominal segments ut beyond that are immobile. few pupae (Lycaenidae and ome Sphingidae) can produce ounds by grating together roughened abdominal segments.



FROM HERMANN WEBER, "GRUNDRISS DER INSEKTENKUNDE"; GUSTAV FISCHER VERLAG, STUTTGART (1954)

FIG. 1.—(TOP) BODY PLAN OF GENERALIZED MALE ADULT BUTTERFLY OR MOTH. LEFT WINGS, RIGHT LEGS AND NERVOUS SYSTEM OF HEAD NOT SHOWN; RIGHT WINGS REDUCED. (BOTTOM) BODY PLAN OF CATERPILLAR

Already present in the newly formed pupa are many partially eveloped adult structures. As the distinctively larval structures reak down the adult organs take shape. The large larval stomach ecomes smaller, while the crop enlarges. The testes and ovaries nlarge greatly, while the accessory genitalia form. The wings, hich began development internally during larval life, evert and mplete development externally, remaining soft and capable of vift expansion. Although the adult may be fully formed in a eek or two, it may remain many months in the pupal covering.

An important structure in many pupae is the cremaster, a pad spike at the end of the abdomen bearing hooklets. Catching silk threads, it holds the pupa in place whether in a cocoon or spended from an exposed silk pad secreted by the larva.

4. Emergence of the Adult.—When the time comes for the nergence of the adult, those pupae that can wriggle move to e surface of the ground, or partly out of the cocoon or burrow, ded by flanges or spines. Then the adult breaks through its pal covering. When the pupa cannot move, the adult must eak out and escape by itself. In some groups the pupa has coon-cutters, such as movable jaws (Micropterigidae) or sawothed structures on the head (Gracillariidae). In some Saturniae the adult has bladelike cutters at the wing bases. In puss oths and others the cocoon is partly dissolved by alkaline secreons. Crawling upward, the adult hangs head up or back down. y abdominal contractions blood is forced into the small wing ds, speedily expanding them. The adult may be able to fly in a ort time, or may have to hang for several hours until its exoeleton and wings have stiffened sufficiently for flight.

III. ADULT STRUCTURE AND FUNCTION

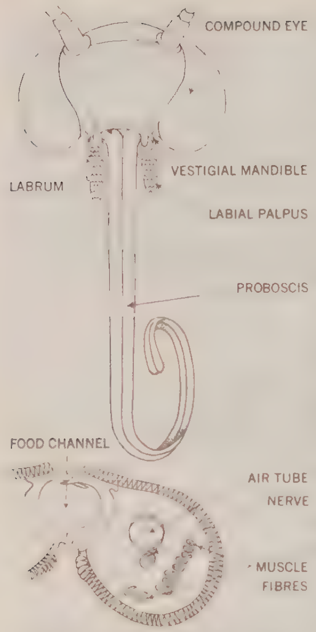
The head, thorax, and abdomen are well differentiated in the ult lepidopteran, or imago. The head bears the main organs of sensation and the organs of ingestion; the thorax bears the organs of locomotion; and the abdomen bears the highly modified appendages constituting the genitalia.

1. Head.—The head is relatively small and subglobular. On either side is a large compound eye, near each of which there may be a small, simple eye (ocellus). Many families also have a pair of clusters of sensory bristles, called chaetosomata. The antennae are long and many-segmented. In most moths they taper gradually to a very fine tip; in some they are often pectinate, having many fine projections like the barbs of a feather; and in a few families they are more or less thickened toward the tip. In skippers and butterflies the antennae are definitely clubbed (clavate). Antennae are often thicker or more extensive in males.

The mouthparts characteristically comprise two pairs of palpi (maxillary and labial) and a tubular, coiled proboscis, or "tongue," through which liquids may be sucked. The most primitive moths (Micropterigidae) lack a proboscis but have retained the primitive, chewing jaws; they visit flowers and chew pollen. In many groups of moths the proboscis is reduced and nonfunctional. Primitively, the maxillary palpi (sing. palpus) are large, but in the advanced moths and the butterflies they are reduced or vestigial.

2. Thorax and Wings.—The prothorax bears the first pair of legs and a pair of spiracles. The larger mesothorax bears the second pair of legs and the front pair of wings. The smaller metathorax bears the hind legs and the hind wings and, in many moths, the membranous auditory organs (tympana).

The wings show great diversity of size, shape, colour, and pattern. In addition to their primary function, that of flight, they have important secondary functions in protection and courtship. When the young adult, just out of the pupa, expands its small wing pads, the upper and lower surfaces come together and fuse. The tubular, tapering veins furnish support. The scales, each of which develops from a single epidermal cell, lie in rows over-


COMPOUND EYE
LABRUM
VESTIGIAL MANDIBLE
LABIAL PALPUS
PROBOSCIS
FOOD CHANNEL
AIR TUBE
NERVE
MUSCLE FIBRES

BY COURTESY OF THE EDITOR OF THE "AMERICAN NATURALIST"

FIG. 2.—(TOP) HEAD-ON VIEW OF MOUTH PARTS OF MOTH; (BOTTOM) HIGHLY MAGNIFIED CROSS SECTION THROUGH PROBOSCIS

lapping like shingles. The usual scale is a flattened, air-filled sac attached by a peglike base. In a few groups the wings are almost devoid of scales. Many males have special scent-scales (androconia), either scattered or concentrated in patches (stigmata), or bundles of scent-hairs, often expansible, that are used in courtship. Very primitive moths have the wing membrane more or less aculeate, *i.e.*, covered with exceedingly small hairlike setae, or aculeae.

The scales and hairs of the wing contain specific pigments responsible for most of the colour. In addition many scales refract and reflect light, creating structural colours: pearly, metallic, and iridescent effects. Fine, parallel ridges on scales may cause a slight iridescence by acting as a diffraction grating (a phonograph record shows a similar iridescence). This, however, is negligible compared to the effects, often very brilliant, of very thin, superimposed films, or layers, in the ridges or the walls of scales (like an oil slick on water). White is a structural effect caused by scattering of light. Many of the most striking effects are caused by combinations of pigmental and structural colours.

The fore and hind wings are coupled together in various ways. In very primitive moths a fingerlike lobe (jugum, or fibula) on the fore wing overlaps the base of the hind wing. In most moths a strong, single or multiple bristle (frenulum) near the base of the hind wing engages a catch (retinaculum) on the fore wing. In some moths, and in skippers and butterflies, the frenulum is lacking and the wings are coordinated by contact and friction of their overlapping areas. In the very primitive moths the fore and hind wings are similar in size, shape, and venation; but the great majority of moths, and all skippers and butterflies, have the hind wings more rounded and reduced in both size and venation. Many of the small moths have both wings reduced and greatly narrowed, but fringed with "hairs." In a number of moths the females are wingless (*e.g.*, Psychidae, some Lymantriidae). In the pyralid *Acentropus* some females are wingless, others winged.

The venation of the wings is perhaps the most important single criterion in identification and classification. It can be understood only in terms of its evolution from primitive ancestral patterns. Each vein has a characteristic pattern of branching and a usual number of branches. The veins are usually designated according to a modification of the Comstock-Needham system, not only in Lepidoptera but also in most other insect orders.

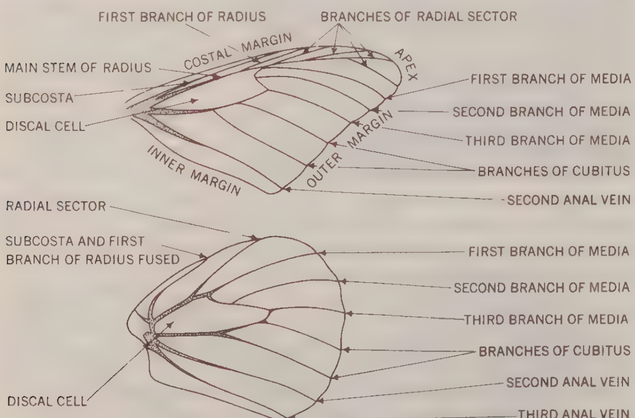
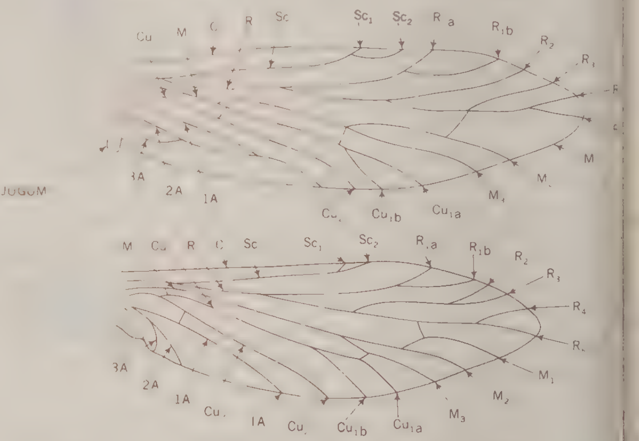

FIRST BRANCH OF RADIUS
BRANCHES OF RADIAL SECTOR
COSTAL MARGIN
APEX
MAIN STEM OF RADIUS
SUBCOSTA
DISCAL CELL
FIRST BRANCH OF MEDIA
SECOND BRANCH OF MEDIA
OUTER MARGIN
THIRD BRANCH OF MEDIA
INNER MARGIN
BRANCHES OF CUBITUS
SECOND ANAL VEIN
RADIAL SECTOR
SUBCOSTA AND FIRST BRANCH OF RADIUS FUSED
FIRST BRANCH OF MEDIA
SECOND BRANCH OF MEDIA
THIRD BRANCH OF MEDIA
BRANCHES OF CUBITUS
SECOND ANAL VEIN
DISCAL CELL
THIRD ANAL VEIN

FIG. 3.—WING VENATION OF MONARCH BUTTERFLY (DANAUS PLEXIPPUS)

The names of the veins (with their symbols in parentheses) and the usual number of branches of each vein (subscript designations) are as follows, in progression from the anterior (costal) margin of a wing to the posterior (inner or anal) margin:

Costa (C), along the anterior margin; no branches
Subcosta (Sc), usually with no branches, rarely with 2 (Sc_1, Sc_2)
Radius (R), almost always with 5 branches (R_1–R_5)
Media (M), with 3 branches (M_1–M_3)
Cubitus (Cu), primitively with 3 branches (Cu_1–Cu_3)
Anal Veins, first (1A), second (2A), and third (3A); all unbranched

The most primitive groups (fig. 4) tend to have the maximum number of veins and branches in both wings. More advanced groups (fig. 5) lack some veins or branches in the fore wing and have the hind wing considerably reduced, especially by the lack of radial branches 2 through 5 (R_2–R_5). Other systems of designating the veins, such as the Herrich-Schaeffer method of numbering them, are being abandoned.


Cu
M
C
R
Sc
Sc1
Sc2
R a
R1b
R2
R3
M
M
M1
3A
2A
1A
JUGUM
Cu
Cu1b
Cu1a
M
Cu
R
C
Sc
Sc1
Sc2
R1a
R1b
R2
R3
R4
R
M1
M2
M3
3A
2A
1A
Cu
1A
Cu
Cu1b
Cu1a

AFTER COMSTOCK, "THE WINGS OF INSECTS"; COMSTOCK PUBLISHING CO., ITHACA (1918)

FIG. 4.—WINGS OF AN ERIOCRANIID MOTH

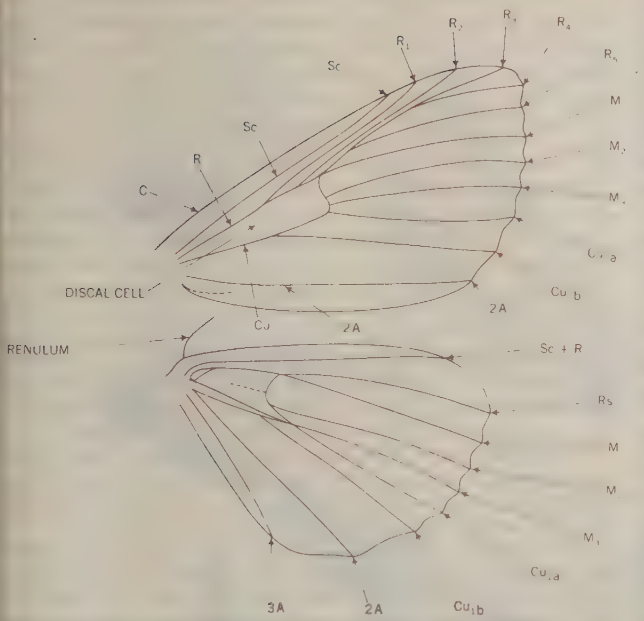
3. Abdomen and Genitalia.—The abdomen has 10 segments with paired spiracles on the first 8. The first or second segments bear tympanic auditory organs in the pyraloid and geometroid moths. True appendages are lacking except for vestiges that may form parts of the secondary sex structures (genitalia).

The genitalia are important in classification, especially in the distinction of species. In males a ringlike structure (vinculum) is the base of attachment of a number of dorsal structures (tegumen, uncus, and gnathos) and of a pair of lateral clasping organs (valvae) that hold and position the female abdomen during copulation. The penis, a median, tubular structure, injects seminal fluid through a tube (aedeagus) and an eversible duct (vesica).

The female genitalia show a number of very different types of organization of the genital ducts and openings. These are considered so fundamental that the division of the Lepidoptera into suborders is now chiefly based upon them. The types are:

1. No special genital openings; both insemination and oviposition take place through the anal opening.
2. A genital opening for insemination, but oviposition through the anus.
3. Separate genital openings for insemination and oviposition, both close together and both close to the anus.
4. Separate opening for insemination and oviposition, the latter close to the anus but the former some distance removed in the 8th abdominal segment.

Type 1 characterizes the extremely primitive Zeugloptera, the mandibulate Micropterigidae. Type 2 occurs in the superfamilies Eriocranioidea, Nepticuloidea, and Incurvarioidea of the primitive suborder Monotrysia. Type 3, termed exoporian, characterizes



DAPTED FROM BORROR AND DELONG, "AN INTRODUCTION TO THE STUDY OF INSECTS"

FIG. 5.—WINGS OF A NOCTUID MOTH (NOCTUIDAE)

he Monotrysian superfamily Hepialioidea. Type 4 characterizes he suborder Ditrysia, the vast majority of Lepidoptera.

In both sexes the genitalia are often extremely complex and quipped with protruding spines, teeth, hairs, and scale tufts. hese mechanical devices are highly important in courtship and ating, and act as a barrier to hybridization between unsuitable artners.

4. **Sense Receptors.**—The compound eyes are very efficient for istinguishing motion but not for resolving clear images of objects t a distance. In courtship, individuals apparently distinguish etails of wing patterns, and diurnal species may be able to disnguish floral shapes. Colour perception is quite acute in some pecies, especially in the blue-violet end of the spectrum. As in any other insects, moths are generally able to perceive ultraiolet rays, to which they are much more strongly attracted than those in the range visible to man. The sense of smell is very cute in many groups, especially in males with large antennae ickly set with olfactory receptors. The sense of taste is also cute, through receptors located chiefly on the palpi and the tarsi f the first pair of legs. The sense of hearing is very acute in any moths that have special receptors (chordotonal sensilla) d tympana on the thorax or abdomen, some of which react to und waves above the limit of human hearing.

IV. NATURAL HISTORY

1. **Evolution and Geologic History.**—The Lepidoptera beng to an important group of orders, the panorpoid complex, hich evolved in the Permian. The ancestral stem split into a umber of branches, from which evolved the modern orders ecoptera (scorpion flies), Megaloptera (dobson flies), Neuropra (lace-wings), Diptera (flies), Trichoptera (caddis flies), and epidoptera. The closest living relatives of the Lepidoptera are e caddis flies. The most primitive moths, the Micropterigidae, e, in fact, quite like some caddis flies. They evolved a number fundamental characteristics evident to a greater or lesser extent various modern groups. The adult mandibles disappeared and ere replaced by the proboscis. The discal cell of the fore wing olved with the loss of the basal parts of the median vein. The enulum replaced the jugum for wing coupling, to be lost in turn the bombycoid moths and the skippers and butterflies. The rvae evolved concomitantly with the seed plants, and develed a multiplicity of specialized ways of feeding on them. The ose appendages of the exarate pupae became fastened down tightly, so that the pupae largely lost the power of mobility.

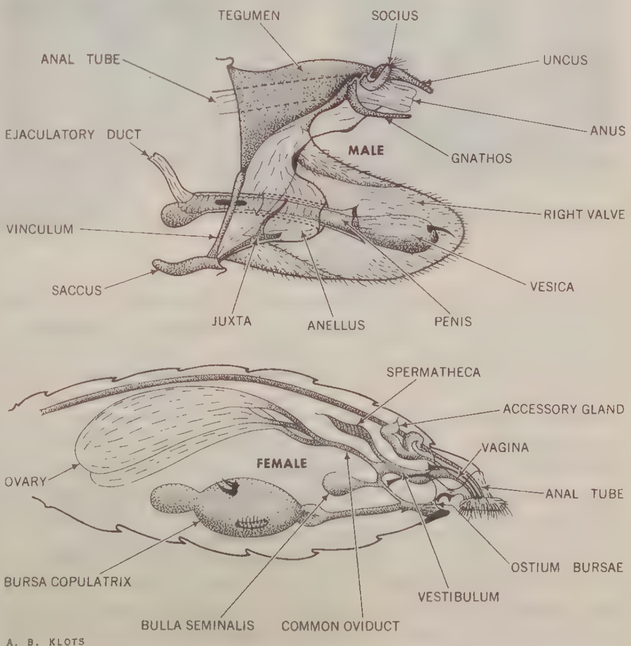
Unfortunately, very few fossil Lepidoptera are known. The earliest undoubted ones are of Eriocranioidea and Tineoidea, of the early Tertiary. The best-known fossil butterflies are very recent, being Cenozoic. Some, from Florissant, Colo., are undoubtedly Nymphalidae and very like existing genera.

2. **Geographic Distribution.**—The large family-level groups and many smaller ones are worldwide, although in some cases more abundant in one faunal region than in another. Thus, the very distinctive Neotropical region (mainly Central and South America) is characterized by the dominance of such butterflies as the Riodinidae, Heliconiinae, Ithomiinae, Morphinae, and Dismorphiinae, and of such moths as the Dioptidae, Pericopidae, and Ctenuchidae. The other regions have many distinctive generic level groups, among which are: Palaearctic (Europe and northern and central Asia), *Erebia* and other Satyrinae, and *Parnassius* (Papilionidae); Nearctic (North America and Greenland), *Catocala* (Noctuidae); Ethiopian (Africa south of the Sahara and Arabia), *Charaxes* (Nymphalidae), *Teracolus* (Pieridae), and many Acraeinae; Oriental (southern Asia) and Australia (including surrounding islands), *Troides* (Papilionidae) and *Delias* (Pieridae).

Many Lepidoptera occur in isolated colonies as relict populations, cut off from relatives elsewhere by geologic or climatic changes. Australia and New Zealand have such relict populations of the primitive Micropterigidae and Hepialidae. In North America, Europe, and Asia many relicts from the Pleistocene glaciations survive at high altitudes in isolated southern mountain ranges; they include such genera as *Oeneis* and *Erebia* (Satyrinae), *Boloria* (Nymphalidae), *Anarta* (Noctuidae), and *Pediasia* (Pyralididae).

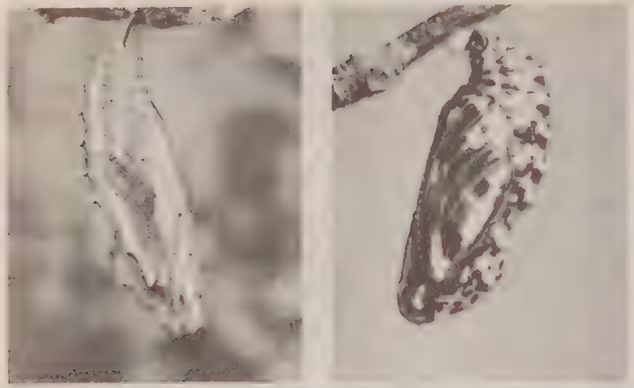
3. **Feeding Habits.**—The great majority of Lepidoptera feed on seed plants, chiefly on the foliage. A small minority feed on fungi, mosses, liverworts, and lichens, and a very few eat other animals and their products. Most leaf eaters simply chew up the whole leaf, but several groups are leaf miners, tunneling inside a single leaf for the whole of their larval life. Such larvae (*e.g.*, Nepticulidae, Gracillariidae, Lyonetiidae) are not only very small but may also be flattened and more or less legless; some have the mandibles specialized for tearing the soft leaf tissue. Other groups mine under bark or under the epidermis of stems.

Nearly all parts of plants are eaten by the larvae of some species. Many (*e.g.*, Pterophoridae, Lycaenidae) eat flowers; others (*e.g.*, Prodoxidae, Olethreutidae, Noctuidae) eat fruits,



A. B. KLOTS

FIG. 6.—LEPIDOPTERAN GENITALIA AND ASSOCIATED STRUCTURES


(LEFT) HERMANN EISENBEISS FROM PHOTO RESEARCHERS (RIGHT) A. B. KLOTS

Chrysalides of (left) painted lady (*Vanessa cardui*) and (right) variegated fritillary (*Euptoieta claudia*)

A. B. KLOTS

Lacework cocoon surrounding the pupal shell of *Urodus parvula*

A. B. KLOTS

(Left) Lacey's flannel moth, cocoon opened; (right) polka dot moth (*Syntomeida epilais*), pupa seen through pupal covering

PUPAE

cones, and seeds. Species of many families bore into buds or soft, succulent stems. Several groups (*e.g.*, *Rhyacionia*, Olethreutidae) bore into the terminal shoots of conifers. Three families—the Hepialidae, Cossidae, and Aegeriidae—are mostly borers, chiefly in wood but also in stems and roots. Scavenging habits are especially common in Tineidae, Blastobasidae, Pyralididae, and some Noctuidae. Relatively few are gall makers, chiefly some Nepticulidae, Gelechiidae, Orneodidae, and Olethreutidae.

A majority of moths and all butterflies feed as adults, sucking flower nectar, sap, fruit juices, or water. A few suck aphid or planthopper honeydew or juices from carrion or excrement.

The symbiotic relationships between the species of Lepidoptera with nectar-feeding adults and the plants whose flowers they visit and pollinate are mostly nonobligate, since only rarely is either the plant or the insect specifically dependent upon the other. Some orchids and other plants with very deep tubular flowers may be dependent for pollination on hawk moths (Sphingidae) with very long probosces. The mutualism of the yucca moths (*Tegeticula*) and yucca plants is definitely obligate. The moth larvae live and feed only in yucca fruits, which develop only from pollinated flowers. Pollination is accomplished by the female moths, by means of specialized tentacles on their first maxillae.

Relatively very few Lepidoptera feed on animals or their products. Two genera of pyralid moths (*Cryptoses* and *Bradypodicola*) live in the fur of sloths, where their larvae may eat algae growing among the hairs. Larvae of the small family Epipyropidae live on the bodies of planthoppers, feeding on their waxy secretions. A few moth larvae (*e.g.*, *Euclemensia*) are internal parasites of scale insects; and a number of others are direct predators on other scale insects. A few noctuid larvae (*e.g.*, *Cosmia*) are predators on other caterpillars. Many lycaenid caterpillars that secrete honeydew have mutualistic relations with ants. Some lycaenid caterpillars, including those of the European large blue butterfly (*Maculinea arion*) feed on ant brood; others, including the North American harvester (*Feniseca tarquinius*), feed on aphids.

4. Predators and Parasites of Lepidoptera.—Worldwide and abundant, the Lepidoptera furnish food for a host of other animals, both predators and scavengers. All stages in their life cycles are subject to parasitism and to heavy predation.

Major predators on Lepidoptera include centipedes, spiders, mantids, bugs, ground beetles, ants, and social and hunting wasps. Important predators among vertebrates include: toads and tree frogs, lizards, birds, rodents, bats, and monkeys. Most of these locate their prey chiefly by sight. In response to this pressure, Lepidoptera have evolved numerous adaptations of coloration and form in defense.

The chief groups of parasites attacking Lepidoptera are tachinid flies and many families of wasps. More precisely called parasitoids, they are probably far more important than direct predators. Lepidoptera seem to have few defenses against parasitoids, unless some of their repellent and toxic secretions act to discourage them. Female parasitoids locate suitable hosts, chiefly by the sense of smell, and lay their eggs near, on, or in them. The parasitoid larvae enter their hosts and live inside them, gradually feeding and growing, at the expense of the host.

Small, red trombiculid mites are often found riding around on adult Lepidoptera. A few mites, however (*e.g.*, *Myrmonyssus*), live and breed as specialized parasites in the tympanic cavities of noctuid moths, where they destroy the moths' auditory structures. Curiously, they settle regularly in only one of a moth's two tympanic cavities, and so do not deafen it completely.

Lepidoptera are subject to attack by a considerable number of protozoa, roundworms, bacteria (*e.g.*, *Bacterium thuringiensis*), viruses (*e.g.*, polyhedral virus), and fungi (*e.g.*, *Cordyceps*), which chiefly affect the larvae. Some of these agents have been used by man as means of controlling injurious species.

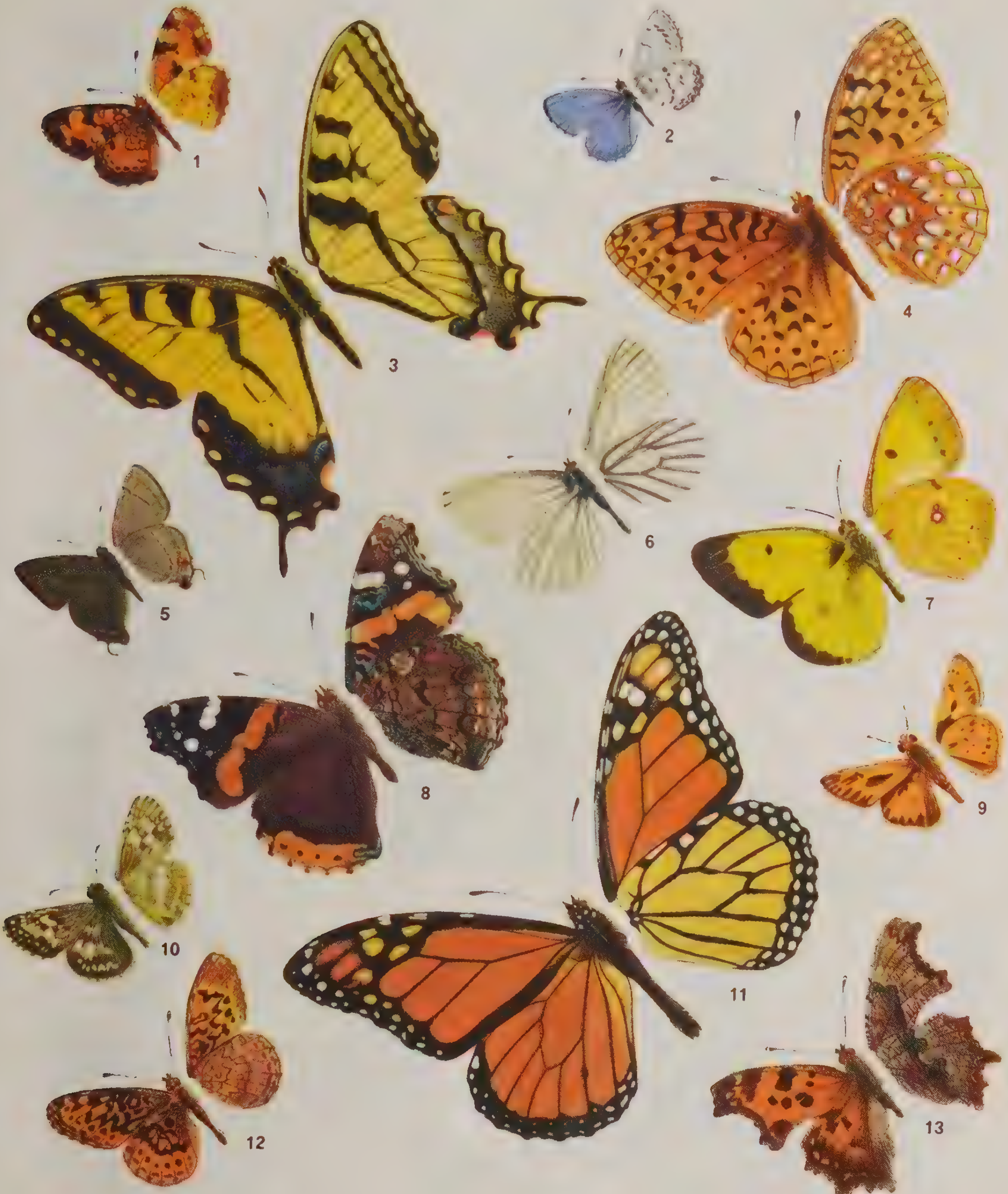
5. Defenses Against Predation.—Lepidoptera exceed any other group of animals in the diversity and complexity of their defense mechanisms.

Escape.—Fast and erratic flight characterizes many groups, especially skippers, some butterflies, hawk moths, and underwing moths (*Catocala*). Caterpillars, especially when young, drop quickly when disturbed, either hanging from a silk thread or falling to concealment; some (*e.g.*, *Catocala*) can jump several inches. Escaping individuals that dart or fall to cover usually become immobile and have a good chance of escape, especially if they are coloured like their surroundings.

Dense, loose hairs and scales render many moths very slippery and difficult to hold, and may also facilitate escape from sticky spider webs. Long, dense hairs and spines on larvae deter many predators, especially birds.

Targets, such as eyespots or prominent tails on the hind wings, attract the attention and invite the attacks of predators. Located on the wings, they may be seized and torn off; but this gives the moth or butterfly time to escape with the loss of nothing vital.

Concealment and Camouflage.—A great many species hide very effectively from predators. Many cutworms (Noctuidae) and other larvae hide in litter or under objects by day, feeding only at

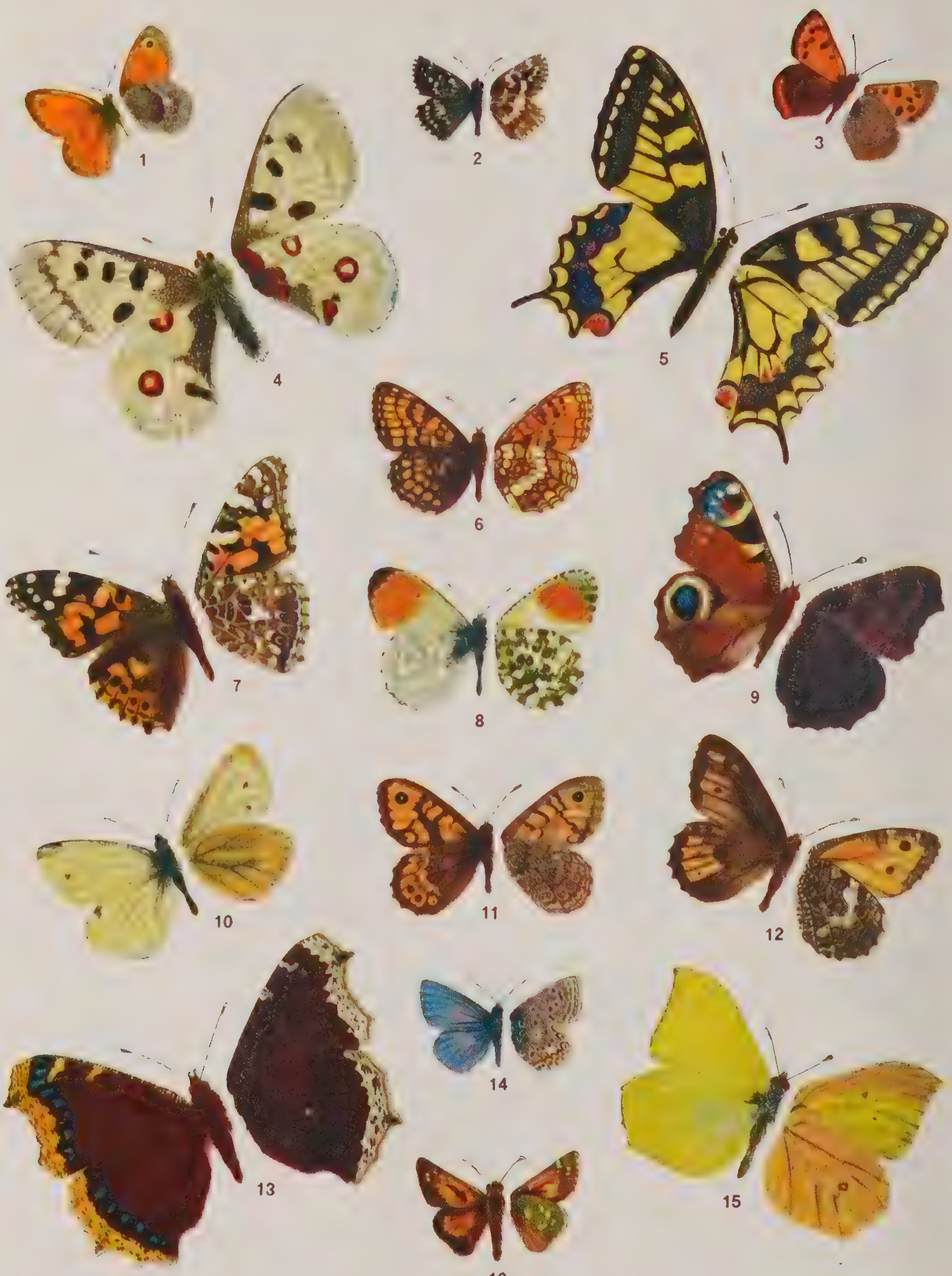


PAINTED FOR "ENCYCLOPÆDIA BRITANNICA" BY MARJORIE STATHAM, THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY

BUTTERFLIES OF NORTH AMERICA

1. Pearl crescent (*Phyciodes tharos*); most of United States and Canada. 2. Spring azure (*Lycaenopsis argiolus*); most of North America. 3. Tiger swallowtail (*Papilio glaucus*); most of North America. 4. Aphrodite fritillary (*Speyeria aphrodite*); United States and southern Canada. 5. Gray hairstreak (*Strymon melinus*); most of United States and southern Canada. 6. Mustard white (*Pieris napi*); most of Canada and northern United States. 7. Common sulphur (*Colias philodice*); most of North America. 8. Red admiral (*Vanessa atalanta*); most of North America, Europe. 9. Fiery skipper (*Hylephila phylaeus*); central United States southward into tropics. 10. Checkered skipper (*Pyrgus communis*); southern Canada and most of United States. 11. Monarch or milkweed butterfly (*Danaüs plexippus*); central Canada southward to Argentina. 12. Meadow fritillary (*Boloria toddi*); southern Canada to Colorado and Virginia. 13. Comma anglewing (*Polygonia comma*); eastern North America southward to North Carolina and Kansas
(Note: Right-hand side of each specimen shows underwing coloration)

BUTTERFLY AND MOTH

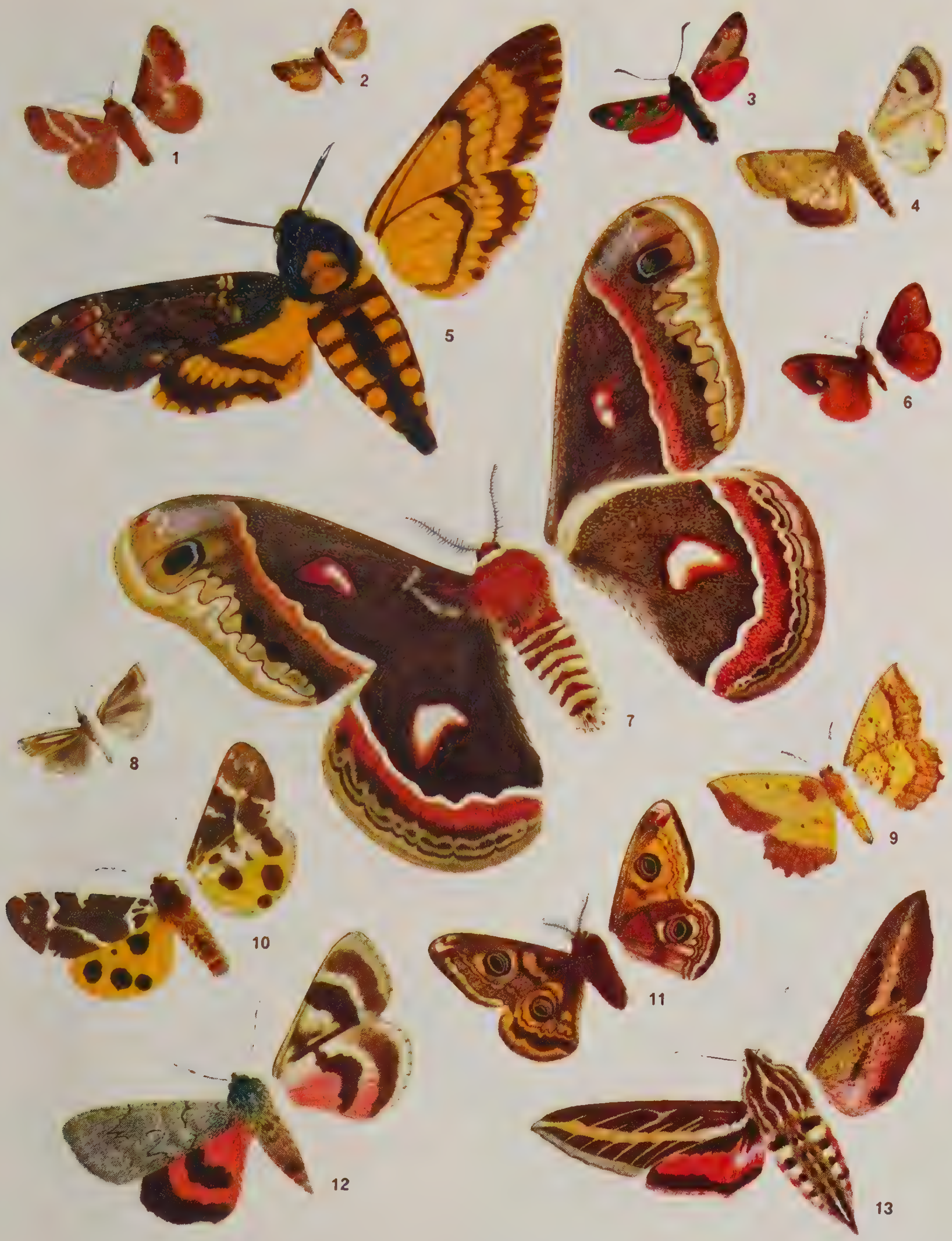


PAINTED FOR "ENCYCLOPÆDIA BRITANNICA" BY MARJORIE STATHAM, THE AMERICAN MUSEUM OF NATURAL HISTORY. NEW YORK CITY

BUTTERFLIES OF EUROPE

1. Small heath (*Coenonympha pamphilus*); Europe and north Africa to central Asia. 2. Grizzled skipper (*Pyrgus malvae*); Europe to central Asia. 3. Small copper (*Lycaena phlaeas*); Europe, Asia, North America. 4. Apollo (*Parnassius apollo*); most of Europe and northern Asia. 5. Swallowtail (*Papilio machaon*); most of Europe, northern Asia and northern North America. 6. Heath fritiliary (*Melitaea athalia*); Europe to central and northern Asia. 7. Painted lady (*Vanessa cardui*); cosmopolitan. 8. Orange tip (*Anthocaris cardamines*); Europe to central Asia. 9. Peacock (*Nymphalis io*); Europe to central Asia. 10. Small white or European cabbage butterfly (*Pieris rapae*); Europe, northern Africa, northern and central Asia, North America (introduced). 11. Wall (*Pararge megera*); Europe, Asia Minor. 12. Grayling (*Eumenis semele*): Europe and western Asia. 13. Camberwell beauty or mourning cloak (*Nymphalis antiopa*); most of Europe, central Asia and North America. 14. Common blue (*Polyommatus icarus*); Europe, north Africa, northern Asia. 15. Brimstone (*Gonepteryx rhamni*); Europe, northern Africa, northern and central Asia. 16. Comma skipper (*Hesperia comma*); northern Europe, Asia and North America

(Note: Right-hand side of each specimen shows underwing coloration)

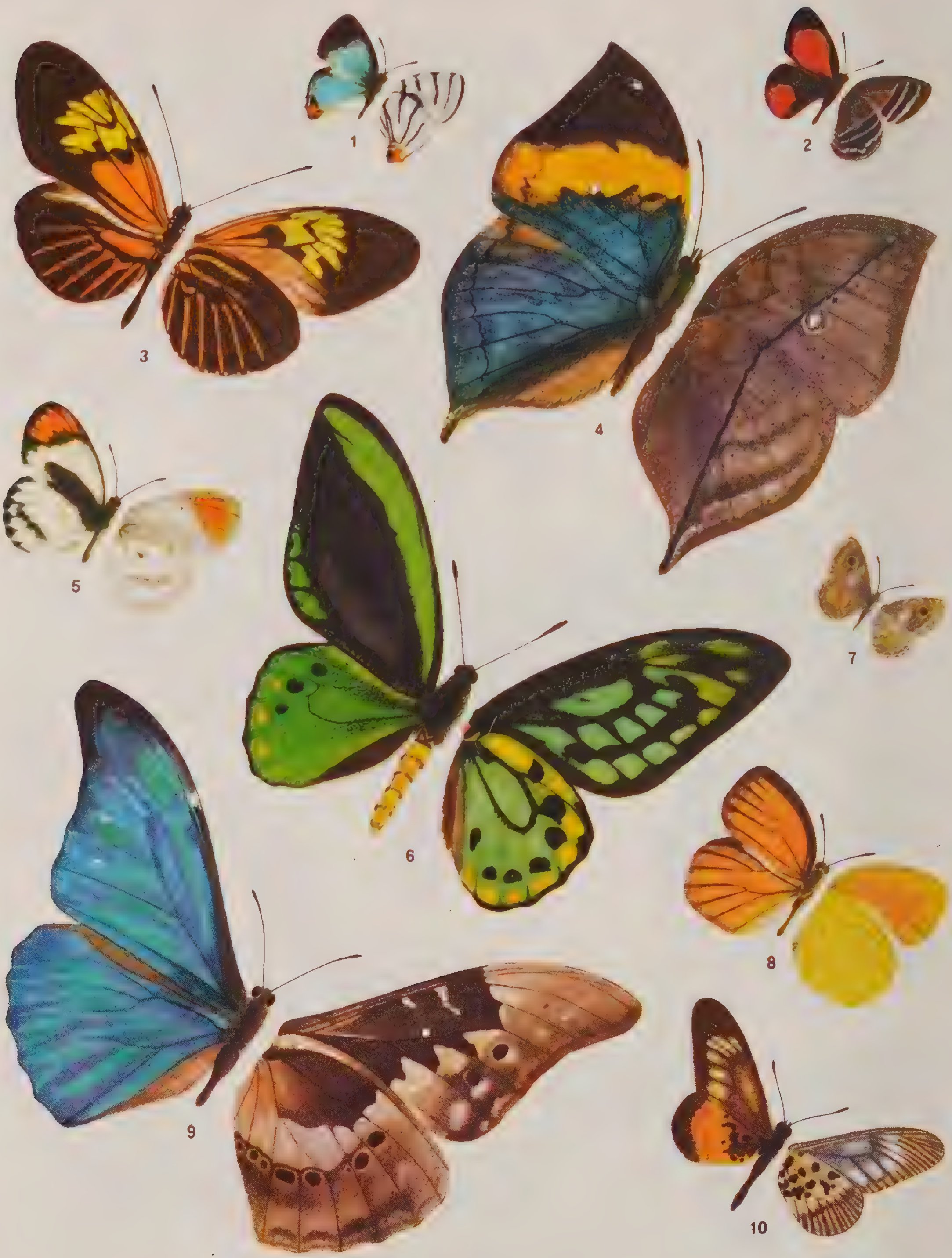


PAINTED FOR "ENCYCLOPÆDIA BRITANNICA" BY MARJORIE STATHAM, THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY

MOTHS OF NORTH AMERICA AND EUROPE

1. Tent caterpillar moth (*Malacosoma americana*); much of North America. 2. Codling moth (*Carpocapsa pomonella*); Europe, North America (introduced). 3. Zygaena moth (*Zygaena filipendulae*); Europe and Asia Minor. 4. Corn worm, cotton bollworm (*Heliothis obsoleta*); Yukon to Manitoba, southward and westward. 5. Death's head moth (*Acherontia atropos*); Africa, Europe (immigrant). 6. Vapourer or tussock moth (*Notolophus antiqua*); Europe, northern North America. 7. Cecropia moth (*Hyalophora cecropia*); eastern North America. 8. Sod webworm moth (*Crambus laqueratellus*); eastern North America. 9. Saw wing (*Euchlaena serrata*); Quebec to Wisconsin, Nebraska and New Jersey. 10. Garden tiger moth (*Arctia caia*); Europe, Asia, northern North America. 11. Emperor moth (*Saturnia pavonia*); Europe, western Asia. 12. Pink underwing (*Catocala concumbens*); Canada and United States south to Missouri and New Jersey. 13. White-lined sphinx (*Celerio lineata*); most of North America

(Note: Right-hand side of each specimen shows underwing coloration)

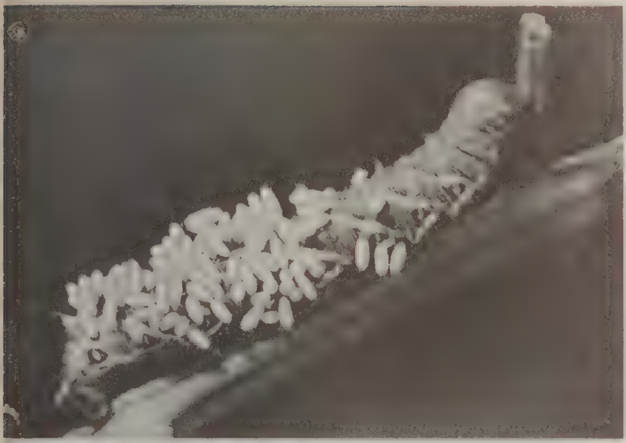


PAINTED FOR "ENCYCLOPÆDIA BRITANNICA" BY MARJORIE STATHAM, THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY

EXOTIC BUTTERFLIES

1. *Thecla phaea;* Guatemala to Ecuador. 2. *Euselasia zena;* Amazon. 3. *Heliconius elevatus;* South America. 4. *Kallima limborgi;* southern Asia. 5. *Colotis evippe;* western Africa. 6. *Ornithoptera priamus;* Australia, New Guinea, Moluccas, etc. 7. *Perophalma tullius;* new world tropics. 8. *Eurema proterpia watsonia;* Arizona to Argentina. 9. *Morpho rhetenor;* central and northern South America. 10. *Acraea peneleos;* Africa

(Note: Right-hand side of each specimen shows underwing coloration)



LOUIS QUITT FROM PHOTO RESEARCHERS

PARASITIZED CATERPILLAR OF TOMATO HORNWORM (PROTOPARCE QUINQUEMACULATA)

night. Many moths hide in extremely narrow crevices, often under loose bark. Hibernating butterflies, such as the mourning cloak (*Nymphalis antiopa*), spend the winter in hollow trees. The larvae of many moths live in individual nests of rolled, folded, or webbed leaves or grass, as do most skipper and many butterfly larvae. Sod webworms live in silk-lined tunnels in turf. Many larvae aggregate in communal nests, such as those of the tent caterpillars (*Malacosoma*), the ermine moth (*Yponomeuta padella*), and the Mexican social white butterfly (*Eucheira socialis*). The larvae of the bagworms (Psychidae) and casebearers (Coleophoridae) live and pupate in individual, portable cases. Often these are masked with bits of leaves and twigs. Some larvae, such as those of the green geometrids (*Synchlora*) attach bits of leaves or petals to themselves. Cocoons are frequently masked with leaves or debris; those of the puss moths are very smooth, hard, and woody, resembling thickenings of twigs.

A cryptic appearance conceals a lepidopteran only in appropriate surroundings, and when accompanied by proper behaviour, usually immobility. Great numbers of larval, pupal, and adult Lepidoptera are thus protected in their natural environments, chiefly on and about plants. Leaf-eating larvae blend into leafy backgrounds. Sphinx caterpillars, or measuring worms, have stripes that simulate leaf veins. The saw-toothed elm caterpillar (*Nerice*) has a jagged outline resembling the edge of a leaf. A great many measuring worms are notably twiglike, with long, slender, stiffly held bodies. Many caterpillars (especially Notodontidae) have very irregular shapes and resemble twisted, dead leaves. Likewise, many adults that rest among leaves or on bark are cryptically coloured and patterned.

Larvae and adults are often disruptively marked; *i.e.*, have bold, contrasting patches or bands of colour that "break up" their outlines into two or more seemingly different masses.

Many moths and butterflies show flash coloration, which serves to startle and thus delay an attacker momentarily. Moths with cryptic fore wings, and butterflies with cryptic undersides, show only these surfaces when at rest. When disturbed they suddenly expose brilliantly coloured and marked hind wings (*e.g.*, in underwing moths) or contrasting uppersides (*e.g.*, in morphos, hairstreaks, and anglewings) with startling effect.

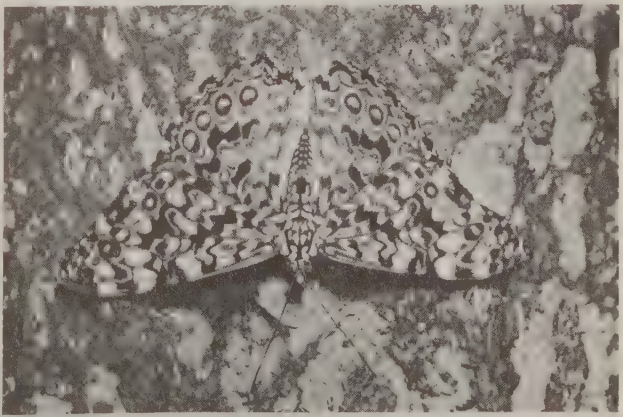
Polymorphism.—The occurrence in a population of two or more distinctive hereditary variants, or morphs, maintained by natural selection, is illustrated by many Lepidoptera. Aside from the common sexual dimorphism of males and females the different morphs usually have differing adaptive values linked with such physiological features as resistance to cold or to toxins in the environment. Many striking dimorphisms in appearance may have great adaptive value because they confuse predators. Melanism, the existence of darker or black morphs, is an example. In environments that are either naturally dark (*e.g.*, in shaded forests) or darkened by soot and industrial wastes, dark moths are cryptic and less likely to be noticed by bird predators. Great increases of airborne pollution in and around large cities have not only darkened the environment generally, but have also eliminated the light-coloured lichens that normally grow abundantly on bark. Some consistently light-colored, variegated, bark-resting moths have accordingly evolved to being predominantly melanic. The work of H. B. D. Kettlewell in England, chiefly with the peppered moth (*Biston betularia*), has abundantly documented the evolution of "industrial" as well as "natural" melanism, and has shown that major, genetic population changes have evolved at a far greater rate than was believed possible. Very little work has been done in this field in North America, where, however, many moths show strong melanism.

Mimicry.—Some very striking polymorphisms occur in species that display mimicry, such as the African swallowtail (*Papilio dardanus*), because of the dominance of different models in different parts of the range of the mimetic species. The North American tiger swallowtail (*Papilio glaucus*) has dimorphic, black or yellow females where it flies with the black pipevine swallowtail (*Battus philenor*), which, being distasteful to predators, is avoided. Where *B. philenor* does not occur, however, the *P. glaucus* females tend to be all nonmimetic yellow, there being no protective significance to black in such a case.

Mimicry is of two types: Batesian, in which unprotected or partially protected forms evolve a resemblance to protected ones, thereby gaining some immunity from predation; and Müllerian, in which protected ones evolve similarities to each other. Other groups of insects are involved, also, such as bees and wasps of which clear wing moths (Aegeriidae) are Batesian mimics and many other day-flying moths are Müllerian mimics. The chief mimetic moths are the Dioptidae, Chalcosiidae, Callidulidae, Aegeriidae, and some day-flying Sphingidae; mimetic butterflies include many Nymphalidae, Papilionidae, Pieridae (especially the New World Dismorphiinae), and Riodinidae. (*See* MIMICRY: *Butterfly Models and Mimics.*)

Chemical and Auditory Defenses.—Chemical defenses involve the secretion of repellent, nauseous, or toxic substances. Sometimes the substances occur generally in the blood (such as a very high concentration of hydrocyanic acid in zygaenid moths) or in the gut. Sometimes they are the product of special glands, which release them at the time of attack. Many groups show autohemorrhization, or reflex bleeding at leg and body joints when disturbed. Tiger moths (Arctiidae) give off bubbling drops of repellent from prothoracic glands. Caterpillars of swallowtail butterflies and tussock moths give off strong smelling, volatile substances from extrusible scent organs (osmeteria).

Many caterpillars introduce toxins that cause severe nettling effects by means of hollow, barbed hairs; those of the slug caterpillar moths (Eucleidae), flannel moths (Megalopygidae), and io moths (*Automeris*) are noted for this. A few adult moths (*Arctia caja*, some Sphingidae) inject toxins through sharp spines on their



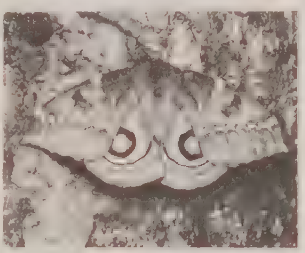
E. S. ROSS

BRAZILIAN BARK BUTTERFLY (AGERONIA), WITH AN INTRICATE OVERALL PATTERN, IS INCONSPICUOUS AGAINST ITS BACKGROUND hind legs. Many caterpillars (*e.g.*, *Datana*, *Schizura*, Notodontidae) can spray formic acid from ventral prothoracic glands. Other toxic substances studied in Lepidoptera include histamin and a digitalislike glycoside (in the monarch butterfly and other species of *Danaus*) derived from the alkaloids of plants.

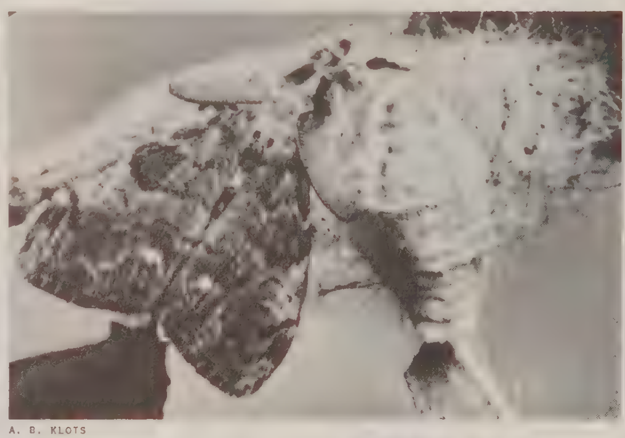
Besides those already mentioned, the chief groups chemically protected are: the moth families Ctenuchidae, Pericopidae, and Zygaenidae; and the butterfly groups Heliconiinae, Ithomiinae, Acraeinae, and the Aristolochia-feeding swallowtails (*Battus*, etc.). The great majority of these and other protected forms are aposematic, *i.e.*, having distinctive, attention-compelling markings, shapes, and behaviour that are easily recognized and remembered by predators (*see* COLORATION, BIOLOGICAL: *Warning*).

Auditory defenses have evolved in some groups. Hawkmoth caterpillars (*e.g.*, Sphingidae) make squeaking or grating sounds when disturbed, and the pupae of many lycaenid butterflies do likewise. The death's head moth (*Acherontia atropos*) makes a loud chirping sound. *Ageronia* butterflies (Nymphalidae), when startled into flight, make a loud, clicking rattle by means of structures on the wings. This may have a startling, and therefore delaying, effect on a pursuer. Arctiid and pericopid moths make a series of very high pitched grating sounds by means of tymbal structures on the sides of the metathorax. Some of these vibrations, supersonic to humans but detectable by bats, may serve aposematically as signals to bats of the moths' inedibility; they may actually interfere with the bats' sonic location systems. Many owlet moths (Noctuidae) can hear in the high-frequency ranges of the bats' sonar systems, and can thus take evasive action when a bat approaches.

SEXUAL DIMORPHISM: IO MOTHS DIFFER IN COLOUR AND PATTERN; TUSSOCK MOTHS DIFFER IN FORM


A. B. KLOTS

Io moth female (*Automeris io*). Compare with male (bottom right)


A. B. KLOTS

White marked tussock moth (*Notolophus leucostigma*); Female, on right, is wingless

6. Courtship and Mating.—Reproductive behaviour depends first upon the ability of the males to find the females, detecting their scent by means of the antennal sensillae. Males with very large, plumy antennae (*e.g.*, Saturniidae, Liparidae) can locate females several miles away, and may form courting swarms about them. Each species may have a particular time of day or night for its courtship assemblies, determined by the female's scent production. In the European ghost swift moth (*Hepialus humuli*) the males form dancing swarms at dusk, to which the females are attracted.

Next, a more or less elaborate courtship may ensue. In butterflies (*e.g.*, *Heliconius*) the sight of characteristic activities, colours, and patterns may be a requisite. Important, too, are male odours, sometimes derived from scent scales (androconia) on the wings, sometimes from masses of glandular scales or hairs on the wings, legs, or abdomen. In danaids the male sweeps these over the female, using special hair-pencils. Courtship in some butterflies is very active (*e.g.*, *Colias*), the female flying far upward followed by the male. Finally, the structures of the genitalia, often extremely complex and characteristic for each species, must be fitted together and interlocked before insemination can occur.

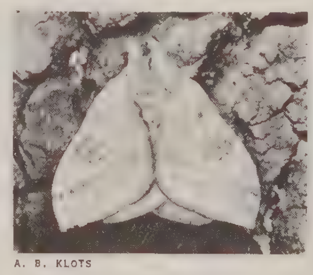
7. Aggregation and Dispersal.—Many Lepidoptera species periodically build up crowded local populations which then move out seeking food. Such are the very destructive swarms of army worms. Other larval groups occur consistently. The marches of the European processionary caterpillars (*Thaumatopoea*) between their nests and feeding areas are famous. In their case, as in many others (*e.g.*, *Datana* and *Symmerista*) there may be a benefit from a group aposematism. Other sociable caterpillars, such as the tent caterpillars and lackeys (*Malacosoma*) of Europe and North America and the social whites (*Eucheira*) of Mexico, benefit from their communal nests.

Sleeping assemblies of adults of such highly protected butterflies as *Heliconius* may form night after night for weeks in the same spot. Migrating monarchs (*Danaus plexippus*) sometimes form similar nightly gatherings. In such assemblies the protection due to the butterflies' distastefulness is greatly enhanced by the group effect.

Large drinking assemblies of butterflies and diurnal moths often form at mud puddles, riverbanks, and manure piles. Many species may be present. The individuals are often definitely attracted visually to the group, and do not merely drop in for a drink. In some species (*e.g.*, *Colias*, *Phoebis*, *Catopsilia*) all or most of the individuals are young males not yet ready to scatter and seek mates.

Dispersal, so necessary for full utilization of available resources and colonization of new areas, normally depends on the flight of the females. Species with wingless females (*e.g.*, Psychidae and some Geometridae and Liparidae) may be dispersed by the wind blowing small larvae hanging from silk threads, or by the winged male carrying the female when they are linked together in copula. Eggs laid on leaves that fall in autumn may be blown far by the wind; and egg-bearing twigs and leaves may be carried by streams. Birds may eat egg-masses and then excrete undigested eggs far away, as they do with certain seeds.

8. Migration.—Many Lepidoptera are famous migrants. The North American monarch is the only species that annually performs a two-way migration, with the same individuals flying southward in the autumn and northward in the spring. It has also crossed the Pacific Ocean, colonizing Hawaii and Australia; it occasionally reaches Europe. The cosmopolitan painted lady (*Vanessa cardui*) and other well-known migrants make one-way flights with no regular returns, usually with no returns at all.


A. B. KLOTS

Io moth male

Most migrants in Europe and North America fly northward in great numbers. In Europe, *V. cardui*, *Utetheisa pulchella* (Arctiidae), *Nomophila noctuella* (Pyralididae), and *Plusia gamma* (Noctuidae) reach Britain and Scandinavia. In North America, *V. cardui*, the cotton moth (*Alabama argillacea*), the black witch (*Erebus odoratus*), and many other noctuid moths, and the cloudless sulfur butterfly (*Phoebis eubule*) often reach Canada. In the tropics many spectacular migrations occur, often with no discernible patterns; flocks of many millions may fly out to sea and be lost. The most famous migrations are of pierid butterflies, *e.g.*, the sulfurs *Colias*, *Phoebis*, and *Catopsilia* and the white *Belenois*; but large migrations have been recorded of the spectacular day-flying moths *Urania leila* and *U. fulgens*.

LOUIS QUITT FROM PHOTO RESEARCHERS

PEARL CRESCENT BUTTERFLIES (PHYCIODES SPECIES) MATING

V. CLASSIFICATION

In the past, many authors divided the order Lepidoptera into two suborders: the Rhopalocera (butterflies) and Heterocera (moths). This gave undue prominence to the butterflies, now regarded as merely one of many superfamilies. Another division into Microlepidoptera and Macrolepidoptera, the small, primitive moths, and the larger, more advanced moths and the butterflies, is popular but hardly scientific. Later, the order was divided chiefly on the basis of the wings: families with the fore and hind wings alike in size and venation were Homoneura; those with the hind wings smaller and reduced in venation were Heteroneura. Alternative names for these based on the wing coupling structures were, respectively, Jugatae and Frenatae. Three suborders may be recognized, based chiefly on the female genitalia: Zeugloptera, Monotrysia, and Ditrysia. The division into superfamilies and families is very complex and subjective, some authorities splitting off many smaller groups, others lumping many small groups into large ones. The position of many isolated families is uncertain. References given in the bibliography provide various viewpoints.

The classification given here follows a middle course. Many small families with no very significant characteristics are merely mentioned, and many dubious or very restricted ones are omitted. A current taxonomic scheme down to the superfamilies is as follows:

- Order Lepidoptera
  - Suborder Zeugloptera
    - Superfamily Micropterigoidea
  - Suborder Monotrysia
    - Superfamily Eriocranioidea
    - “ Hepialoidea
    - “ Nepticuloidea
    - “ Incurvarioidea
  - Suborder Ditrysia
    - Superfamily Zygaenoidea
    - “ Tineoidea
    - “ Gelechioidea (Moths)
    - “ Yponomeutoidea
    - “ Cossoidea
    - “ Castnioidea
    - “ Tortricoidea
    - “ Pyralidoidea
    - “ Bombycoidea
    - “ Geometroidea
    - “ Sphingoidea
    - “ Noctuoidea
    - “ Hesperioidea (skippers)
    - “ Papilionoidea (butterflies)

A. MOTHS

1. Suborder Zeugloptera.—In this group the females have no separate genital openings, insemination and egglaying occurring through the anus. Both adults and pupae have functional jaws as, of course, do the larvae. The wings are homoneurous (alike in size and venation) and aculeate ("hairy"), the fore and hind being coupled by a jugum (lobe at the base of the fore wing).

Micropterigidae.—This small, widely distributed family is very significant because of its extremely primitive characteristics. The caterpillars feed on mosses and liverworts, the day-flying moths on pollen. North America and Europe have several species, Australia and New Zealand many more.

2. Suborder Monotrysia.—In this group the females have one or two genital openings, always near the anus. The wings are at least partly aculeate.

Superfamily Eriocranioidea.—The females have one genital opening, a long cloaca and a piercing ovipositor. The wings are homoneurous and aculeate. The adults have a short proboscis; the pupae have functional jaws.

Eriocraniidae.—This small family, widely distributed but chiefly North American and European, connects the Micropterigidae and the higher moths. The adults, which suck nectar, are often brilliantly coloured. Related families: Mnesarchiidae (New Zealand) and Neopseustidae (India and Taiwan).

Superfamily Hepialoidea.—The females have 2 genital openings in the 9th abdominal segment. The wings are homoneurous and aculeate. The adults have mouthparts reduced and nonfunctional. The antennae are very short.

Hepialidae (*Swifts and Ghost Moths*).—A worldwide family of about 300 species, chiefly in Australia and New Zealand, of medium-sized to very large moths, some brilliantly coloured. The caterpillars mostly bore in wood or turf; grass grubs (*Porina*) are sometimes serious pests of grass and forage crops. Related families: Prototheoridae (Africa and Australia), Palaeosetidae (Australia), Anomosetidae (Australia).

Superfamily Nepticuloidea.—The females have one genital opening on the 9th abdominal segment and a soft ovipositor. The wings are heteroneurous (dissimilar) and somewhat aculeate.

Nepticulidae (*Stigmellidae*) (*Midget Moths*).—A worldwide family of very small to minute moths with broad eyecaps on the 1st antennal segments. The caterpillars are mostly leaf and bark miners, but a few live in galls.

Opostegidae and Tischeriidae.—Small but worldwide families

KARL WEIDMANN FROM NATIONAL AUDUBON SOCIETY

TROPICAL AMERICAN SULFUR BUTTERFLIES (PHOEBIS SPECIES) GATHERING ON A MOIST SANDBAR of small moths with narrow, long-fringed wings. The caterpillars are leaf, stem, or bark miners.

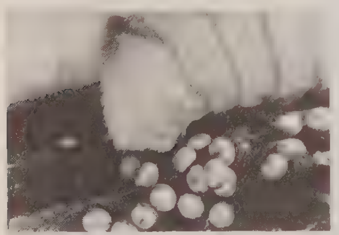
Superfamily Incurvarioidea.—Incurvariidae (Fairy Moths).—A small but worldwide family of small moths, many with brilliant colours and diurnal habits. The male's antennae may be several times as long as the wing expanse. The caterpillars are mostly leaf miners, casemakers, or fruit borers. The mutualistic relations of the yucca moths (*Tegeticula*) with their foodplants are famous (*see* above). This family is sometimes split into Incurvariidae, Adelidae, and Prodoxidae. The related Heliozelidae (shield bearers) are widely distributed.

3. Suborder Ditrysia.—In this group the females have two widely separated genital openings, the receptive one being on the 8th abdominal segment. The wings are strongly heteroneurous, without aculeae, usually with a frenulum (a bristle at the base of the hind wing) for coupling the wings. Here belong the great majority of the Lepidoptera: the more advanced moths, the skippers, and the butterflies. Their classification is based on many characteristics of the egg, larva, pupa, and adult.

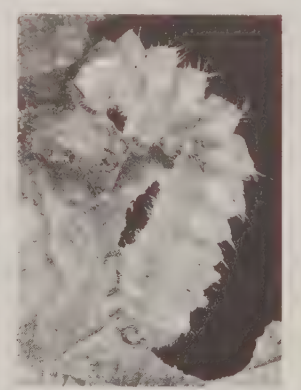
Superfamily Zygaenoidea.—The adults have broad to very broad wings, with short fringes and some primitive venation. The pupae are primitive and quite mobile.

Eucleidae (Limacodidae) (Slug Caterpillar Moths).—The caterpillars are broad and flat beneath, with reduced prolegs; they move glidingly, with the head hidden beneath the prothorax. Many have poisonous, irritant setae. The moths have heavy, hairy bodies and vestigial probosces.

Megalopygidae (Flannel Moths).—The caterpillars resemble slug caterpillars but have all the usual prolegs plus additional ones. They have very toxic, nettling setae. The family is almost limited to the New World.


LOUIS QUITT FROM PHOTO RESEARCHERS

Moth depositing eggs on a twig

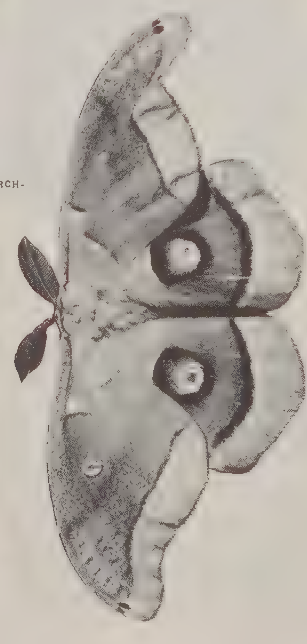

ROHMER B. BEARD FROM NATIONAL AUDUBON SOCIETY

Caterpillar feeding

LIFE CYCLE OF POLYPHEMUS MOTH (ANTHERAEA POLYPHEMUS)

JOHN H. GERARD

Cocoon


Adult ready for flight

H. R. HUNGERFORD FROM PHOTO RESEARCHERS

LOUIS QUITT FROM PHOTO RESEARCHERS

Moth emerges from cocoon

LOUIS QUITT FROM PHOTO RESEARCHERS

Newly emerged adult expanding its wings

Zygaenidae (Burnet and Forester Moths).—The moths are usually brightly coloured and diurnal, have strong probosces, and visit flowers. They are strongly protected by high concentrations of hydrogen cyanide in the blood. The caterpillars are leaf skeletonizers. Closely related are the Aididae and Chalcosiidae (Old World tropics) and the Pyromorphidae and Dalceridae (New World).

Superfamily Tineoidea.—A large group of families of mostly small moths of diverse habits. All have some primitive characters of venation and life cycle. The wings are frequently narrow, with long fringes. (Some authorities lump the gelechioids and yponomeutoids here; this article separates them as superfamilies.)

Tineidae (Clothes Moths).—A worldwide family of small, narrow-winged moths with rough, hairy heads and usually large maxillary palpi. The larvae are often casemakers feeding on animal and plant debris, fungi, etc. The clothes moths (*Tinea, Tineola, Trichophaga*) are destructive household pests. A related family, the Acrolophidae, are burrowing webworms.

Psychidae (Bagworm Moths).—A large, cosmopolitan family characterized by the cases in which the larvae live and pupate, the broad, short-fringed wings of the males, and the great reduction of the females, sometimes to wingless creatures that never leave the case.

Epipyropidae (Parasitic Moths).—A small family, chiefly Oriental. The larvae live as external parasites on certain homopterous insects. Young larvae of the Australian Cyclotornidae live similarly, then later move to ant nests.

Coleophoridae (Casebearer Moths).—A worldwide family of small, very narrow winged moths. The larvae mostly mine leaves when young, then live in portable, elongate cases with complex shapes.

Gracillariidae, Lyonetiidae, Elachistidae, and Douglasiidae.—A group of worldwide families, totaling about 2,000 species, of narrow-winged, long-fringed moths that often have bright metallic markings. The larvae are chiefly leaf miners, many being highly flattened and otherwise specialized.

Superfamily Gelechioidea.—A group of worldwide families totaling more than 12,000 species. The adults on the whole are somewhat larger and broader winged than the tineoids (above). Relatively few of the caterpillars are leaf miners.

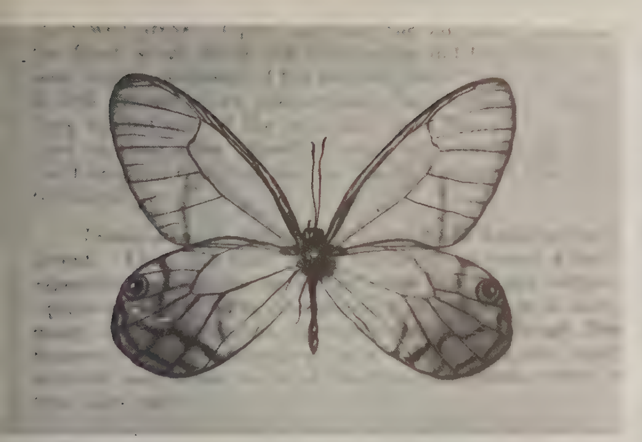
Gelechiidae.—Most of the caterpillars are leaf tiers, rollers, and crumplers; others bore in stems, fruits, and tubers; and a few are gall makers. Several are serious economic pests, like the pink bollworm of cotton (*Pectinophora gossypiella*), the potato tuberworm (*Gnorimoschema operculella*), and the Angoumois grain moth (*Sitotroga cerealella*).

Cosmopterigidae.—Many adults are very narrow winged and have bright, often metallic marking. The larvae are leaf miners or bore in stems, fruits, or seeds, live as leaf tiers or are scavengers. Related families: Lavernidae, Momphidae, Walshiidae.

Oecophoridae.—The adults tend to be somewhat broad winged. The larvae typically web leaves and flower heads together. Related families: Ethmiidae, Stenomatidae, Xylorictidae.

Blastobasidae.—The adults are often drab, with reduced mouthparts. The larvae are mostly scavengers, but some feed on scale insects.

Superfamily Yponomeutoidea.—Aegeriidae (Sesiidae) (Wasp, or Clear Wing, Moths).—The adults are diurnal, often brightly coloured, with yellow, orange, or scarlet, usually have the wings



A. B. KLOTS

CLEARWING OR GLASSWING SATYR (PIERELLA)

mostly transparent, and are often extremely close mimics of wasps. The caterpillars are stem, twig, and rootstock borers. Some are injurious to fruit crops, such as the currant borer (*Ramosia tipuliformis*) and the peach tree borer (*Sanninoidea exitiosa*).

Yponomeutidae (*Ermine Moths*).—Many of the moths, especially in the tropics, are very brightly coloured. The caterpillars weave leaves together in webs or live in shoots, buds, or fruits; a few are leaf miners. Related families: Plutellidae, Glyphipterigidae, Heliodinidae, Scythrididae.

Superfamily Cossoidea.—*Cossidae* (*Carpenterworm, or Goat, Moths*).—Adults range up to 250 mm. in wing expanse, among the largest, and certainly the heaviest, of moths. The larvae are wood borers, penetrating even solid heartwood, and may require at least two years to mature. Some are very destructive, including the coffee borer (*Zeuzera coffeae*) and the leopard moth (*Z. pyrina*).

Superfamily Castnioidea.—*Castniidae.*—A small family of medium-sized to large moths of the New World and Indo-Australian tropics. The adults are heavy bodied, broad winged, and often brightly coloured. They are diurnal, have clubbed antennae, and superficially resemble butterflies. The larvae are often stem borers.

Superfamily Tortricoidea.—The families classified here form one of the major, worldwide groups of moths. They have fairly broad, short fringed wings that seldom expand more than 25 mm. The majority have cryptic colours and patterns. The larvae are mostly leaf folders and leaf rollers, but many bore in soft stems, fruits, and flower heads.

Tortricidae (*Leaf Roller Moths*).—Larvae of the green *Tortrix viridana* defoliate oak forests in Europe; and those of the spruce budworm (*Choristoneura fumiferana*) are perhaps the worst forest pests in North America. Some species of *Peronea* and *Acleris* show most extraordinary polymorphisms of colour and pattern.

Olethreutidae.—The chief subfamilies, the Olethreutinae, Eucosminae, and Laspeyresiinae are sometimes ranked as families. Many species are serious pests, such as the pine shoot moths (*Rhyacionia*) and the codling moth (*Laspeyresia pomonella*) and the oriental fruit moth (*L. molesta*). Smaller related families: Phaloniidae (chiefly Northern Hemispheric), Carposinidae (chiefly Indo-Australian), and Chlidanotidae (Indo-Australian and Neotropical).

Superfamily Pyralidoidea.—An enormous, worldwide group of about 20,000 species. Veins $Sc+R_1$ of the hind wings are typically closely approximate or fused to beyond the cell; and most of the groups have a pair of tympanal organs on the 1st abdominal segment. The moths are usually slender bodied with long legs, and many have narrow fore wings and broader hind wings.

Pyralididae.—Many of the subfamilies of this very large family have been recognized, at times, as families. The Pyraustinae is the largest group; most of the larvae live in rolled or tied leaves, or bore in soft stems or roots. The European corn borer (*Pyrausta nubilalis*) is a notable pest member. The caterpillars of the small subfamily Nymphulinae are aquatic, having tracheal gills and living in either quiet or running fresh waters. The larvae of the Pyralidinae are mostly scavengers. So are those of the Galleriinae, many of which live in bee or wasp nests; those of the bee, or wax, moth (*Galleria mellonella*) do considerable damage in beehives. Caterpillars of the Crambinae are either sod webworms or borers of soft stems. The larvae of the very large subfamily Phycitinae are very diverse in habits. Most tie or web leaves together; but many are borers, *e.g.*, the pine borers (*Dioryctria*) and the cactus borers (*Cactoblastis*). Others are scavengers, some being pests of stored food and some predatory on scale insects. Other important subfamilies are: Chrysauginae, Schoenobiinae, Endotrichinae, and Ancylolominae. Probably related is the small, chiefly tropical family Thyrididae.

Pterophoridae (*Alucitidae*) (*Plume Moths*).—The moths have very long, slender legs and slender bodies; the wings are generally deeply cleft, with long fringes. The caterpillars web the leaves of many plants.

Orneodidae (*Feather-Winged Moths*).—This is a small but worldwide family of uncertain relationship. Each wing is very deeply cleft into 6 or more very narrow, plumelike divisions. Despite this, the moths fly very rapidly and well.

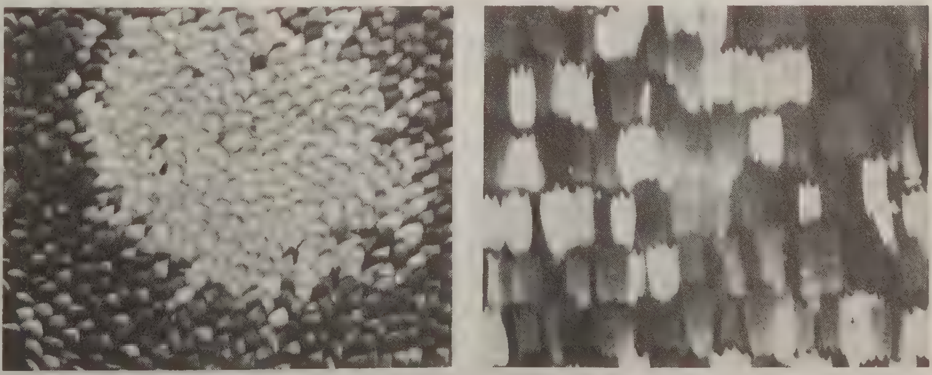
The preceding groups are those often called Microlepidoptera, or "micros," while the following are the Macrolepidoptera, or "macros." The terms are convenient for popular use, even though some "micros" (*e.g.*, Hepialidae and Cossidae) are among the largest of moths, and some "macros" have wing expanses of only 10 mm.

Superfamily Bombycoidea.—The adults are large to very large, characterized chiefly by the usual absence of a frenulum. The proboscis is reduced and nonfunctional, the male antennae are pectinate, and there are neither tympanic organs nor maxillary palpi.

Bombycidae (*Silkworm Moths*).—This small family centres around the domesticated silkworm moth (*Bombyx mori*) and a few of its relatives, all Asian. Related family: Eupterotidae.

Lasiocampidae (*Tent Caterpillar Moths*).—The larvae are usually hairy and often brightly coloured. *Malacosoma neustria* of Europe and *M. americana* of North America have gregarious larvae known as lackeys and tent caterpillars; other species are solitary.

Saturniidae (*Giant Silkworm Moths*).—Every continent has



A. B. KLOTS

WING SCALES: (LEFT) AN EYESPOT OF A PARNASSIAN BUTTERFLY (PARNASSIUS APOLLO); (RIGHT) FRONT WING OF AN UNDERWING MOTH (CATOCALA) some well-known species of this family, great favourites with collectors because of their very large size, bright colours, and striking wing shapes and patterns. The largest are the Indo-Australian *Attacus atlas* and *Coscinoscera hercules*, with wing expanses up to 275 mm. (11 in.). Europe has the emperor, or giant peacock (*Saturnia pavonia*). The most familiar North American species are the cecropia (*Hyalophora cecropia*), io (*Automeris io*), luna (*Actias luna*), and polyphemus (*Antheraea polyphemus*). The very large, fleshy caterpillars often have brightly coloured knobs and spines. Most species spin dense, firm cocoons of brown, green, or silvery silk.

Citheroniidae (*Regal Moths*).—Often considered a subfamily of the saturniids, these are large to very large moths, often brightly coloured. The caterpillars of the North American *Citheronia regalis*, called hickory horned devils, are very striking. Pupation is in the ground; there is no cocoon. Related families: Brahmaeidae (African and Indo-Australian) and Lacosomidae (New World).

LOUIS QUITT FROM PHOTO RESEARCHERS

AMERICAN EASTERN TENT CATERPILLARS (MALACOSOMA AMERICANA) AFTER HATCHING CONSTRUCT A SILKEN NEST FOR SHELTER

Superfamily Geometroidea.—The families included here all have abdominal tympana. (Some authorities split this group into three superfamilies: the Geometroidea, Uranioidea, and Drepanoidea.)

Geometridae.—This is one of the largest and most widespread moth families, abundantly represented nearly everywhere. The long, slender larvae—called measuring worms, or inch worms—lack most of the anterior prolegs and crawl with a characteristic looping gait. Pupation is usually in the ground. Both caterpillars and adults are commonly very cryptic, resembling twigs, dead leaves, or bark. Numerous species destructive to foliage include cankerworms (*Palaeacrita* and *Alsophila* species) and the winter moth (*Operophtera brumata*).

Uraniidae.—The uraniids are mostly tropical. Some of the moths, such as *Chrysiridia*, from Madagascar, and *Urania*, in the New World, are large day-flyers, with black and iridescent green colours and long-tailed hind wings. The oriental *Epicopeia* (sometimes separated as a family) mimic protected species of swallowtail butterflies.

Drepanidae (*Hooktips*).—This small, worldwide family is best represented in the Indo-Australian region. Many of the moths have the apexes of the fore wings strongly hooked. The caterpillars usually have the last pair of prolegs aborted. Related families: Thyatiridae (Cymatophoridae) and Epiplemidae, both worldwide.

Superfamily Sphingoidea.—Sphingidae (*Hawk, or Sphinx, Moths*).—A worldwide family of medium-sized to very large, powerful, fast-flying moths with long, narrow fore wings, thick antennae, and usually strong probosces. They feed by hovering in front of flowers and drawing nectar through their extended probosces. Some are active during the day, many at dusk. The caterpillars are mostly smooth with a single, long horn at the rear of the abdomen; they typically rest with the head and thorax reared up, fancifully like the Sphinx in profile. The family includes the destructive tobacco hornworm (*Protoparce sexta*) and tomato hornworm (*P. quinquemaculata*).

Superfamily Noctuoidea.—A tympanic organ on either side of the metathorax is the most consistent feature of the families included here.

Noctuidae (*Owlet Moths*).—This, the largest family of Lepidoptera, has abundant members everywhere, and presents a great diversity of size, colours, and habits. Sizes range from a wing expanse of 10 mm. (*Hypenodes*) to 275 mm. (*Thysania*). Many species are among the most brilliantly coloured insects, but the majority are plain and cryptic. Nearly every type of plant food is exploited: leaves, flowers, fruits, stems, rootstocks, and woodland litter. *Cosmia* and a few other genera are cannibalistic. Many of the most injurious of all moths are such noctuids as the cutworms and army worms.

Agaristidae (*Forester Moths*).—A comparatively small but worldwide family. Many of the moths are brightly coloured, aposematic, or mimetic day-flyers. The Australian *Hecatesia fenestrata* males make a whistling sound during flight by means of hollow structures on the fore wings.

Notodontidae (*Prominents*).—The adults are mostly dull-coloured, but the caterpillars show a vast variety of cryptic, disruptive, and aposematic appearances. Some caterpillars can project a defensive spray of formic acid. In many genera the last prolegs are greatly reduced or specialized.

Arctiidae (*Tiger Moths*).—Many of the species, especially in the tropics, have bright, aposematic colours and patterns, and are apparently highly protected by toxic secretions. Many have densely hairy caterpillars called "woolly bears."

Closely related are several other families, chiefly tropical. The New World Dioptidae and Pericopidae contain many boldly coloured and marked day-flying species that are members of mimicry complexes. The worldwide Ctenuchidae (*Syntomidae, Euchromiidae, Amatidae*) includes many day-flying mimics of wasps and protected beetles. The Lithosiidae also contains many aposematic species; their caterpillars are lichen-feeders.

Liparidae (*Lymantriidae*) (*Tussock Moths*).—This family is best known for the injurious habits of such species as the gypsy moth (*Lymantria dispar*) and the nun moth (*L. monacha*). Many of the caterpillars have prominent tussocks and pencils of long hair, osmeteria, and urticating spines. The Old World Thaumatopoeidae, similarly protected, is best known for the "processionary" habits of the gregarious caterpillars.

B. Skippers

Superfamily Hesperioidea.—The skippers and the true butterflies (below) are best distinguished from moths by the presence of clubbed antennae and the lack of a frenulum. Skippers are very fast-flying lepidopterans with short, usually pointed fore wings, broad heads, antennae usually hooked beyond the club, and all veins arising from the cell of the fore wing simple (unbranched). They are active during the day.

Euschemonidae (*Regent Skipper*).—Only one species comprises this family: the anomalous Australian skipper of which the male has a frenulum and retinaculum—like a moth; the female, however, is a perfectly normal skipper.

Megathymidae (*Giant Skippers*).—A small New World family of very large skippers whose larvae bore in the stems of yucca and agave plants, constructing silk-lined tubes.

Hesperiidae (*True Skippers*).—Among the more than 3,000 species, the adults range from small, drab specimens to large tropical ones with brilliant, iridescent colours. Most of the larvae live concealed in individual leaf nests or in webs among grasses; they form flimsy cocoons.

C. Butterflies

Superfamily Papilionoidea.—A general evolutionary trend in the butterflies has been from a primitive condition in which the fore legs are fully developed (Pieridae, Papilionidae) to one in which they are greatly reduced and useless for walking (Nymphalidae). Intermediate conditions occur in the Lycaenidae. Butterfly pupae (called chrysalids) are often brightly coloured and marked and are usually not enclosed in cocoons. They either hang head down, from the cremaster (most Nymphalidae), or are additionally supported by a silk girdle about the body (Pieridae, Papilionidae, and Lycaenidae).

Pieridae (*Whites and Sulfur Butterflies*).—The yellow European brimstone (*Gonepteryx rhamni*) may be the species that inspired the name "butterfly." Many pierids are common in the temperate regions, but, as in all butterfly groups, there are far more in the tropics that are outstanding in size and colour. Pierids are noted for their mass migrations, and also for congregating to sip water from wet ground. The caterpillars of *Pieris rapae* and *P. brassicae* are pests of plants of the cabbage family, and *Colias* species damage clover and alfalfa. The pupae have a characteristic frontal horn on the head.

Papilionidae (*Swallowtail and Parnassian Butterflies*).—Although many more species occur in the tropics, everywhere there is at least one familiar swallowtail. The tails on the hind wings are missing in some genera, such as the northern *Thais* and *Parnassius*, and even, occasionally, in many species of normally-tailed genera. Females of the Indo-Australian *Troides* are the largest of butterflies. Caterpillars are protected by extrusible, strong-smelling osmeteria, and the adults of *Battus* are chemically protected, aposematic, and much mimicked.

Lycaenidae (*Blues, Coppers, and Hairstreak Butterflies*).—A large, diverse, worldwide family of small butterflies. Delicate tails on the hind wings occur in all subfamilies, but most commonly in the Theclinae (hairstreaks). Many of the sepcies are iridescent blue or green or, in the coppers (Lycaeninae), metallic-looking coppery. Many larvae secrete honeydew and have mutualistic relations with ants; some prey on the ant brood. The caterpillars of the North American harvester (*Feniseca tarquinius*) and its Asian relatives are predators on aphids. Many pupae have stridulatory structures on the abdomen.

Riodinidae (*Metalmark Butterflies*).—Closely allied to the Lycaenidae, this large family, chiefly tropical American, has an unequalled diversity of wing shapes and colours. Many of the species are involved in the riot of mimicry that characterizes South American butterflies. Europe has only one species, North America only a few.

Libytheidae (*Snout Butterflies*).—This family is worldwide but contains only about a dozen species. All are rather alike, and have long, protruding palpi. Some species are strongly, but unpredictably, migratory.

Nymphalidae (*Brush-footed Butterflies*).—This, the largest family of butterflies, is so diverse that it has often been split into a number of families. The Nymphalinae is the basic group, with many familiar species such as the fritillaries, admirals, checkerspots, and anglewings. The Satyrinae contains the familiar wood nymphs, meadow browns, and heaths; with distinctive larvae that spin crude cocoons, this group comes very close to deserving family rank. The very large Brassolinae and the iridescent Morphinae are Neotropical. So are the highly protected, aposematic Heliconiinae and Ithomiinae which, with the worldwide Danainae, are models in many mimicry complexes. Most species of the pantropical Acraeinae are also highly protected and aposematic models.

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BUTTERFLY FISH, the common name of the family Chaetodontidae; these are laterally compressed, brilliantly coloured fishes of tropical seas with, as their Latin name indicates, bristlelike teeth. Young butterfly fish have a collar or sheath, around the head and neck; they lose this collar as they mature. The brilliantly coloured adults are easily seen as they dart among coral reefs. Black spots (ocelli) often occur on the tail or fins. Their habit of pointing toward potential danger may help conceal them. Few exceed 8 in. in length and they seldom are used for food. Butterfly fishes often have toxins in the viscera and occasionally in the muscles. (C. HU.)

BUTTERFLY WEED (*Asclepias tuberosa*), a North American plant of the milkweed family (Asclepiadaceae), known also as pleurisy-root, orange-root, and orange milkweed. It is native to dry fields from Maine to Ontario and Minnesota and southward to Florida, Texas, Arizona, and Chihuahua. The butterfly weed is a stout, rough-haired perennial, with long horizontal roots. The usually erect, somewhat branching stem, 1 ft. to 3 ft. high, is very leafy throughout, and about midsummer bears numerous clusters of bright orange flowers. Unlike most milkweeds, this plant has a very scanty milky juice. The root once was used in medicine, especially for pulmonary affections. Butterfly weed is planted in wild gardens and is sparingly grown as a border plant.

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BUTTERFLY WEED (ASCLEPIAS TUBEROSA)

BUTTERMILK, the liquid residue after removing the butter from cream by the churning process. It consists mainly of water, some 90%, together with milk sugar, about 5%, and casein, about 3%. In addition it contains small quantities of butterfat and lactic acid. To the latter, which is formed during the ripening of the cream, buttermilk owes its slightly acid taste. In North America until about 1900 buttermilk was used chiefly for feeding pigs, especially in the leading dairy districts, but, because of its healthful and nutritious qualities, it later became widely popular as a beverage.

In the United States and Canada it is extensively bottled or packaged in cartons for the market and sold at dairies, grocery stores, delicatessens, soda fountains, and restaurants. In some sections, most of the buttermilk sold commercially is "cultivated." Certain bacteria are added to skimmed milk to produce fermentation. The resulting product is somewhat thicker than natural buttermilk, but is in other respects similar. *See* DAIRY INDUSTRY; MILK.

BUTTERNUT: *see* WALNUT.

BUTTERWORT, the popular name of a small insectivorous plant, *Pinguicula vulgaris,* which grows in wet, boggy land. It is an herb with a rosette of fleshy, oblong leaves, one to three inches long, lying flat against the ground, of a pale colour, and with a sticky surface. Small insects settle on the leaves and are caught in the viscid secretion. This, like the secretion of the sundew and other insectivorous plants, contains a digestive enzyme which renders the nitrogenous substances of the body of the insect soluble and capable of absorption by the leaf. In this way the plant obtains nitrogenous food by means of its leaves. The leaves bear two sets of glands, the larger borne on usually unicellular stalks, the smaller almost sessile. When a fly is captured, the viscid secretion becomes strongly acid and the naturally incurved margins of the leaf curve still further inward, rendering contact between the insect and the leaf surface more complete. The plant is widely distributed in the north temperate zone, extending into the arctic zone. In North America it ranges from the high northern tundras southward to Newfoundland, New York, Minnesota, Montana, and British Columbia. The butterwort belongs to the bladderwort family (Lentibulariaceae), which comprises various other carnivorous plants. *See* CARNIVOROUS PLANTS.

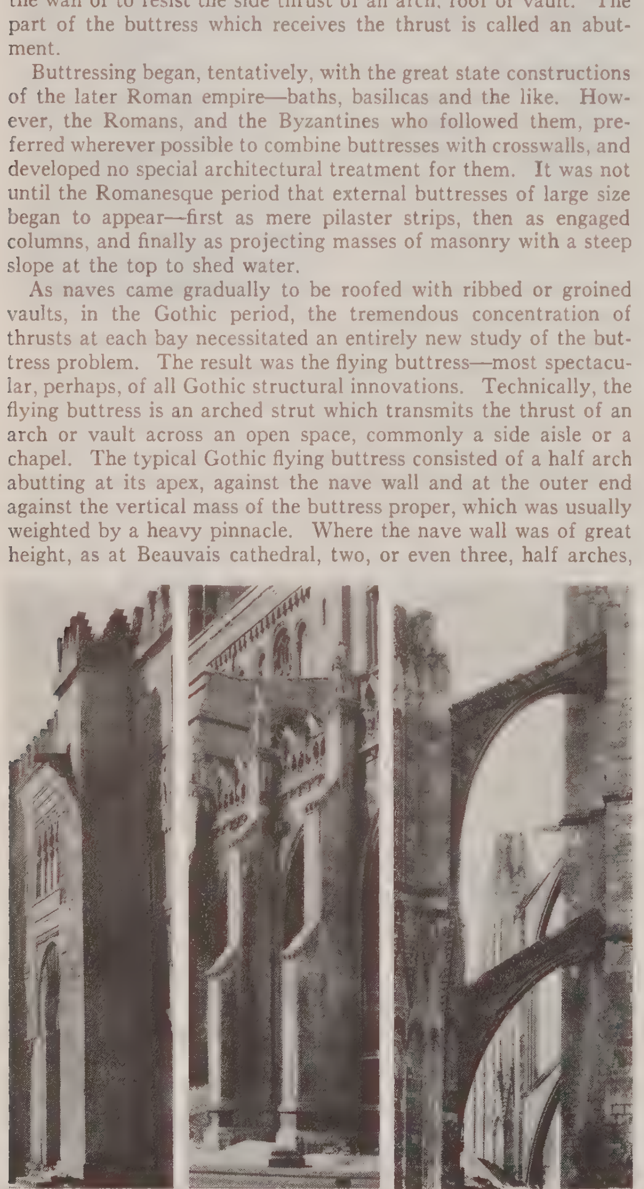
See also F. E. Lloyd, *The Carnivorous Plants* (1942).

BUTTONBUSH (*Cephalanthus occidentalis*), a North American shrub or small tree of the madder family (Rubiaceae; *q.v.*), called button willow and also honeyballs in California. It grows in swamps almost throughout North America and in Mexico and Cuba. In the northern parts of its range it is a shrub 3 to 12 ft. high, but in southern Arkansas and eastern Texas it attains a height of 40 to 50 ft., with a straight trunk a foot in diameter. It bears ovate, entire, pointed leaves and small, fragrant, creamy white flowers in globular stalked heads about an inch in diameter. In the northeastern states the buttonbush is sparingly cultivated as an ornamental plant.

BUTTRESS, in architecture, the term given to a mass of masonry projecting from the face of a wall, either to strengthen the wall or to resist the side thrust of an arch, roof or vault. The part of the buttress which receives the thrust is called an abutment.

Buttressing began, tentatively, with the great state constructions of the later Roman empire—baths, basilicas and the like. However, the Romans, and the Byzantines who followed them, preferred wherever possible to combine buttresses with crosswalls, and developed no special architectural treatment for them. It was not until the Romanesque period that external buttresses of large size began to appear—first as mere pilaster strips, then as engaged columns, and finally as projecting masses of masonry with a steep slope at the top to shed water.

As naves came gradually to be roofed with ribbed or groined vaults, in the Gothic period, the tremendous concentration of thrusts at each bay necessitated an entirely new study of the buttress problem. The result was the flying buttress—most spectacular, perhaps, of all Gothic structural innovations. Technically, the flying buttress is an arched strut which transmits the thrust of an arch or vault across an open space, commonly a side aisle or a chapel. The typical Gothic flying buttress consisted of a half arch abutting at its apex, against the nave wall and at the outer end against the vertical mass of the buttress proper, which was usually weighted by a heavy pinnacle. Where the nave wall was of great height, as at Beauvais cathedral, two, or even three, half arches, one over the other, formed the flying buttress.



(LEFT) THREE LIONS, INC.; (CENTRE) A. F. KERSTING; (RIGHT) EWING GALLOWAY

BUTTRESSES: (LEFT) ENGAGED COLUMN, GREAT MOSQUE, CÓRDOBA, SPAIN, 8TH CENTURY; (CENTRE) SLOPING BUTTRESSES, PETERBOROUGH CATHEDRAL, ENG., 12TH CENTURY; (RIGHT) FLYING BUTTRESSES, CATHEDRAL OF ST. GATIEN, TOURS, FRANCE, 12TH–16TH CENTURIES

In later Gothic architecture elaborately sculptured buttresses were an outstanding feature; but with the revival of Roman building practices during the Renaissance, their importance steadily diminished. In modern architecture, where masonry vaults are seldom found, buttresses have reverted to being mere wall strengtheners, treated in the simplest possible manner. *See* also ARCHITECTURE; ARCH AND VAULT; ARCHITECTURAL ENGINEERING; GOTHIC ART AND ARCHITECTURE. (AN. G.)

BUTUNG, an island S.E. of Celebes, Indon., one of a group which includes Butung, Muna (*q.v.*), Kabaena and Wowoni. Butung Strait, between Butung and Muna, is narrow and difficult to navigate, but beautiful. Butung is 95 mi. long; the area is 1,759 sq.mi. It has an axial chain of limestone hills (highest point Wani, 3,904 ft.) and is thickly forested. Pop. (1961) 253,262. The coast people are mostly Muslim Buginese. There are traditionally three classes: descendants of nobles, free inhabitants and slaves. They carry on weaving and copperwork, but are chiefly trading sailors and fishermen, and their well-built prahus traverse all the seas of the archipelago. Houses are built of wood, on piles, and sometimes villages are in shallow water offshore, with approach by a bamboo causeway. Butung formerly had a reputation for piracy, and on the south coast the old pirate haunt of Wasuemba is still to be seen, surrounded by thick walls of coral blocks, not far from the village of Wabula. Butung comes under the jurisdiction of South Sulawesi (Celebes), but there is a local sultan, whose *kraton,* or fortress, at Wabula is on a steep hill. Teak is found, and is used for boatbuilding; coconuts are grown, and there is some trade in copra and a kind of small dried fish; a few of the inhabitants engage in pearl-dealing. Butung yields much natural asphalt. Its port is Labuantobelo, at the north end of the island. The administrative centre is Baubau in the southwest. Japan occupied the island in World War II.

(J. O. M. B.)

BUTYL ACETATES. This collective term is applied to the acetic acid esters of *n*-butyl alcohol, isobutyl alcohol and secondary butyl alcohol. The butyl acetates are colourless, neutral, mobile liquids having pleasant fruitlike odours. Their commercial importance depends upon their great solvent power for nitrocellulose and for other film-forming compounds used in the lacquer and varnish industries. The acetic acid ester of tertiary butyl alcohol is extremely difficult to prepare and has no commercial importance.

Normal butyl acetate is the standard medium evaporating solvent of the lacquer industry. The commercial product contains 90%–92% *n*-butyl acetate and 8%–10% of *n*-butyl alcohol. Its use in lacquer formulations imparts low viscosity, good flow-out and high resin compatibility characteristics. The butyl acetates of commerce contain 90% butyl acetates and 10% butyl alcohol. Principal users were the manufacturers of lacquers, enamels, patent leathers, linoleum and celluloid products. Pure *n*-butyl acetate boils at 126.1° C.; it is lighter than water, since its specific gravity at 20°/4° C. is 0.882.

Secondary butyl acetate is not as good a lacquer solvent as *n*-butyl acetate. Its evaporation rate is approximately 1.8 times as fast as *n*-butyl acetate. It therefore has a greater tendency to cause blushing of the lacquer films. Its primary use is as a substitute for *n*-butyl acetate. The boiling point is 111.5° C., specific gravity at 20°/4° C. is 0.869.

Isobutyl acetate imparts slightly lower viscosity characteristics than does *n*-butyl acetate to nitrocellulose lacquers. It boils at 117.2° C. and has a specific gravity at 20°/4° C. of 0.875. The commercial product contains 90%–100% ester and 0%–5% isobutyl alcohol. Its evaporation rate is approximately 1.5 times that of *n*-butyl acetate. (D. G. Z.; N. C. S.; X.)

BUTYL ALCOHOLS, a class of organic compounds, of which four members are known: normal butyl alcohol, secondary butyl alcohol, isobutyl alcohol and tertiary butyl alcohol. They have the formula C_4H_9OH. All but tertiary butyl alcohol find extensive use as solvents for lacquers. They are also used extensively in the manufacture of various esters. Tertiary butyl alcohol is used mostly in the manufacture of derivatives. These alcohols are slightly viscous liquids with penetrating odours. They are somewhat poisonous if taken internally but can be handled with safety if ordinary precautions are taken.

Normal butyl alcohol (butanol) is made commercially by fermentation of corn or molasses and also from acetylene by a series of reactions involving addition of water, condensation and reduction. Secondary butyl alcohol is ordinarily produced from butylene present in cracking gases from petroleum refineries by solution in sulfuric acid followed by reaction with water. Tertiary butyl alcohol is similarly produced from isobutylene. Isobutyl alcohol is made commercially by causing carbon monoxide and hydrogen to react at high pressure.

BUTYRIC ACID is the first acid in the fatty acid series to show structural isomerism (*q.v.*). There are two acids of the formula $C_3H_7.CO_2H$. Normal butyric acid or fermentation butyric acid is found in butter, as a hexyl ester in the oil of *Heracleum giganteum*, as an octyl ester in parsnip (*Pastinaca sativa*), and in the oil of *Eucalyptus perriniana* as *n*-butyl butyrate; it has also been noticed in meat juice, in perspiration and in excrement. The acid is an oily liquid of unpleasant smell, solidifies at −19° C. and boils at 162.3° C.

Isobutyric acid, $(CH_3)_2.CH.COOH$, is found in the free state in carobs (*Ceratonia siliqua*) and in the root of *Arnica dulcis*, and as an ethyl ester in croton oil. It is a liquid of somewhat unpleasant smell, boiling at 155.5° C.

BUXACEAE, the boxwood family, a small group of evergreen plants with 6 genera and 30–60 species, mostly shrubs or small trees, in the warmer parts of both hemispheres. Representatives of the genus *Buxus*, known as boxwood (*q.v.*), are highly prized for garden hedges and borders; certain species of *Pachysandra* are used as ground covers.

BUXTEHUDE, DIETRICH (*c.* 1637–1707), Danish organist and composer of church music. The exact date and place of Buxtehude's birth are not known. His father came from Oldesloe and was organist at Helsingborg from about 1638 to 1641 and at Helsingor (Elsinore) from about 1642 to 1671. Nothing is known of Buxtehude's youth, but it can be assumed that his musical education at least was given him by his father. Buxtehude was organist at St. Mary's, Helsingborg (1657–58), and at St. Mary's, Helsingor, from 1660. In 1668 he went to St. Mary's, Lübeck, Ger., and remained there for the rest of his life. With the duties of organist he combined those of *Werkmeister*, a post similar to a bursar's. In the same year he married Anna Tunder, the daughter of his predecessor, Franz Tunder. It is not known that Buxtehude journeyed outside Lübeck, though visits by organists to one another were common at this time. In 1703 he was himself visited by Handel, who hoped to succeed him, but marriage with one of Buxtehude's five daughters was a condition; in 1705 Bach also found this condition unacceptable. Buxtehude died at Lübeck on May 9, 1707, and was buried in St. Mary's on May 16.

The duties of the St. Mary's organist included, as well as writing the usual incidental service music, composition for public festivals and for marriages and funerals of the great merchant families of Lübeck. Buxtehude left a considerable amount of vocal and instrumental music, much of which was not recovered until the 20th century; much more certainly remains lost.

Buxtehude's instrumental music is simple and pleasing; it is always well constructed but rarely aims at technical virtuosities. The most important and influential part of it is that for organ, which includes toccatas, preludes and fugues, *chaconnes*, pieces based on chorales, and a *passacaglia* to which that of J. S. Bach in C minor (*Bach Werke Verzeichnis*, 582) is clearly indebted. The preludes are generally brief and, with one exception, are unlike those of Bach in having no thematic connection with the much longer fugues that follow them. The form of these fugues often consists of several sections contrasting in rhythm and tempo, rather than of a progressive contrapuntal development. Here Buxtehude may have been influenced by the somewhat similar form of Jan Sweelinck's keyboard fantasias. A few short fugues in simple counterpoint are, however, also among Buxtehude's work. The pieces based on chorales include a number of simple chorale preludes with the decorated melody placed in a high register and in counterpoint with an independent part on the pedals, and also several long works in which the chorale text is treated with such technical elaboration that the result is a kind of instrumental motet. This extended chorale treatment seems to have been confined to northern Germany; Nikolaus Bruhns, a pupil of Tunder and Buxtehude, is among the other organists who have left examples.

Little of Buxtehude's harpsichord music remains but much is known to be lost, including a suite illustrating the planets. A suite of dances, which is extant, is of special interest for Buxtehude's use of the hymn-tune *Auf meinen lieben Gott* for his theme. Among his secular music are a number of sonatas for various combinations of two or three stringed instruments with *continuo*. Fourteen of these were published in two parts at Hamburg in 1696 as the composer's Opus 1 and 2.

Most of Buxtehude's vocal music consists of church cantatas, in the history of which he is an important figure, although the influence of his vocal work was less widespread than that of his organ music. Over 100 cantatas are extant, composed in a great variety of forms, of which only the main groups will be mentioned here. All are imbued with a devout simplicity that contrasts strongly with the elaborations of their Bachian successors. It is uncertain whether they were composed for services or for "concert" performance; the latter seems more likely. It is possible that some were written for the famous *Abendmusiken*, concerts of mixed vocal and instrumental music held in St. Mary's in the late afternoons of the five Sundays before Christmas. A few programs of these, including the 1700 series, are known, but no extant work by Buxtehude is mentioned.

The cantata texts are rarely liturgical. The Bible, the hymnbook and sacred verse of the time are their main sources. Latin texts are used for about 30, which include a set of seven based on a poem by St. Bernard on the seven last words from the cross. The settings are of three main kinds: (1) Those for solo voice with continuo and with or without string ritornelli between stanzas. These cantatas have formal affinities with the secular *Arien* of such composers as Adam Krieger; (2) for choir, either unaccompanied or with organ continuo, and sometimes a group of strings to provide an overture (also known as sinfonia or sonata), instrumental comments and brief interludes during the cantata; (3) for soloists and choir, often with continuo and a group of instruments as in (2). A more extended work, on the Last Judgment, was discovered in 1927 and has been termed an oratorio; it is a succession of arias for soloists or chorus with instrumental ritornelli. These are for strings instead of the brass, which might have been sometimes expected.

See a collected edition of Buxtehude's works that was begun in 1925, Ugrino ed., vol. vii (1937). *See* also W. Stahl, *Dietrich Buxtehude* (1937). (C. P. Co.)

BUXTON, SIR THOMAS FOWELL (1786–1845), English philanthropist, chiefly remembered for his work for the campaign to abolish slavery, was born at Castle Hedingham, Essex, on April 1, 1786, and was educated at Trinity college, Dublin. In 1807 he married Hannah Gurney, sister of Elizabeth Fry. He entered the brewery of Truman, Hanbury and company in 1808, became a partner in 1811, and soon had the whole concern in his hands. In 1818 he published his able *Inquiry into Prison Discipline*. The same year he was elected M.P. for Weymouth, a borough he represented till 1837. In the house of commons Buxton worked for the abolition of slavery in British colonies, taking over the leadership of the agitation in 1822. He was not entirely satisfied, however, with the abolition act of 1833, which included some clauses to which his better judgment was opposed. Although his health was giving way, he continued his interest in social work, including prison conditions on the continent. He was made a baronet in 1840, and devoted himself to a plan for ameliorating the condition of African Negroes. The failure of the Niger expedition of 1841 was a blow from which he never recovered. He died at his home in Norfolk on Feb. 19, 1845.

Buxton's *Memoirs* (1848), with selections from his correspondence, were edited by his third son, Charles Buxton (1823–71), a member of parliament who consistently advocated humane and liberal policies, especially for the colonies. (A. Bri.)

BUXTON, a municipal borough, holiday resort and spa in Derbyshire, Eng., 38 mi. N.W. of Derby by road, is situated in the centre of the Peak District (*q.v.*) National park. Pop. (1961) 19,155. Area 9.9 sq.mi. Standing between 1,000 ft. and 1,100 ft. above sea level, Buxton is the highest market town in England. Situated in a basin protected by hills of grit and limestone rising to 1,810 ft. at Axe Edge, it lies on the river Wye (a tributary of the Derwent), which in the Pavilion gardens disappears underground from a waterfall. The mineral waters of Buxton, which are tasteless and odourless, have long enjoyed a great reputation and were known and used by the Romans, who called the place Aquae Arnemetiae and whose roads connected it with Derby, Edale and Manchester. After the departure of the Romans the baths seem to have been long neglected, but were rebuilt and again frequented in the 16th century. Later the church of St. Anne (1625) acquired fame for the cures effected. At the close of the 18th century the duke of Devonshire, lord of the manor, spent large sums of money on improvements in the town. The Crescent was built during 1780–86 in the Doric style by John Carr, and in its Pump room the drinking of the mineral waters is still practised, although the chalybeate spring is no longer used. The thermal mineral water rises from the springs at a temperature of 82° F. and is much used at the municipal physical treatment centre, where it is superheated for the treatment of rheumatic diseases and nonrheumatic complaints affecting muscles, joints and nerves. There are numerous public and private baths, open the year round, some of which have a sustained tonic effect; treatment is also given at the Devonshire Royal hospital.

Buxton has a repertory theatre, and drama, music and cricket festivals are held annually. The public museum contains archaeological and natural history collections. A traditional annual event is the Wells Dressing festival which also takes place in the surrounding villages.

Buxton has a few light industries, including the making of brake linings, and limestone is quarried nearby. In the neighbourhood are Poole's cavern, a dripstone cave; Diamond hill, so called from the quartz crystals in its rocks; and Chee tor, a 300-ft. cliff on the bank of the Wye. Arbor Low, 9½ mi. S.E., is a "henge," a stone circle of the Bronze Age. (D. B. A.)

BUYER. As commonly used in the business world, a buyer is the authorized purchasing agent for some other individual or for a business firm. On the stock exchange, a buyer or broker is an individual or a firm legally invested with the power to buy stocks and bonds upon orders from purchasers. Large department stores, composed of a great number of departments, have a buyer at the head of each department. These buyers, whether men or women, are employed by the store owner to buy on the market, for the store's account such articles as are required to keep their departments running and meet the anticipated demands of customers. It is the duty of each buyer to select the best quality goods at the lowest possible price, and to undersell corresponding departments in other stores whenever possible.

In commercial and manufacturing establishments, an important procurement and buying function is undertaken by the purchasing agent who is responsible for buying the raw materials and supplies needed for the firm's operations. He is sometimes referred to as the "buyer." To perform his duties effectively a buyer or purchasing agent must become familiar with all possible sources of goods and materials as well as with their characteristics. He endeavours to supply goods of the desired quality when needed, at favourable costs, and to maintain a minimum inventory. (O. R. G.)

BUYIDS, a Persian dynasty (945–1055 A.D.) whose homeland was Dailam in the Elburz uplands in northern Iran. Their eponym was Abu Shuja' Buya, who had three sons, Ali, Hasan and Ahmad. Ali, having been appointed governor of Karaj about 930 by the Dailamite leader Mardawij ibn Ziyar, seized Isfahan while Hasan and Ahmad took Fars and Kerman during 935–936. In Dec. 945 Ahmad entered Baghdad, the caliph's capital. After obtaining the title of Amir al-Umara and Mu'izz al-Dawla for himself, and those of 'Imad al-Dawla and Rukn al-Dawla for Ali and Hasan respectively, Ahmad deposed the caliph al-Mustakfi in Jan. 946 substituting al-Muti'. Henceforth until 1055 the Buyids controlled the Abbasid caliphs. On Ali's death (in 949 or 950) Rukn al-Dawla became head of the family, his son, Adud al-Dawla ruling Fars, but the family co-operation broke down after Mu'izz al-Dawla's death in 967. By 977 Adud al-Dawla ruled over Fars, Iraq and Kerman. He was the dynasty's most enlightened prince, celebrated for his public works including the amir's dam (Bendameer) still standing near Shiraz. After his death in 982 the ebb of the dynasty's power was expedited by fractious Turk and Dailamite subordinates until only Baghdad remained under their control. The last Buyid ruler, al-Malik abu Mansur, was deposed by Togrul Beg the Seljuk, in 1055. The significance of the Buyids is that they provided, between the Arab invasion and that of Sunnite Turks, a purely Persian and Shi'ite entr'acte in Iran's history. In their time popular and passionate observance of certain Shi'ite festivals, still maintained, was inaugurated, and visits to the Shi'ite holy places, Najaf and Karbala, in Iraq assumed significance.

See V. Minorsky, *La Domination des Dailamites* (1932); article "Buwayhids or Buyids" in *Encyclopaedia of Islam,* 2nd ed. (1960). (P. W. A.)

BUYS, PAULUS (1531–1594), Netherlands patriot, the leading statesman of the province of Holland from 1572 to 1585, was born at Amersfoort in the province of Utrecht. He became pensionary of Leiden in 1561 and advocate of the province of Holland in 1572. In close touch with the exiled prince of Orange, William the Silent, he prepared, together with others, the rising of the greater part of the province in 1572 (*see* NETHERLANDS, THE), and particularly the adhesion of Leiden to the cause of the rebels. In 1573 he became a member of the council of nine which assisted William, but his efforts to make him count of Holland and Zeeland were cut short by the murder of the prince (1584). After this he resigned his office (1585), partly in protest against the temporarily prevailing policy of seeking help from France, and retired to his native province of Utrecht. Having always advocated an English alliance, he was one of the negotiators of the treaty of Westminster with Elizabeth I (Aug. 20, 1585). A member of the council of state under the governorship of the earl of Leicester, he soon came into conflict with the earl, mainly because of the latter's favouring the democratic Calvinists and alienating the liberal urban aristocracies. With the connivance of Leicester he was arrested by the Utrecht democrats in July 1586, and held prisoner for six months. He died at IJsselstein on May 4, 1594.

See W. van Everdingen, *Het leven van Mr. Paulus Buys* (1895); L. J. Rogier, *Paulus Buys en Leicester* (1948). (A. G. J.)

BUYS BALLOT'S LAW, in meteorology, takes its name from Dutch meteorologist C. H. D. Buys Ballot who first stated the law in 1857. The law states that in the northern hemisphere a person standing with his back to the wind has high pressure on his right and low on his left; in the southern hemisphere, the low pressure area would be on the right. Strictly speaking the law states that the angle between the wind and the pressure gradient is a right angle. This is almost exactly true in the free atmosphere though not at the surface, where the angle is usually less than 90°. The law is not applicable in equatorial regions. (*See* WIND: *General Winds.*)

CHRISTOPH HENDRIK DIDERICUS BUYS BALLOT (1817–1890) was born at Kloetinge, Zeeland, Neth., on Oct. 10, 1817. He was director of the Royal Netherlands Meteorological institute from 1854 until his death. He derived the law empirically, unaware that it had already been deduced on theoretical grounds some months earlier by the U.S. meteorologist William Ferrel, whose priority he later acknowledged. He died on Feb. 3, 1890. (WR. BR.)

BUZĂU, a town of Rumania, situated on the Buzău river 97 km. (60 mi.) N.E. of Bucharest, is the administrative centre of a district of the same name in the Ploești region. Pop. (196 est.) 54,165. Lying between the Carpathian mountains and the fertile lowlands of southeastern Rumania, it is important as a railroad junction and as a market for petroleum, timber and grain. Industries include woodworking, textile, alcohol and building materials manufactures and wineries.

Archaeological excavations in the vicinity revealed vestiges of Thracian and Gothic settlements. The first historic mention of the town is a reference to the Buzău fair in a document of 1431. In the town are the ruins of the cathedral, built in the 15th century and renovated by the Walachian ruler Matei Basarab in 1640.

BUZZARD, the name applied in England to large hawklike birds of the genus *Buteo* and in North America to various new world vultures (family Cathartidae), especially the turkey vulture (*Cathartes aura*) (*see* VULTURE). In North America *Buteo* species are called buteos, "buzzard hawks" or simply hawks.

CY LA TOUR

RED-TAILED HAWK (BUTEO JAMAICENSIS), A NORTH AMERICAN BUZZARD HAWK OR BUTEO

True buzzards, or buteos, occupy a subfamily (Buteoninae) of the family Accipitridae. When in flight they can usually be distinguished from other birds of prey by their broad wings and expansive, rounded tails. When hunting they customarily soar gracefully for hours but in direct flight the wingbeats are slow and heavy. The plumage of most species is essentially dark brown above and white or mottled with brown below. The tail and underside of the wings usually are barred. However, there is much variability of pigmentation, and a melanistic colour phase commonly occurs. Buzzards customarily prey on small mammals and beetles and only occasionally attack birds. Carrion is also eaten. The nest is a large, substantial structure of sticks lined with softer materials and usually is placed in a tree or on a cliff. The whitish eggs (two to five) are blotched or spotted with brown.

The best-known species, the common buzzard (*B. buteo*), is found from Scandinavia south to islands of the Mediterranean. The rough-legged buzzard (*B. lagopus*), so named because of its feathered tarsus, breeds at high latitudes in both hemispheres and winters south to the Adriatic sea and southern parts of the United States. Other species range over much of Eurasia and north Africa. (E. R. BE.)

BYBLIS, a heroine of Greek mythology who fell in love with her brother Caunus. He fled when she disclosed her passion, and she, wandering after him, was transformed into a weeping ountain named for her. This myth, originally connected with Aphrodite worship in Asia Minor, became a popular romantic tale with the Hellenistic writers and with Ovid. (H. W. PA.)

BYBLIS, a genus of carnivorous plants belonging to the family Byblidaceae. There are two species inhabiting western and northwestern Australia. They grow in somewhat drier localities than other carnivorous plants found in the same general environment. *Byblis* is a low perennial, herbaceous except at the somewhat woody base, and produces long, slender, linear leaves armed with sessile glands, which have a digestive function, and numerous stalked glands, which secrete mucilage. This entraps small insects. The whole operation of catching and digesting prey appears to be similar o that in *Drosophyllum* (*q.v.*), from which *Byblis* differs in having mucilage and digestive glands of much simpler structure. *See* also CARNIVOROUS PLANTS. (F. E. L.)

BYBLOS (mod. JUBAYL or JEBEIL; biblical GEBAL), an ncient seaport on the coast of Lebanon and possibly the oldest ontinuously inhabited town in the world with monuments pertaining to Amorite, Hyksos, Phoenician, Greco-Roman and medieval periods. Its biblical name is sustained in the small Lebanese own on the site which lies 17 mi. N. of Beirut and south of Tarabulus esh-Sham (Tripoli). Because of its significance as the chief arbour for the export of cedar and other valuable wood to Egypt, early became a great centre of trade, called Kubna in ancient Egyptian and Gubla in cuneiform inscriptions. The Greek name Byblos goes back at least to Mycenaean times, and papyrus received its early Greek name (*byblos, byblinos*) from the fact that it was exported to the Aegean through Byblos. Hence the word "Bible" is derived from Byblos as "the (papyrus) book."

Systematic excavations were begun there by Pierre Montet in 1921, 60 years after the first scratching by Ernest Renan (*q.v.*). In 1926 Maurice Dunand resumed the work and continued it for many years with great success. One totally unexpected result of the excavations was to show that the Byblos of the Late Bronze and Iron ages must have been submerged in the Mediterranean by some historically unrecorded earthquake.

Byblos was occupied as early as the Neolithic Age, and during the 4th millennium there were two successive Chalcolithic settlements, the second of which was already very extensive. A flourishing city stood there through the entire Bronze Age. Egyptian monuments found on the site, including many inscriptions, attest close relations with the Nile valley during every dynasty from the 1st to the 6th.

Egyptian mentions of Byblos, its cedar trade and shipping, begin in the available hieroglyphic sources at the outset of the 4th dynasty and continue into the 6th, toward the end of which the city was destroyed by an unknown invader. In the 21st century B.C. a native prince, Abishemu, left a small obelisk with an Egyptian inscription of historical interest. During the 12th dynasty Byblos again became an Egyptian dependency, and the chief goddess of the city, Baalat ("the Lady"), was admitted into the Egyptian pantheon. In the Amarna Age the prince of Byblos, Rib-Adda, declared that his city was just as Egyptian as Memphis; the cuneiform letters which he wrote to Egypt are several times as numerous as those from any other Syro-Palestinian vassal. After the collapse of the New Egyptian empire in the 12th century B.C. Byblos became the foremost city-state of Phoenicia, as is known from the report of Wen-amun, an Egyptian envoy to the Byblian prince Zakar-Baal.

Byblos has yielded nearly all known early Phoenician inscriptions, chiefly from the 10th century B.C.; the earliest datable text is on the famous sarcophagus of Ahiram (discovered by Montet in 1922). By that time, however, the Sidonian kingdom, with its capital at Tyre, had become dominant in Phoenicia and Byblos never recovered its relative importance though it flourished into Roman times.

The crusaders captured the town in 1103 and called it Gibelet, but lost it to Saladin in 1189. The imposing citadel, still standing, is essentially a crusader work. *See* also PHOENICIA.

See P. Montet, *Byblos et l'Égypte* (1928); M. Dunand, *Fouilles de Byblos*, vol. i–iii (1937 *et seq.*), *Byblia Grammata* (1945).
(W. F. A.)

BYDGOSZCZ (Ger. BROMBERG), a town in northern Poland, capital of Bydgoszcz *wojewodztwo* (province). Pop. (1960) 232,007.

Bydgoszcz lies on the border of agricultural Kujavia (Kujawy) and wooded Pomerania (Pomorze). It is a junction of water and rail communications on the Brda river (a tributary of the Vistula) and on the Bydgoszcz canal (25 km. or 15½ mi. long) which links the Vistula basin with that of the Oder. After the building of this canal in the 18th century, Bydgoszcz developed more rapidly than any other town in the *wojewodztwo*. The importance of the canal increased after World War II, when the mouth of the Oder became Polish territory. By the early 1960s Bydgoszcz was the most important inland port in Poland. It was also a railway junction for lines including the Prague-Baltic line and the line linking Upper Silesia with the Baltic coast. Bydgoszcz was the most important industrial centre of the province and has chemical, metallurgical (machinery), timber (sawmills, furniture), printing, tanning and clothing factories. It has two theatres and a concert hall.

Referred to in historical documents as a 13th-century frontier castle between Kujavia and Pomerania, Bydgoszcz suffered greatly during the wars with the Teutonic knights. It obtained town rights in 1346. Transferred to Prussia after the first partition of Poland in 1772, it was returned to Poland by the treaty of Versailles.

BYDGOSZCZ *wojewodztwo*, a province in northern Poland, was formerly part of historic Pomorze (*q.v.*). Pop. (1960) 1,706,200; area 20,798 sq.km. (8,030 sq.mi.). Moraine elevations, with numerous lakes, form the circumference of the region, while the central sector is the broad Torun-Gorzow valley used by the Vistula, Notec and Brda rivers. Old geological formations (Paleozoic and Mesozoic) form an anticlinal embankment lying in a southeast-northwest direction, where Poland's richest deposits of salt, clay and lime occur. These minerals were used in development of the chemical industry and the spas of Ciechocinek with its radioactive saline springs, and Inowroclaw. The high standard of cultivation in the district gives high yields per acre, although the soils are poor except for the marshy black earth regions in Kujavia and the Vistula region.

See M. Kiełczewska-Zaleska, *Województwo bydgoskie* (1952); Instytut Bałtycki, *Pamiętniki*, vol. xliii (1948); W. Winid, *Kanał bydgoski* (1928). (K. M. Wi.)

BYELORUSSIA: *see* BELORUSSIAN SOVIET SOCIALIST REPUBLIC.

BYLAW, a regulation made by a subordinate authority, such as a public or private corporation, association or society, for the government of its internal affairs or its dealings with others. In the United States the term is usually restricted to rules made by a private corporation for the regulation of internal matters. The power to make such rules is vested in the shareholders but may be delegated to the directors either by statute or charter. Bylaws commonly deal with such matters as the calling of shareholders' and directors' meetings or the qualifications and duties of officers. Bylaws are not enforceable if they conflict with the charter, statutes or public policy. Thus a bylaw cannot unduly restrict the right of shareholders to inspect the books of the corporation. Directors and officers are bound by the bylaws and hold office subject to their provisions. In contradistinction to British usage, the term bylaw does not include municipal ordinances. (*See* also CORPORATION: *Corporation Law.*) (X.)

England.—In England, bylaw designates either (1) a regulation made by a common-law corporation, one of whose legal privileges is the power to make regulations for the government of its members, or (2) a regulation made by a statutory corporation which, unlike the former, has no power to make such regulations unless it is expressly conferred upon it. Thus a municipal corporation, which is always a common-law corporation created by charter, has an inherent power to make such bylaws, while a statutory corporation, a term which includes other local authorities and statutory undertakers, always has its power defined by statute. In practice, however, the common-law power of municipal corporations to make bylaws is rarely used, and borough councils rely on specific authority to make bylaws conferred by various general acts relating to local government, public health, etc.

The procedure relating to the making and confirmation of bylaws by local authorities outside London was reviewed by the Local Government and Public Health Consolidation committee in 1933, and on their recommendation a single code of procedure was enacted by the Local Government act, 1933, in substitution for earlier provisions which differed in various ways. A similar code was enacted in respect of the metropolitan authorities in the London Government act, 1939. Bylaws made under these codes do not have effect until they are confirmed by the minister of the crown specified in the statute conferring the power of making bylaws. Before application for confirmation is made, public notices must be given and copies of the bylaws made available for public inspection. Copies may also be purchased by members of the public.

The minister may confirm or refuse to confirm any bylaws submitted to him and may fix the date on which they are to come into operation. Confirmed bylaws must be kept available for inspection by the public, and copies may be purchased on application to the local authority. Bylaws may be made for limited periods, and some acts (*e.g.*, the Public Health act, 1936, as regards building bylaws) empower the minister to require a local authority to make bylaws satisfactory to him and, in their default, to make bylaws himself on their behalf. The bylaws of statutory undertakers usually require the approval of a government department; *e.g.*, railway bylaws are subject to disallowance by the minister of transport and civil aviation.

There is an important difference between statutory instruments and bylaws, in that the latter may be quashed by the courts, even when they are otherwise legitimate, on the mere ground that they are "unreasonable" (*i.e.*, oppressive or repugnant to the common law or statute) or that they are uncertain in their terms. The courts have, however, laid down an important principle that in the exercise of their power to declare a bylaw "unreasonable" they will extend more latitude to the interpretation of bylaws made by local authorities than to that of bylaws made by "profit-making companies," which "the courts must scrutinize jealously" (see *Kruse* v. *Johnson*, 1898, 2 Q.B. 91, the leading case on the subject).

It is a rule of law that when the power to make bylaws exists, whether at common law or by statute, there is also the power to enforce the bylaw by pecuniary penalties (see *Hall* v. *Nixon*, 1875, L.R. 10 Q.B. 159). It is usual, however, for any statute giving power to make bylaws to prescribe maximum penalties on summary proceedings, special penalties being frequently provided for offenses which continue after conviction or after a reasonable time allowed by the magistrates' court. It was suggested in *Salt* v. *Scott Hall*, 1903, K.B. 245, that although a bylaw may be reasonable in its general operation, the subject is protected against its oppressive enforcement by the rule that the magistrates are not bound to convict in every case of infringement of a bylaw that comes before them. The magistrates have power under s. 7 of the Criminal Justice act, 1948, if they think the circumstances warrant it, to grant the defendant an absolute or a conditional discharge.

In addition to the summary prosecution of offenses, where a breach of a bylaw also constitutes an infringement of public rights or public interests, an injunction may be granted at the suit of the attorney general.

A local authority has no power to relax or waive the requirements of its bylaws unless such power is expressly conferred by the bylaws themselves or by statute; *e.g.*, s. 63 of the Public Health act, 1936, which enables a local authority with the consent of the minister of housing and local government to dispense with compliance with building bylaws in a case where their strict application would be unreasonable.

The Interpretation act of 1889 provides that a statutory power to make bylaws includes a power to rescind, revoke, amend and vary them, a fact which, as the court observed in *Kruse* v. *Johnson*, means that a local authority can always, under the pressure of the public opinion of the locality, be compelled to alter them if they are unpopular or unnecessary. (E. J. O. G.)

BYNG, JOHN (1704–1757), British admiral, who was executed in 1757 for failing to do his utmost to relieve Minorca from attack by the French the previous year, was the son of George Byng, Viscount Torrington, himself a distinguished admiral who destroyed the Spanish fleet off Cape Passaro in 1718. His son entered the navy that year, becoming a rear admiral in 1745. In 1755, on the eve of the Seven Years' War, it was feared that the British Mediterranean base at Minorca would be attacked. Byng was sent out to save the island, but by the time he arrived (May 1756) a force under the duc de Richelieu had landed and was besieging Ft. St. Philip. Byng engaged the French fleet, under the marquis de La Galissonière, which covered this operation, but faulty tactics allowed the French to break off the action with little damage. At a council of war held afterward, Byng decided that his force was insufficient to renew the attack or relieve the castle. He therefore returned to Gibraltar, leaving Minorca to its fate. This failure aroused a storm of anger in England. The government under the duke of Newcastle tried to escape blame by having Byng arrested and court-martialed on board his own flagship at Portsmouth. He was acquitted of charges of disaffection and cowardice, but was found technically guilty of neglect of duty in battle. Under the recently revised Articles of War the members of the court had no alternative but to condemn him to death, although they never expected their sentence, which was accompanied by a strong recommendation for mercy, to be carried out. But the mob clamoured for a scapegoat and most of the ministers were determined to save themselves by sacrificing Byng. He was therefore shot on board the "Monarque" in Portsmouth harbour on March 14, 1757. Shortly before his death he said: "They make a precedent of me such as admirals hereafter may feel the effects of"—a remark which is echoed in that of Voltaire in *Candide* that in England it was found necessary from time to time to shoot an admiral "pour encourager les autres."

See W. C. B. Tunstall, *Admiral Byng* (1928). (C. C. L.)

BYNG, JULIAN HEDWORTH GEORGE BYNG, 1st Viscount (1862–1935), British field marshal, who was a distinguished commander during World War I and later became governor general of Canada, was born at Wrotham Park, Barnet, on Sept. 11, 1862, the son of the 2nd earl of Strafford. He joined the 10th Hussars in 1883, served in the Sudan expedition (1884) and the South African War (1899–1902), and in 1912 took command of the British troops in Egypt. During World War I he commanded, successively, the 3rd cavalry division in France (1914), the cavalry corps (1915), and the IX corps at Gallipoli. As commander of the Canadian corps in France (from May 1916), he was responsible for the capture of Vimy ridge in April 1917, and as commander of the 3rd army (from June 1917) he carried out the surprise tank attack on Cambrai in Nov. 1917. Although very popular as governor general of Canada (1921–26), his refusal to allow the Liberal government a dissolution in 1926 led to a constitutional crisis (*see* Canada: *History*). As commissioner of police in London (1928–31) he carried out a number of reforms. Byng, who had been made a baron in 1919 and a viscount in 1926, was, despite his retirement, given his field marshal's baton in 1932. He died in Essex on June 6, 1935. (R. G. Th.)

BYNKERSHOEK, CORNELIS VAN (1673–1743), Dutch jurist, was born at Middelburg, Zeeland. He studied law at Franeker, Friesland, and was called to the bar at The Hague. In 1703 he was appointed a member of the supreme court of Holland and Zeeland, of which he became president in 1724. In that position he enjoyed great prestige, but his judicial career did not prevent him from publishing a large and varied number of works of legal scholarship.

His writings on Roman and Dutch municipal law are important, but his fame rests chiefly on what he did for the development of international law on positive lines. To a greater extent than any of his predecessors in this field he took actual usage, as appearing from ordinances issued by the States-General or other governments and from treaties concluded between Christian states as the basis of his studies. On questions like the sovereignty of the seas, the legal position of ambassadors, private property in war time, prizes, neutrality, contraband, blockade, his opinions have always been regarded as carrying great weight and have exercised considerable influence.

Bibliography.—Bynkershoek's principal works in the domain of international law are *De dominio maris* (1702), *De foro legatorum* (1721), *Quaestiones juris publici* (1737). Complete editions of his works were published after his death, one at Geneva in 1761, and another at Leiden in 1766. *See* O. W. S. Numan, *Cornelis van Bynkershoek* (1869); J. Delpech, in *Les fondateurs du droit international* (1904); Coleman Philipson, in *Journal of the Society of Comparative Legislation* (1908).

BYRD, RICHARD EVELYN (1888–1957), celebrated pioneer aviator and navigator and foremost antarctic explorer of the second quarter of the 20th century, made important contributions to transatlantic flying and was first to command and navigate flights over the earth's north and south poles. He was born Oct. 25, 1888, at Winchester, Va., the brother of the U.S. senator Harry F. Byrd. When he was 12 years old Richard Byrd made an unescorted trip around the world. He attended Shenandoah Valley Military academy, Virginia Military institute and the University of Virginia before entering the U.S. Naval academy, where he graduated in 1912. After three years of active service, he was retired because of leg injuries which he had sustained while participating in sports at the naval academy. Shortly thereafter he was readmitted into naval aviation, however. Byrd received pilot training but soon gravitated to administrative positions. He received the rank of commander in 1926 after his north pole flight and of rear admiral in 1930 after his south pole flight. He was instrumental in the development of naval aviation reserves, the bureau of aeronautics and numerous congressional bills benefiting naval personnel and interests. During World War II he served on the staff of the chief of naval operations and, among other duties, evaluated Pacific islands as operational sites. His talent for organization and administration and his influence and skill in public relations led him to serve in many important government, patriotic and humanitarian capacities.

At the close of World War I Byrd developed plans and navigational aids for the first NC flying boat transatlantic flights but was deprived of a place in the principal aircraft. He also assisted with dirigibles built for transatlantic crossings. He later aided Charles A. Lindbergh with navigational training and the use of his specially extended runway for his Atlantic flight. Shortly afterward, on June 29, 1927, Byrd with three companions left New York on a multiple-engine crossing of the Atlantic, with the first official mail service and a pay load of 800 lb. Fog prevented landing at Paris, and the plane was ditched off the coast of France on July 1 after 42 hours and exhaustion of the fuel supply.

Byrd's polar career began in 1924 when he had command of a small naval aviation detachment with Commander D. B. MacMillan's arctic expedition to western Greenland, based at Etah. Controversy over the success of those early U.S. flights over Greenland and Ellsmere Island led Byrd to prove his points by organizing a private expedition to get his plane, the *Josephine Ford*, to Kings Bay, Spitsbergen. On May 9, 1926, he and his pilot, Floyd Bennett, flew over the north pole.

With that success and his transatlantic flight a year later Byrd became an international hero and had little difficulty finding support for an antarctic expedition. In late Dec. 1928 he established Little America at the Bay of Whales, Antarctica, with 42 men. On Nov. 29, 1929, he and three companions flew over the south pole. He also discovered the Rockefeller and Edsel Ford mountains and the western portion of Marie Byrd Land, named by him in honour of his wife.

Five years later he returned to Little America with a 56-man wintering party, extended exploration of Marie Byrd Land and continued scientific observations. In 1934 he spent the polar winter alone in a tiny hut at Bolling advanced base, 123 mi. south of the main base. This was man's farthest south and Antarctica's first and only inland habitation for the next 21 years. Carbon monoxide fumes nearly cost him his life before his unrequested relief arrived after five months.

Byrd's three subsequent antarctic trips were in summer seasons while serving as director of U.S. government expeditions. For brief periods on each trip he continued personally to take an active part in exploration. At the request of Pres. Franklin D. Roosevelt he took command of the U.S. antarctic service, which was terminated after the first year because of the approach of World War II. Bases were located at Little America and Stonington Island, Palmer peninsula. Byrd's discovery of Thurston peninsula greatly decreased the length of unexplored coast of the continent.

After World War II he served as officer in charge of Naval Task Force 68—Operation "Highjump," a 4,000-man, multi-unit summer season effort (1946–47) to photograph the antarctic coast from the air. Byrd flew into Little America on one of the six R4D aircraft launched by jet assist from the deck of the aircraft carrier "Philippine Sea" north of the ice pack about 700 mi. from the camp. He made a second flight over the south pole and took part in several other flights. In 1955 Byrd was made officer in charge of U.S. antarctic programs, the senior authority for government antarctic matters. He accompanied Naval Operation "Deep Freeze I" aboard the newest and most powerful icebreaker "Glacier" on its maiden voyage and took his last exploratory flight over the heartland of Antarctica and once again over the south pole on Jan. 8, 1956.

Byrd died March 11, 1957 in Boston, Mass., and was given full honours at Arlington National cemetery. Short of kings and heads of state, few men in their lifetime received more honours or greater acclaim than he. His books are *Skyward* (1928), *Little America*

(1930), *Discovery* (1935), and *Alone* (1938). He also contributed a number of articles to *National Geographic* magazine.

See Charles J. V. Murphy, *Struggle, the Life of Commander Byrd* (1928); F. Green, *Dick Byrd, Air Explorer* (1928). (Pl. A. S.)

BYRD, WILLIAM (1543–1623), the greatest English composer of the age of Shakespeare, was born in 1543, possibly in Lincolnshire. Of his origins and early life virtually nothing is known. He was a pupil and protegé of Thomas Tallis (*q.v.*), and this suggests that he may have belonged to the same family as the Thomas Byrd who was, like Tallis, a member of the Chapel Royal under Edward VI and Mary Tudor. Byrd's first authenticated appointment was as organist at Lincoln cathedral (Feb. 27, 1563). In 1572 he moved to London to take up his post as a gentleman of the Chapel Royal, where he shared the duties of organist with Tallis.

The close personal and professional relationship between the two men had important musical consequences. In 1575 Elizabeth I granted them a joint monopoly for the printing, publishing and sale of music, as well as for the importing of music and the printing of music paper. The first work under their imprint appeared in that year—a collection of *Cantiones Sacrae* dedicated to the queen; of the 34 motets it contained, Tallis contributed 16 and Byrd 18.

In 1577 Byrd moved to Harlington, Middlesex, where he and his family lived for the next 15 years. As a devout and lifelong Catholic he probably preferred the greater privacy of living outside London. Yet in spite of his close social contact with many other Catholics, some of whom were certainly implicated in treasonable activities, his own loyalty to the government was never questioned.

In 1585 Tallis died, and in the following year Byrd's first wife, Juliana. These sad events may have prompted him to set his musical house in order. for in the next three years he published four collections of his own music: *Psalmes, Sonets, and songs of Sadnes and pietie* (1588), *Songs of sundrie natures* (1589) and two further books of *Cantiones Sacrae* (1589 and 1591). The two secular volumes were dedicated respectively to Sir Christopher Hatton, the lord chancellor, and to Lord Hunsdon, the lord chamberlain and first cousin to the queen. Both volumes of motets were dedicated to prominent Catholics: the earl of Worcester, a great friend and patron of Byrd's, whose loyalty to the crown was unimpeachable, and Lord Lumley, who was now again in favour after being deeply implicated in the Ridolfi plot (1571). Also in 1591 a manuscript volume of Byrd's keyboard music was prepared for "my ladye Nevell" (probably Rachel, wife of Sir Edward Nevill), while many more keyboard pieces found their way into the volume known as the Fitzwilliam virginal book, copied by another well-known Catholic, Francis Tregian, during his imprisonment in the Fleet.

In 1592 or 1593 Byrd moved with his family to a property at Stondon Massey, Essex, and despite prolonged litigation he lived there for the rest of his life. At the accession of James I the Catholics' prospects temporarily brightened, and this probably prompted Byrd's next three publications. In his collection of three Masses (n.d.) and two books of *Gradualia* (1605, 1607) he attempted to provide singlehanded a basic liturgical repertory, comprising music for the ordinary of the Mass and for the proper of all main feasts. It is significant that the dedicatees of both books of *Gradualia* were prominent Catholics ennobled within the first years of James's reign: the earl of Northampton and Lord Petre of Writtle, another close friend of Byrd's. One further publication came from Byrd, the *Psalmes, Songs and Sonnets* of 1611, containing English sacred and secular music. Byrd died on July 4, 1623.

Byrd's musical stature can hardly be overrated. He wrote extensively for every medium then available except, it seems, the lute. His virginal and organ music brought the English keyboard style to new heights and pointed the way to the achievements of John Bull and Giles Farnaby, Orlando Gibbons and Thomas Tomkins. In music for viol consort he also played an extremely important role, pioneering the development of the freely composed fantasia, which was to become the most important form for Jacobean and later composers. Although he admired Italian madrigals and as a publisher helped introduce them to England, Byrd's own secular vocal music is distinctly conservative; much of it is conceived for the old-fashioned medium of solo voice accompanied by viol consort, later abandoned by the English madrigalists, with Thomas Morley (Byrd's pupil) at their head.

Byrd's religious beliefs did not prevent him from composing a great deal of church music to English words, most of which has survived only in manuscript. Although this is of generally high quality it cannot be denied that Byrd maintained his highest consistent level in his Latin sacred music. Of this, the 1589 and 1591 sets of *Cantiones Sacrae* (mostly designed for the private edification of the Catholic circles Byrd moved in, and therefore unrestricted by liturgical considerations) have an intensity unrivaled in England and a breadth of scale unknown on the continent. Although the *Gradualia* are necessarily more concise and superficially more similar to the work of G. P. da Palestrina and T. L. de Victoria, with which Byrd was well acquainted, closer examination reveals their real individuality as well as an astonishingly consistent level of inspiration.

Bibliography.—*The Collected Works of William Byrd,* ed. by E. H. Fellowes (1937–50); and a more scholarly edition of the sacred works in vol. 2, 7 and 9 of *Tudor Church Music* (1921–). *See* also E. H. Fellowes, *William Byrd,* 2nd ed. (1948). (J. J. N.)

BYRD, WILLIAM, of Westover (1674–1744), a Virginia planter, satirist and writer of diaries which give an intimate picture of colonial life on the southern plantations, was born March 28, 1674, in the James river plantation home of his father, also William Byrd, Indian trader and slave importer. The boy went to school in England, traveled in Holland and studied law in the Middle Temple. After he was admitted to the bar in 1695, he returned to Virginia, but two years later was again in London as colonial agent. Almost all his youth was thus spent in England where he was intimate with Sir Robert Southwell, president of the Royal society, John Campbell, 2nd duke of Argyll and other members of the aristocracy and literati. He was a member of the Royal society.

In 1705, after his father died, Byrd returned to Virginia to manage a large estate. Through marriage he became allied to some of the most powerful Virginia families. He was receiver general as his father had been, and like his father was a colonel of the county militia. In 1708 he was made a king's councilor, an appointment he held for life. He spent the years 1715 to 1726 (except for a trip home in 1720–21) in England, part of the time as colonial agent. He was the spokesman of the large planters against Gov. Alexander Spotswood. Then he returned to the colony fo the last time, to lead the busy life of a planter and a member of the ruling clique. He built a great house at Westover, the estate o his father, on the James river, experimented with crops, founded the city of Richmond, collected the largest private library in the colonies (4,000 volumes), and acquired some 179,000 ac. Byrd was twice married; he was survived by four daughters and a son William Byrd III. He died at Westover, Aug. 26, 1744.

Byrd's "History of the Dividing Line," a witty, satirical account of a 1728 survey of the North Carolina-Virginia boundary for which he was appointed one of the commissioners, is a classic of colonial literature, as are accounts of similar expeditions "Journey to the Land of Eden" and "A Progress to the Mines," published in *The Westover Manuscripts* (1841). Byrd kept a less literary but very revealing diary in shorthand, three portions of which have been discovered, transcribed and published. The earliest known diaries of any length for the southern colonies, they illuminate the domestic economy of the great plantations.

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BYROM, JOHN (1692–1763), English poet and inventor of a system of shorthand, was born at Kersal Cell, near Manchester, on Feb. 29, 1692. He was educated at Trinity college, Cambridge, where he was elected fellow in 1714. He then went abroad, ostensibly to study medicine; in view of his Jacobite leanings his journey may have been political. On his return to London in 1718 he taught his own method of shorthand and was elected a fellow of the Royal society in 1724. He died in London on Sept. 26, 1763.

Byrom's first poem, "Colin and Phoebe," appeared in the *Spectator* (Oct. 1714), and his collected *Miscellaneous Poems* were published in 1773. His poems are lively and show ingenuity in the use of rhyme, which is particularly telling in his poetic epigrams. A high churchman, and a follower of William Law, many of whose prose works he paraphrased in verse, thus winning praise from John Wesley, he also wrote some forceful hymns, the most famous of which is the Christmas hymn, "Christians awake, salute the happy morn." His diary gives interesting portraits and letters of the many great men of his time whom he knew intimately. Although his system of shorthand (*The Universal English Shorthand,* 1767) was soon superseded, it marked a stage in the development of shorthand.

See Sir A. W. Ward (ed.), *The Poems of John Byrom,* Chetham society (1894–95); R. Parkinson (ed.), *The Private Journal and Literary Remains of John Byrom,* Chetham society, 4 vol. in 2 (1854–57); H. Talon (ed.), *Selections from the Journals and Papers* (1950).

BYRON, GEORGE GORDON (NOEL) BYRON, 6TH BARON (1788–1824), English poet and satirist, a colourful figure whose poetry and personality captured the imagination of Europe. His name became a symbol for the deepest romantic melancholy on the one hand and for the aspirations of political liberalism on the other. Renowned as the "gloomy egoist" (*Childe Harold*) during most of the 19th century, he is now more generally esteemed for the satiric realism of his *Don Juan* and the facetious wit of his letters.

The poet's grandfather, second son of the 4th Lord Byron, was an admiral in the British navy and his father was the handsome and profligate Capt. John Byron who first seduced and later married the marchioness of Carmarthen. On the death of his first wife (who bore him a daughter Augusta), the captain married Catherine Gordon of Gight, an only child of a proud Scottish family that traced its ancestry to James I of Scotland. Mrs. Byron, after following her husband to Paris while he squandered most of her fortune, returned to England, where her son was born with a clubfoot on Jan. 22, 1788, at 16 Holles street, Cavendish square, London. She took her child, George Gordon, to Aberdeen, where they lived in lodgings on a meagre income. Her husband died in France in 1791. The boy, who early developed an extreme sensitiveness to his lameness, attended the Aberdeen grammar school. His nurse, May Gray, helped to awaken precocious passions in him when he was only nine. This experience and a quite different one—his idealized love for his distant cousin Mary Duff at about the same period and a similar feeling for his cousin Margaret Parker—shaped his parallel and paradoxical attitudes toward women through the rest of his life.

In 1798, at the age of ten, George Gordon inherited the title and estates of his great-uncle, the "wicked" Lord Byron. His mother proudly took him to England. The boy fell in love with the ghostly halls and spacious grounds of Newstead abbey, which had been presented to the Byrons by Henry VIII, and he and his mother lived in its ruins for a while. The young Byron was tutored in Nottingham by a Mr. Rogers and his clubfoot was doctored by a quack named Lavender who tried to straighten it. John Hanson, Mrs. Byron's attorney, rescued the boy from the pernicious influence of May Gray, the tortures of Lavender and the uneven temper of his mother. Hanson took him to London, where Dr. Matthew Baillie prescribed a brace and later a special boot for his foot and then sent him to Dr. Glennie's school at Dulwich in the autumn of 1799.

In 1801 Hanson took his protégé to Harrow. Byron's first years were marked by battles with the boys and quarrels with the masters, but later his friendships with younger boys fostered a romantic attachment to the school. It is possible that these friendships gave the first impetus to his sexual ambivalence, which became more pronounced at Cambridge and in Greece. Dr. Drury, the headmaster, won his confidence and encouraged his participation in the "Speech Day" recitations that stimulated Byron's early ambition to become a parliamentary orator. Byron spent the summer of 1803 with his mother at Southwell, near Nottingham, but he soon escaped to Newstead and stayed with his tenant, Lord Grey, while he courted his distant cousin, Mary Chaworth, at nearby Annesley hall. This first adolescent love kept him from returning to Harrow in the autumn, and when Mary, already engaged, grew tired of "that lame boy," he indulged his grief by writing melancholy poetry and she became the symbol of idealized and unattainable love.

Byron took "super-excellent" rooms at Trinity college, Cambridge, in the autumn of 1805 and piled up debts at a rate that alarmed his mother. But after indulging in the conventional vices of the undergraduates, which did not much engross him, he spent his time with a few favourites and with a devoted chorister, John Edleston, for whom he developed "a violent, though *pure,* love and passion." After the first term Byron indulged in dissipations in London that put him farther in debt. He returned in the summer of 1806 to Southwell where he gathered his early poems in a volume privately printed in November with the title *Fugitive Pieces.* The following June his first published poems, *Hours of Idleness,* appeared. When he returned to Trinity for the autumn term he formed a close friendship with John Cam Hobhouse, who stirred his interest in liberal Whiggism. At the beginning of 1808 he entered into "an abyss of Sensuality" in London that threatened to undermine his health as well as his finances. A sarcastic critique of his *Hours of Idleness* in the *Edinburgh Review* caused him to revise a Popean satire he had begun and to add some lines on Francis Jeffrey, the supposed reviewer (it was actually Henry Brougham). In the autumn he regained possession of Newstead from his tenant, furnished some of the empty halls and entertained his friends there. On reaching his majority in Jan. 1809, he took his seat in the house of lords, published his satire anonymously as *English Bards and Scotch Reviewers* and then embarked with his friend Hobhouse on a grand tour.

The travelers sailed on July 2, 1809, on the Lisbon packet, crossed Spain to Seville and Cádiz and proceeded by Gilbraltar to Malta. There Byron fell in love briefly with Mrs. Spencer Smith and almost fought a duel on her account. Byron and Hobhouse next landed at Préveza in western Greece and made an inland voyage to Janina (Ioannina) and later to Tepelene in Albania to visit the cruel but mild-mannered despot Ali Pasha. On their return Byron began at Janina an autobiographical poem (*Childe Harold*) which he continued during the journey to Athens where they arrived on Christmas day. They lodged with a widow, whose daughter, Theresa Macri, Byron celebrated as "The Maid of Athens." In March 1810 he sailed with Hobhouse for Constantinople by way of Smyrna and while becalmed at the mouth of the Hellespont, Byron visited the site of Troy and swam the channel from Sestos to Abydos in imitation of Leander. After two months in Constantinople, Byron returned to Athens and Hobhouse went back to England. Byron's sojourn in Greece made a lasting impression on his mind and character. After visiting Veli Pasha at Tripolitza (Tripolis) he took lodgings in a Capuchin monastery in Athens where he formed a friendship with Nicolo Giraud, a young boy who taught him Italian and to whom he bequeathed £7,000 in his will of 1811 (later changed). He bathed in the sea, made a journey to Sounion—which inspired his "Isles of Greece"—and delighted in the sunshine and the moral tolerance of the people.

Byron arrived in London on July 14, 1811, and his mother died on Aug. 1 before he could reach her at Newstead. He was further shocked to learn that John Edleston, the beloved choir boy, had died in his absence. He poured out his grief in a number of poems to Thyrza. During the autumn he met Thomas Moore and Samuel Rogers who brought him into the Holland house circle. On Feb. 27, 1812, he made his first speech in the house of lords on the frame-breaking bill, going beyond even the radical Whigs in his humanitarian plea for the Nottingham weavers. At the beginning of March *Childe Harold's Pilgrimage* was published by John Murray and took the town by storm. Byron was lionized in Whig society. The handsome poet with the clubfoot, curly auburn hair, pale face and pouting lips, who had bared his soul in the melancholy verses of *Childe Harold,* was swept into a liaison with the passionate and eccentric Lady Caroline Lamb, daughter-in-law of Lord and Lady Melbourne. Although her open defiance of conventions shocked him and he was ultimately repelled by her reckless indiscretions, the scandal of an elopement was barely prevented by Hobhouse. Byron took consolation in the "autumnal charms" of Lady Oxford who encouraged his political radicalism.

During the summer of 1813 Byron apparently entered into intimate relations with his half sister Augusta Leigh. His confidante, Lady Melbourne, encouraged his flirtation with Lady Frances Webster as a diversion from this dangerous liaison. The agitations of these two love affairs and the sense of mingled guilt and exultation they aroused in his mind are reflected in the Oriental tales he wrote during the year, *The Giaour* and *The Bride of Abydos.* He "spared" Lady Frances while "Platonism" still prevailed, but it was not so easy to break with Augusta. The affair went on through the winter and summer of 1814, while his emotions found vent in the gloomy and remorseful Oriental tales, *The Corsair* (which sold 10,000 copies on the day of publication) and *Lara.*

Seeking escape in marriage, in September he proposed to and was accepted by Lady Melbourne's niece, Anne Isabella (Annabella) Milbanke, only child of Sir Ralph and Lady Judith (née Noel) Milbanke. She had met Byron at Melbourne house in 1812 and had intrigued him by her innocence and her serious conversation. He had proposed to her through Lady Melbourne when he was trying to extricate himself from the affair with Caroline Lamb. She refused but later renewed the correspondence that led to the second proposal. The marriage took place at Seaham, the home of the Milbankes near Durham, on Jan. 2, 1815. After a honeymoon "not all sunshine," the Byrons settled in a large house at 13, Piccadilly terrace, London, in March. Delays in negotiations to sell Newstead left them financially embarrassed and before long bailiffs were in the house. Byron escaped to Murray's parlor where he met Walter Scott, and to the Theatre Royal in Drury lane, where he had become one of the subcommittee of management with his friend Douglas Kinnaird. Augusta had come for a visit to Piccadilly terrace and Byron, exasperated by debts, irritated by Annabella's humourless sensitivity and liberated by drink, talked wildly and hinted at past sins.

Lady Byron gave birth to a daughter, Augusta Ada, on Dec. 10, and on Jan. 15 she left with the child for a visit to her parents. Two weeks later Byron received word from her father that she would not return to him. The reasons for her decision were never given and rumours began to fly, most of them centring on Byron's relations with Augusta. When the rumours grew, Byron signed the legal separation papers, parted fondly from Augusta and went abroad, never returning to England.

After visiting the field of Waterloo, which inspired some stanzas of a new canto of *Childe Harold,* he followed the Rhine into Switzerland. At the Villa Diodati near Geneva he was closely associated with Shelley and his entourage which included William Godwin's daughter Mary, and Godwin's step-daughter by a second marriage, Claire Clairmont, who had insinuated herself into a liaison with Byron before he left England. A boat trip to the head of the lake with Shelley gave Byron material for his "Prisoner of Chillon." He completed the third canto of *Childe Harold* at Diodati (published Nov. 18, 1816). Madame de Staël, whom he visited at Coppet, tried to effect a reconciliation between him and his wife, but was rebuffed by Lady Byron. At the end of the summer the Shelley party left for England, Claire carrying Byron's illegitimate daughter (born Jan. 12, 1817, and named Allegra by Byron). A tour of the Bernese Oberland with Hobhouse provided the scenery for *Manfred* (published June 16, 1817), the Faustian poetic drama which reflected Byron's brooding sense of guilt and remorse and the wider frustrations of the romantic spirit doomed by the reflection that man is "half dust, half deity, alike unfit to sink or soar."

On Oct. 5 Byron and Hobhouse left Diodati for Italy. After a stop in Milan they arrived in Venice on Nov. 10. Byron was not disappointed in the seagirt city, which had always been, he wrote, "(next to the East) the greenest island of my imagination." He took lodgings in the Frezzeria in the house of a draper with whose dark-eyed wife, Marianna Segati, he proceeded to fall in love. He studied Armenian at the monastery of S. Lazzaro and occasionally attended the *conversazioni* of the Countess Albrizzi, "the de Stäel of Venice." In May he joined Hobhouse in Rome and rode over the ruins gathering impressions which he recorded in a fourth canto of *Childe Harold* (published April 28, 1818). At a summer villa at La Mira on the Brenta he also wrote *Beppo,* a rollicking satire on Italian manners. There he met Margarita Cogni, wife of a baker, who followed him to Venice and eventually replaced Marianna Segati in his affections. When he leased the Palazzo Mocenigo on the Grand canal in May 1818, she became his housekeeper. His descriptions of the vagaries of this "gentle tigress" are among the most entertaining passages in his letters from Italy. During the summer he completed the first canto of *Don Juan* (cantos i and ii published July 15, 1819), a picaresque verse satire in the manner of *Beppo,* with more pointed references to his own experiences. Claire had sent his illegitimate daughter Allegra for him to raise and was continually annoying him with admonitions. The sale of Newstead abbey to his school friend Thomas Wildman in the autumn for £94,500 finally cleared most of his debts, which had risen to £34,000, and left him with an income of £3,300. And since he had come abroad his yearly earnings from writing had averaged more than £2,000.

Shelley and other visitors in 1818 had found Byron grown fat, with hair long and turning gray, looking older than his years, and sunk in sexual promiscuity. A chance meeting with the Countess Teresa Guiccioli in April 1819 changed the course of his life. In a few days he fell completely in love with Teresa, who was only 20 and married to a wealthy and eccentric man nearly three times her age. Byron followed her to Ravenna and later in the summer she accompanied him back to Venice and stayed at his villa at La Mira until her husband called for her. In October Byron presented Thomas Moore, who came for a visit, with the manuscript of his memoirs, which Moore sold to Murray for 2,000 guineas but which was burned at the insistence of Hobhouse and Murray after Byron's death. Byron returned to Ravenna in Jan. 1820 as the accepted *cavalier servente* of Teresa. He won the friendship of her father and brother, the Counts Ruggero and Pietro Gamba, who initiated him into the secret revoluntionary society of the *Carbonari.* In Ravenna he was brought into closer touch with the life of the Italian people than he had ever been in Venice. He gave arms to the Carbonari and alms to the poor. It was one of the happiest and most productive periods of his life. He wrote there *The Prophecy of Dante;* cantos iii, iv, and v of *Don Juan;* the poetic dramas *Marino Faliero, Sardanapalus, The Two Foscari* and *Cain* (all published in 1821); and his satire on Southey, *The Vision of Judgment.* When Teresa's father and brother were exiled for their part in an abortive uprising and she, now separated from her husband, was forced to follow them, Byron reluctantly removed to Pisa where Shelley had rented the Casa Lanfranchi on the Lung Arno for him. He arrived on Nov. 1, 1821, having left his daughter Allegra in the convent at Bagnacavallo near Ravenna where, despite the protests of Claire, he had sent her to be educated.

Byron paid daily visits to Teresa, whose father and brother had found temporary asylum in Pisa. Suspected and watched by government spies as a dangerous revolutionary, he made no friends among the natives. His associates included a circle gathered around Shelley: Edward Williams, Thomas Medwin, John Taaffe, Edward John Trelawny and Capt. Daniel Roberts. Byron commissioned Roberts to have a boat, the "Bolivar," built for him. The death of his mother-in-law, Lady Noel, in Jan. 1822 gave him an additional income of £3,000. By the terms of the will he henceforth took the name of Noel Byron. The comfortable routine into which he had settled was broken in March by an unfortunate affray ending with the stabbing of a dragoon by one of Byron's servants. Close upon this came word of the death of Allegra in the convent on April 20. Shelley had rented a house on the Bay of Lerici and Byron leased the Villa Dupuy near Leghorn for the summer, taking Teresa and the Gambas with him.

There Leigh Hunt found him on July 1 when he arrived from England to join with Shelley and Byron in the editing of a new periodical. Shelley came from Lerici to help install Hunt and his family in the lower floor of Byron's Casa Lanfranchi. At the same time the Gambas were expelled from Tuscany, and Byron returned with Teresa to Pisa. The drowning of Shelley on July 8 left Hunt entirely dependent on Byron who had already "loaned" him £250 for his passage and furnished an apartment for him and his family. Byron found Hunt an agreeable companion but their relations were somewhat strained by Mrs. Hunt's moral condescension and by the depredations of her six uninhibited children. Byron contributed his *Vision of Judgment* to the first number of the new periodical, *The Liberal*, which was published in London by Hunt's brother John (Oct. 15, 1822). Byron was writing new cantos of *Don Juan*. At the end of September he moved his entire household to Albaro, a suburb of Genoa, where the Gambas had found asylum and had taken a large house, the Casa Saluzzo, for him. Mary Shelley had leased another house nearby for herself and the Hunts.

Byron's interest in the periodical had waned, but he continued to support Hunt and to give manuscripts to *The Liberal*. After a quarrel with Murray, Byron gave all his later work, including cantos vi to xvi of *Don Juan*, *The Age of Bronze* and *The Island*, to John Hunt. Restive in the domesticity of his life with the countess Guiccioli and longing for the opportunity for some noble action that would vindicate and redeem him in the eyes of his countrymen, Byron seized eagerly the offer from the London Greek committee, which came in April 1823, to act as its agent in aiding the Greeks in their war for independence from the Turks. He prepared to take supplies and money to the scene of the struggle. In the meantime the arrival in Genoa of the countess of Blessington and her party turned his thoughts nostalgically to England. His last weeks in Italy were made hectic by quarrels with Leigh Hunt and Mary Shelley and by the emotional strain of the final parting from Teresa.

On July 16, Byron left Genoa on a chartered ship, the "Hercules," accompanied by Trelawny and the young Count Pietro Gamba. They arrived at the Ionian island of Cephalonia on Aug. 2, and Byron settled in the village of Metaxata near Argostoli to await developments. After a trip to Ithaca, he tried to forward the floating in London of a loan for the Greeks. He was avidly wooed by the Greek factions, all eager for his cash and influence. Finally he sent £4,000 of his own money to activate the Greek fleet and then sailed for Missolonghi on Dec. 29 to join Prince Alexander Mavrokordatos, leader of the forces in western Greece.

With tremendous energy he entered into the plans to attack he Turkish-held fortress of Lepanto. He employed the firemaster William Parry to prepare artillery and took under his own command and pay the Suliote soldiers, reputedly the bravest of the Greeks. In addition he made efforts to unite eastern and western Greece by effecting a reconciliation of the factions. But a serious illness on Feb. 15, 1824, followed by the usual remedy of bleeding weakened him at the same time that an insurrection of the Suliotes opened his eyes to their cupidity. Though his enthusiasm for the Greek cause was undiminished, he had thenceforth a more realistic view of the obstacles and was often depressed. He was also suffering from the emotional strain of an unequal friendship with Loukas Chalandritsanos, a Greek boy, whom he had brought as a page from Cephalonia and to whom he addressed his last agonized poems including his lines on completing his 36th year. He still fixed his hopes on the Greek loan and the uniting of the dissident parties. He was planning to attend a conference with Odysseus and other leaders at Salona when, drenched by a sudden downpour during his daily ride, he contracted a fever which was aggravated by the bleeding insisted on by the doctors. After a painful and pathetic illness of ten days, he died on April 19, 1824. Deeply mourned throughout the land, he became a symbol of disinterested patriotism and a Greek national hero. His body was carried back to England and, refused burial in Westminster abbey, was deposited in the vault of his ancestors in Hucknall Torkard church near Newstead.

On close examination the paradox of Byron's character resolves itself into understandable elements. Disappointment at the failure of the dreams of his youth, magnified by sensitivity to his lameness, made him keenly aware of the imperfection of reality, and his belief in inevitable human frailty, imbibed from early Calvinistic training, was never quite dissipated by later skepticism. A spoiled only child revolted by the crudities of his mother's temper, longing for an ideal love and disillusioned by a premature sexual experience, he alternated between a deep-seated melancholy and mockery of the disparity between real life and the unattainable ideal. A feminine quality impelled him not only toward sexual ambivalence but also toward showing that facet of his nature most congenial to each of his friends. To Hobhouse he was the facetious companion, humorous, cynical and realistic. To Edleston, and to most women, he could be tender, melancholy and idealistic. But his weakness was also his strength. His chameleonlike character was engendered not by hypocrisy but by sympathy and adaptability, for the side he showed was a real if only partial revelation of his true self. And that "mobility" of character noted by Lady Blessington permitted him to savour and to record the mood and the thought of the moment with a sensitivity denied to those tied to the conventions of consistency.

Byron's work, more patently autobiographic than that of any of his contemporaries, even among the self-revealing romantics, displays both the melancholy inspired by the imperfections of life and the irony attending the unmasking of the hypocritical face of reality. In fact, the *Weltschmerz* of *Childe Harold* and the satiric realism of *Don Juan* are but two sides of the same coin. In the former Byron ran the gamut of the moods of romantic despair. In *Don Juan* he was concerned with the same disparity between real and ideal, but in the main he shows it in its comic or at least sardonic aspects. And yet there are enough Childe Harold-like passages in the poem to remind the reader that the one mood easily melts into the other.

It is well to remember that Byron was born in the 18th century. An admirer of Pope from his school days, he modeled his first important poem, *English Bards and Scotch Reviewers*, on the *Dunciad*. And a degree of hard-headed 18th-century rationalism tempered much of his work, particularly his satires. It is probable that this leaven prevented Byron from succumbing, even in his highest flights of romantic idealism, to transcendental vagaries or German mysticism. He had a natural contempt for "metaquizzical" poets like Wordsworth, and he wished that Coleridge would "explain his explanation."

Byron was diverted from his satiric-realistic bent by the success of *Childe Harold*. He followed this up with the Oriental tales, which reflected the gloomy moods of self-analysis and disenchantment of his years of fame. In *Manfred* and the third and fourth cantos of *Childe Harold* he projected the brooding remorse and despair that followed the debacle of his ambitions and of his life and loves in England. But gradually the relaxed and freer life in Italy opened up again the satiric vein, and he found his forte in the mock-heroic style of the Italian satirists Berni, Casti and Pulci. The ottava rima, which he first used in *Beppo*, was easily adaptable to the digressive commentary, and its final couplet was ideally suited to the deflation of sentimental pretensions. In the successive cantos of *Don Juan*, which he at first intended only "to be a little quietly facetious upon every thing," but which he soon took more seriously as "a versified Aurora Borealis" reflecting all his mobile moods, Byron constructed his masterpiece, distilling it from his own varied experience and observation of life. "Almost all *Don Juan* is *real* life, either my own, or from people I knew," he wrote his publisher. Yet, for the most part, except in the castigation of Southey and a few others, the poem transcends the bitterness of personal feelings. In his most unified and sustained mock-heroic poem, *The Vision of Judgment*, he rose to good humour even when satirizing Southey. The mockery of the laureate's fulsome praise of George III is less digressive than Byron's other satires and at times it reaches sheer brilliance.

In the main, Byron's historical dramas were successful only insofar as the protagonists reflected aspects of his own personality. Though all the dramas are provided with characters whose speeches are replete with Byronic philosophy and confession, *Sardanapalus* is perhaps the most self-revealing. The Assyrian king, steeped in luxury and indolence, effeminate and slothful, rises to heroic action as Byron saw himself doing in defense of Italian freedom. *Cain* gave ample scope to Byron's philosophical and religious skepticism and speculation and caused a furor among the orthodox. It convinced Goethe that Byron's true bent was to dramatize the Old Testament.

Byron was a superb letter writer, conversational, witty and relaxed. An increasing number of his letters made available for the first time in the 20th century have contributed to the growth of his literary reputation. Among his most entertaining epistles are those to Lady Melbourne, Hobhouse and Douglas Kinnaird and his letters from Italy to his publisher John Murray and to Thomas Moore. With an admirable incisiveness, whether dealing with love or poetry, he cuts through to the heart of the matter. His apt and amusing turns of phrase make even his business letters fascinating.

See also references under "Byron, George Gordon (Noel) Byron" in the Index.

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(L. A. M.)

BYRON, JOHN (1723–1786), British admiral, whose account, published in 1768, of a shipwreck in South America was to some extent used by his grandson, the poet, in *Don Juan,* was born on Nov. 8, 1723, the second son of the 4th Baron Byron. In 1741 he was a midshipman on board the "Wager" when she was wrecked off the coast of Chile during George Anson's voyage round the world. After unparalleled hardships Byron eventually reached a Spanish prison and was repatriated in 1745. He was appointed to the command of the frigate "Dolphin" in 1764 and sent out to the Pacific ocean in an attempt to discover the supposed southern continent, but he did not have the temperament of an explorer and only made a fruitless circumnavigation lasting 22 months. Appointed governor of Newfoundland in 1769, he reached flag rank in 1775 and became vice-admiral in 1778. In 1779 he lived up to his nickname "Foul-weather Jack" when, in command of a fleet sent to relieve British forces in America, he encountered one of the worst Atlantic gales on record. As commander in chief of the West Indies he fought an inconclusive battle with the comte d'Estaing off Grenada that year. He died in England on April 10, 1786.

(C. C. L.)

BYTOM (Ger. BEUTHEN), a Polish town in the Katowice *wojewodztwo* (province) in Upper Silesia. Pop. (1960) 182,500.

Situated on the old trade route between Wroclaw (Breslau) and Cracow in a mining district (lead, zinc) that was early exploited in the 12th century, the town has developed over a long period. It is a large industrial centre, with coal mines, foundries and factories. It lies on the railway between Wroclaw, 120 mi. to the northwest, and Cracow. The Silesian opera house and museum are situated there.

Bytom was the capital of the Bytom castellany, which was separated from the Cracow territories in the 12th century, and incorporated in Silesia. From 1282 it was capital of the independent dukedom of Bytom, whose ruler acknowledged vassalship to the king of Bohemia in 1289. Like Bohemia, Bytom came under the Habsburgs until Austria was forced to yield it to Prussia in 1742. Germany kept it after the 1921 plebiscite, though 68% of the population of the Bytom *powiat* (district) had voted for unification with Poland (*see* SILESIA). During World War II Bytom, then in the extreme southeast of Upper Silesia, was a centre of the Polish underground movement in Germany. It became Polish after the war.

NOWY BYTOM (New Bytom) lies between Bytom and Katowice. It was allotted to Poland as a result of the 1921 plebiscite. Classed as a town in 1951, Nowy Bytom had 84,000 inhabitants in 1958.

(K. M. WI.)

BYTOWNITE (named from Bytown, now Ottawa, Ont.), a rock-forming mineral of the plagioclase group of feldspars. *Se* FELDSPAR.

BYZANTINE ART AND ARCHITECTURE. The Byzantine era really began with the transference of the capital of the empire from Rome to the site of ancient Byzantium on the Bosporus in the year A.D. 330, the new capital thereafter being called Constantinople, after its founder the emperor Constantine (324–337). Seventeen years before that the same emperor had been responsible for recognizing Christianity in the so-called "Peace of the Church," and Christianity became from the outset the official religion of the new city. An art dedicated to the service of the faith had already begun to develop even in the days when Christians were oppressed. In the new centre, on the confines of Europe and Asia, it not only received official recognition but was also subjected to a number of new influences, so that it owed a debt on the one hand to Italy and Rome and on the other to Syria and Asia Minor, where Oriental elements were to the fore. And it must not be forgotten that the population of Constantinople and its neighbourhood was Greek, not Latin, so that the poetic philosophical outlook of the Greek world was itself a very considerable influence.

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I. Introduction
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  2. Sculpture
  3. Mosaics
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III. The Iconoclastic Age, 726–843
IV. The Second Golden Age, 843–1204
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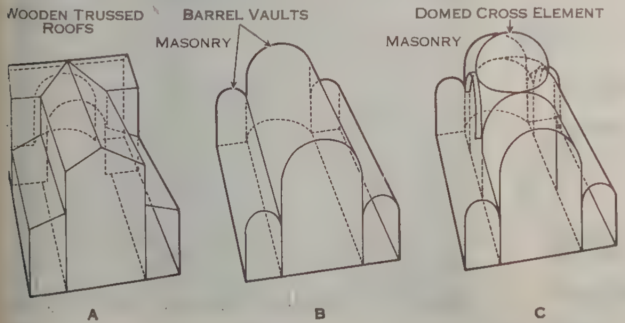
I. INTRODUCTION

There has been much discussion among authorities as to when an art that can truly be called Byzantine first came into being. At the beginning the term "Early Christian" is more appropriate, for there was little difference between what was produced at Byzantium and what had been produced at Rome; classical idioms predominated, and though the subject matter may already have become Christian, it could not be claimed that a new and distinctive style evolved more than slowly (*see* Early Christian Art and Architecture). But by the 6th century, though classical elements were to remain important for a long time to come, works were being produced that were clearly in a new style, and if any single date is to be chosen to mark the beginning of Byzantine art, the year 500 is the most convenient. The changes that had by then become apparent were stabilized as a result of the lavish and brilliant patronage of Justinian I (527–565), and the architecture and sculptured decoration of his great cathedral of Hagia Sophia (Sancta Sophia) illustrate the change. At Constantinople any mosaics that might have been set up at this time have perished, but those in S. Vitale (526–547) and some in S. Apollinare Nuovo (*c.* 561) at Ravenna, Italy, are no doubt close in style to those at Constantinople.

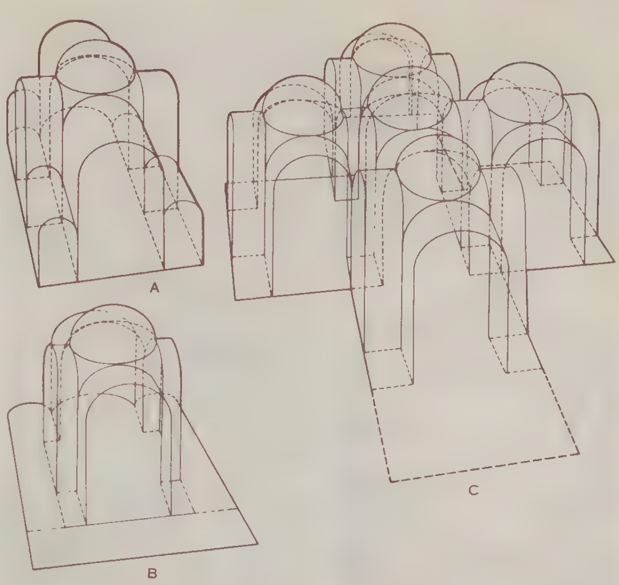
Because much has been destroyed and because the next two centuries were less productive, it is now hard to trace with any exactitude the course of developments immediately after Justinian's reign; all one can say is that by the end of the first quarter of the 8th century so great an importance had accrued to the depiction of the saintly and divine forms in art that a large body of opinion in the state feared the population was in danger of lapsing into idolatry. As a countermeasure a decree forbidding representation in religious art was promulgated, and from around 730 until 843 the empire was under the control of emperors who are called iconoclasts and to most of whom representation in religious art was anathema. Church building nevertheless continued, and secular art seems to have flourished, though little has survived; one can gather some idea of what mosaic decorations of the period were like by looking at the mosaics set up by Byzantine craftsmen for Islamic patrons in the Dome of the Rock at Jerusalem (*c.* 690) and in the Great Mosque at Damascus (*c.* 715).

With the return to power of the icon lovers, as they were called, in 843, figural art once more became important in the churches. Elaborate representational decorations in mosaic were set up in the more important buildings, painted ones in the poorer, and during the next two or three centuries the sumptuous arts of ivory-carving, metalworking, enameling, and silk-weaving were developed to an unprecedented degree. It was an age of great brilliance and represents the acme of Byzantine culture. Even in the 12th century, when political and economic conditions were far less favourable, there was little change in the quality or quantity of the art produced, and the period between 843 and 1204, when Constantinople fell before the attack of the Fourth Crusade, is to be counted as the Second Golden Age of Byzantine art.



TER K. J. CONANT, "A BRIEF COMMENTARY ON EARLY MEDIEVAL CHURCH ARCHITECTURE"

EVELOPMENT OF THE BASILICA DURING THE TRANSITION TO BYZANTINE RCHITECTURE: (A) BASILICA; (B) BARREL VAULTED BASILICA; (C) DOMED ASILICA



AFTER K. J. CONANT, "A BRIEF COMMENTARY ON EARLY MEDIEVAL CHURCH ARCHITECTURE"

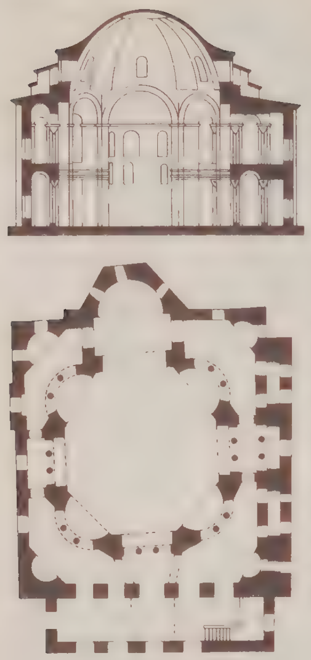
CHURCH TYPES OF THE FIRST GOLDEN AGE BASED ON THE DOMED CROSS ELEMENT: (A) CRUCIFORM DOMED BASILICA; (B) DOMED BASILICA WITH CRUCIFORM NAVE; (C) "FREE CROSS" OR COMPOSITE DOMED CROSS CHURCH

In 1204 Constantinople was sacked by the crusaders, its treasures were destroyed or dispersed, and the brilliant middle period of Byzantine art was brought to an end. But even though the empire was thereafter impoverished and, when the Latins were eventually driven out in 1261, consisted of little more than the hinterland of Constantinople itself, art continued to flourish. Toward the end of the Second Golden Age Byzantine influence had made itself felt outside the empire, as for example in the mosaics of Sicily and Venice, and the Byzantine style had been adopted by the Orthodox states that were growing up in Russia, Bulgaria, and the Western Balkans. During the 13th century, when Constantinople was in Latin hands, it was in these outlying areas that the most important developments in painting took place. But once the Greek emperors had returned to Constantinople in 1261, developments there began anew, and some of the finest Byzantine mosaics and paintings date from this last phase. True, economic conditions did not permit the production of the rich works in gold, ivory, enamel, or precious stones that had formerly been so important, but less costly though no less beautiful works in paint or miniature mosaic took their place, while in the sphere of architecture the churches of this last phase, though small, were usually both elaborate and beautiful.

Constantinople fell to the Turks in 1453 and the little that remained of the empire, together with the independent Orthodox states except for Russia, was in Turkish hands by soon after 1460. That did not mean the end of Byzantine art; in Greece, the Western Balkans, and Bulgaria the style lived on as the art of peoples subject to Muslim overlordship. Although no very great works were produced, many good buildings and painted decorations were set up and fine icons painted. In Russia, on the other hand, a national art of great quality saw continuous development from the Byzantine basis until the end of the 17th century, when a new style was introduced from the West at the time of Peter the Great.

II. THE FIRST PHASE, 330–726

When Constantine I began to build his new capital on the Bosporus, a mass of artisans was assembled for the purpose. The

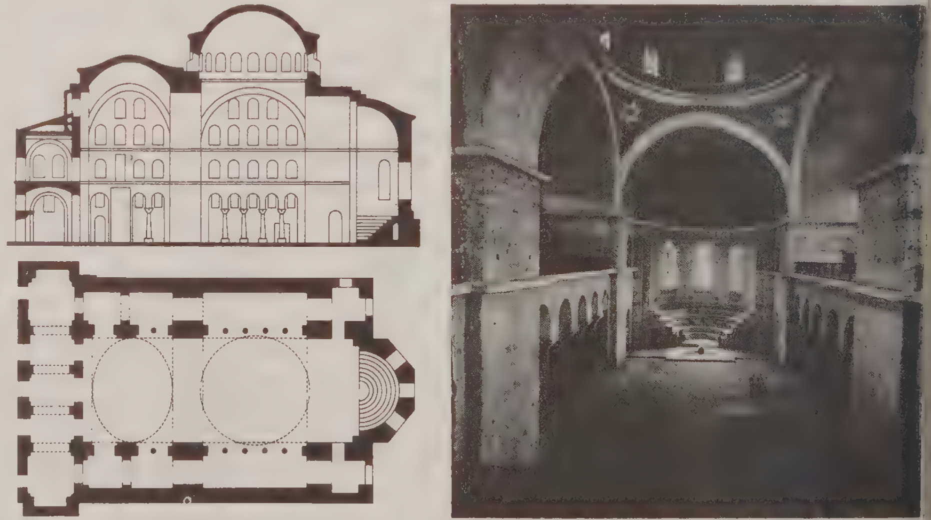


FROM D. T. RICE, "THE BYZANTINES," PUBLISHED BY THAMES AND HUDSON LTD., LONDON, AND F. A. PRAEGER, INC., NEW YORK (AFTER VAN MILLINGEN)

CROSS SECTION AND PLAN OF THE CHURCH OF SS. SERGIUS AND BACCHUS, CONSTANTINOPLE, A CENTRALIZED BASILICA

majority of them was drawn from Rome, so that at first official art was virtually Roman art; the classical basilica was adopted as the usual type of Christian church; portrait statues of emperors were set up as in pagan times, and sarcophagi were elaborately sculptured; floor mosaics of classical character were widely used; works in ivory and metal retained a basically Roman character. But change was in the air even before the capital had been moved from Rome. In architecture the trabeated style in stone, which had been taken over from the Greeks, was already giving place to an architecture of arches, vaults, and domes in brick, while sculptural ornament was becoming more formal and less naturalistic. These changes were accelerated at Constantinople, in the course of the natural process of change and because of the closer proximity of the city to Asia Minor and Syria, both fertile centres of new artistic ideas that had developed independently of Rome. Indeed, church architecture in those areas progressed very considerably between the 4th and the 6th centuries, while in the visual arts a style which favoured formality and expression rather than an idealized naturalism had begun to find favour at an early date.

1. Architecture.—Constantine's new capital was elaborately laid out and boasted an important series of secular buildings—walls, hippodrome, forums, public buildings, arcaded streets, and an imperial palace—all of great magnificence. The religious structures he set up were of two principal types: longitudinal basilicas and centralized churches. The former, with three aisles separated by columns, were intended for congregational worship; the latter, which were circular, square, or even octagonal, were for burial or commemorative usage. Both types were to be found over a very wide area, though there were, of course, numerous local variations. It was through a subtle combination of the two types that the characteristic Byzantine church was arrived at, thanks to some experiments made in the east Mediterranean area in the 5th century. The progress of these cannot be followed exactly because so much has been destroyed, but the earliest church that survives in Constantinople, that of St. John of Studios, shows that this process had already gone quite far by the year it was set up, 463. It is a basilica in that it has an eastern apse and three aisles, but on plan it approaches a centralized building, for it is nearly square, in contrast to the long basilicas in vogue in Rome. A similar change characterizes the sculptures that adorn its facade, for they are in low relief, and the motifs are treated formally, as pieces of pattern, rather than as depictions of natural forms.

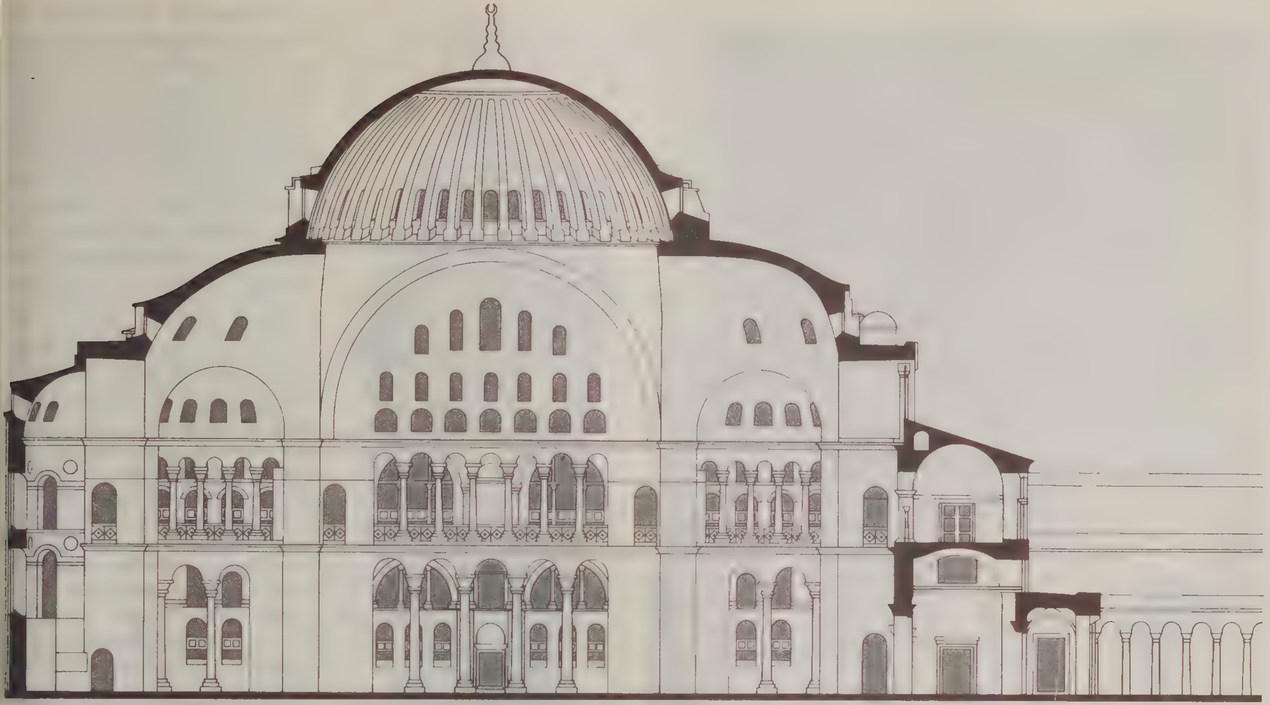


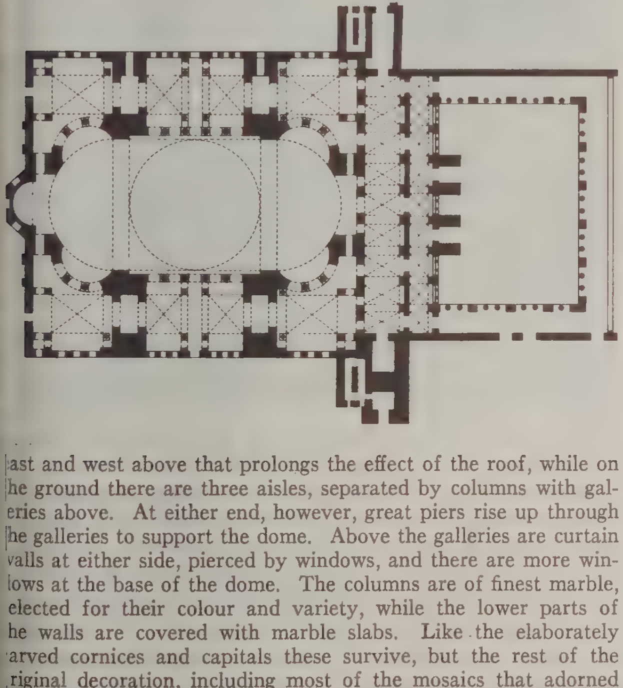
(LEFT) FROM D. T. RICE, "THE BYZANTINES," PUBLISHED BY THAMES AND HUDSON LTD., LONDON, AND F. A. PRAEGER, INC., NEW YO (AFTER VAN MILLINGEN); (RIGHT) J. POWELL

CHURCH OF ST. EIRENE, CONSTANTINOPLE, A PROTOTYPE OF THE BYZANTINE LONGITUDINAL BASILICA: (LEFT) CROSS SECTION AND PLAN; (RIGHT) INTERIOR

The process of development that we see here in embryo had greatly advanced by the end of the century, as recently discovered remains of the church of St. Polyeuktos show. The church was founded by Juliana Anicia, whose name is known to us from an important illuminated manuscript dated 512. The change was advanced still farther some 30 years later, thanks to the patronage of the emperor Justinian, one of the greatest builders of all time. He was responsible for four major churches in Constantinople, SS. Sergius and Bacchus, a centralized building very similar to S. Vitale at Ravenna, the church of St. Eirene (Irene), a basilica roofed by two domes in echelon, the church of the Holy Apostles, which was cruciform, with a dome at the crossing and another on each of the arms of the cross, and finally the great cathedral of Hagia Sophia, where the ideas of longitudinal basilica and centralized building were combined in a wholly original manner. The distinctive feature of all of them was the form of roof, the dome. In SS. Sergius and Bacchus it stood on an octagonal base, so that no great problems were involved in converting the angular ground plan to a circle on which the dome could rest. But in the others the dome stands above a square, and the transition from the one to the other was complicated. Two separate processes of doing this had been evolved by this time: the squinch, a niche or arch in the corner of the square, which transformed it into an octagon, over which the dome could be placed without great difficulty; and the pendentive, a sort of spherical triangle fitted into the corners of the square, its vertical sides corresponding with the curves of the arches supporting the dome and its upper one with the circular base of the drum. Like a nerve in the human body this served to brace and support the weight and to transfer it downward to the ground at the same time. The squinch served its purpose well enough and continued in use for many centuries, but it had certain weaknesses; the pendentive was one of the great architectural inventions of al time, transforming what had been mere building, where stress was counteracted by mass, into organic architecture, where thrust was compensated by thrust and strength depended on balance. So far as is known the squinch was first used in Persia and the pendentive in Syria, so that they can be termed respectively the Eastern and the Western solutions. (*See* ARCH AND VAULT.)

Though Justinian's domed basilicas are the models from which Byzantine architecture developed, Hagia Sophia remained unique and no attempt was thereafter made by Byzantine builders to emulate it. On plan it is almost square, but looked at from within it appears to be rectangular, for there is a great semidome a





FROM (TOP) RENATE BAUMANN, AFTER R. L. VAN NICE, "SAINT SOPHIA IN ISTANBUL," (BOTTOM) D. T. RICE, "THE BYZANTINES," PUBLISHED BY THAMES AND HUDSON LTD., LONDON, AND F. A. PRAEGER, INC., NEW YORK (AFTER SALZENBERG)

CROSS SECTION AND PLAN OF HAGIA SOPHIA, CONSTANTINOPLE

ast and west above that prolongs the effect of the roof, while on he ground there are three aisles, separated by columns with galeries above. At either end, however, great piers rise up through he galleries to support the dome. Above the galleries are curtain valls at either side, pierced by windows, and there are more winlows at the base of the dome. The columns are of finest marble, elected for their colour and variety, while the lower parts of he walls are covered with marble slabs. Like the elaborately arved cornices and capitals these survive, but the rest of the riginal decoration, including most of the mosaics that adorned he upper parts of the walls and the roof, have perished. They vere all described in the most glowing terms by early writers. ut enough does survive to warrant the inclusion of Hagia Sophia the list of the world's greatest buildings. It was built as the esult of the destruction in a riot of its predecessor, the basilica egun by Constantine, and the work of rebuilding was completed the amazingly short period of five years, ten months, and four ays, under the direction of two architects from Asia Minor, nthemius of Tralles and Isidorus of Miletus, in the year 537.

From the little known it would seem that similar changes were king place in secular architecture. The walls of the city, which ill in greater part survive, were set up under Theodosius II arly in the 5th century, and already the method of construction (where a number of courses of brick alternate with those of stone) and the forms of vaulting used to support the floors in the numerous towers show a number of innovations. The walls themselves, a triple line of defense, with 192 towers at alternate intervals in the inner and middle wall, were far in advance of anything set up previously; they were, indeed, so well conceived that they served to protect the city against every assault until the Turks attacked with vastly superior odds, supported by cannon, in 1453. Distinctive again were the underground cisterns, of which more than 30 are known in Constantinople today. They all took on the same character, with strong outer walls and roofs of small domes supported on tall columns. Some are of great size, some comparatively small. In some, like the great cistern near Hagia Sophia called by the Turks the Yeri-batan-saray (underground palace), old material was reused; in others, like the even more impressive Bin-bir-derek cistern (The Thousand and One Columns), new columns of unusually tall and slender proportions and new capitals of cubic form were designed specially. These cisterns assured an adequate supply of water even when the aqueducts that fed the city were cut by an attacking enemy. Many of them were still in use at the end of the 19th century. Contemporary texts show that the houses were often large and elaborate and had at least two stories, while the imperial palace was built on enormous terraces of masonry on the slopes bordering the upper shores of the Sea of Marmara. The palace was founded by Constantine, but practically every subsequent emperor added to it, and it eventually became a vast conglomeration of buildings extending over more than 100 ac. Many of the buildings were of a very original character, if the descriptions that survive are to be believed; unfortunately nearly all have been destroyed in the course of time.

2. Sculpture.—Sculpture underwent changes very similar to those in architecture. The decorative work in Hagia Sophia illustrates its nature. In the classical world naturalistic representation had prevailed; at Hagia Sophia the forms are still basically representational, but they are treated in an abstract manner, more advanced in degree than at St. Polyeuktos. Capitals of the period are similarly stylized even when they use bird or animal forms, for these are usually treated as part of an over-

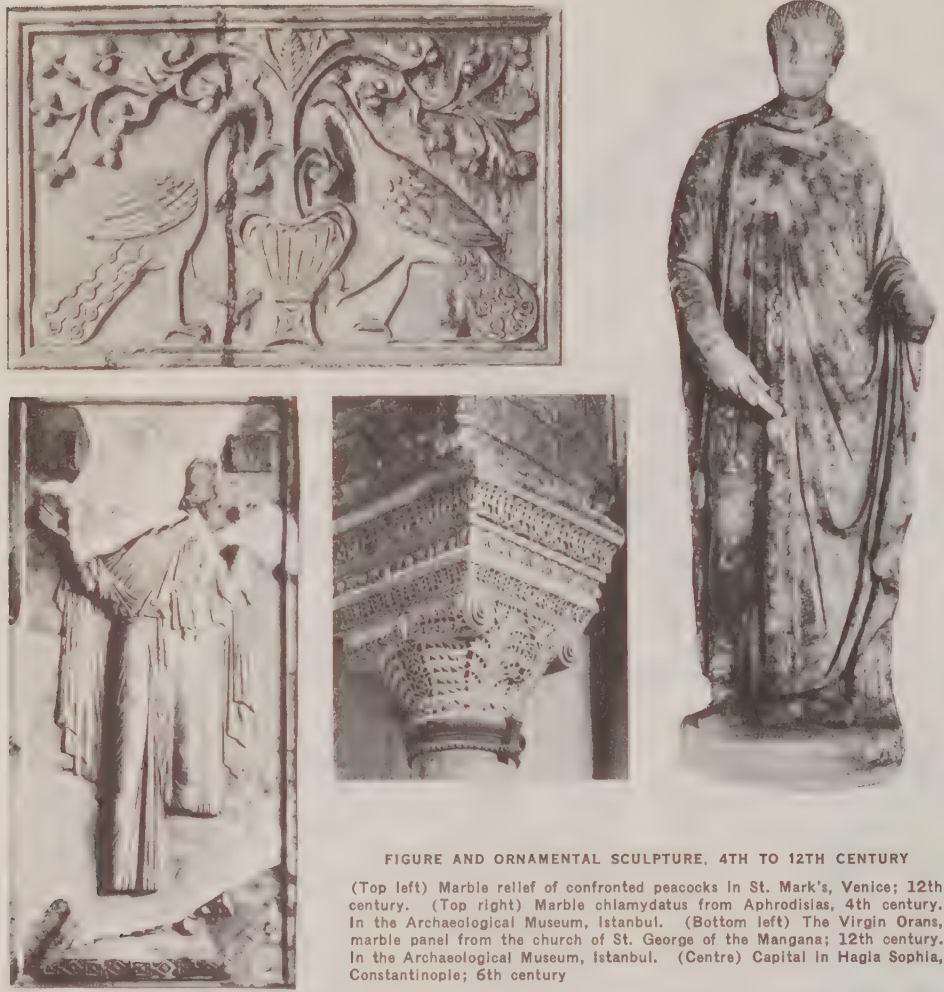


FIGURE AND ORNAMENTAL SCULPTURE, 4TH TO 12TH CENTURY

(Top left) Marble relief of confronted peacocks in St. Mark's, Venice; 12th century. (Top right) Marble chlamydatus from Aphrodisias, 4th century. In the Archaeological Museum, Istanbul. (Bottom left) The Virgin Orans, marble panel from the church of St. George of the Mangana; 12th century. In the Archaeological Museum, Istanbul. (Centre) Capital in Hagia Sophia, Constantinople; 6th century

BY COURTESY OF (TOP RIGHT, BOTTOM LEFT) THE ARCHAEOLOGICAL MUSEUM, ISTANBUL; PHOTOGRAPHS, (TOP LEFT) ALINARI, (CENTRE) HIRMER FOTOARCHIV MUNCHEN

all balanced pattern. With this tendency toward stylization in architectural sculpture it is not surprising to find that three-dimensional, representational sculpture was progressively going out of fashion. Portrait sculptures had been made of most of the early emperors, and the texts tell us that a mounted figure of Justinian I topped a column in front of Hagia Sophia. But that was the last of the series; figural compositions in high relief had adorned sarcophagi and similar reliefs had found a place on the walls of churches, but virtually none of these dates from later than Justinian's reign. Instead, flat slabs with low-relief ornament akin to that on the capitals and cornices of Hagia Sophia, some of it even purely geometric, came into vogue. These slabs were used for the lower sections of windows or to form a screen between the body of the church and the sanctuary; they were later to develop into the high structures called iconostases, which eventually became universal in Orthodox churches.

3. Mosaics.—The writers speak with enthusiasm of the mosaics that decorated Hagia Sophia, but except for some ornamental work on the vaults nothing survives there from the Justinianic age, nor is anything of importance to be found in St. Eirene (Irene) or SS. Sergius and Bacchus, while the church of the Holy Apostles was destroyed soon after the Turkish conquest of Constantinople in 1453. Most of Justinian's other numerous foundations, at such places as Ephesus, Jerusalem, or Bethlehem, have been razed or so much altered that little of the original work remains, and only in three places have extensive mosaic decorations of the early period survived; namely, at Ravenna, at Salonika, and in the church of the monastery of St. Catherine on Mt. Sinai.

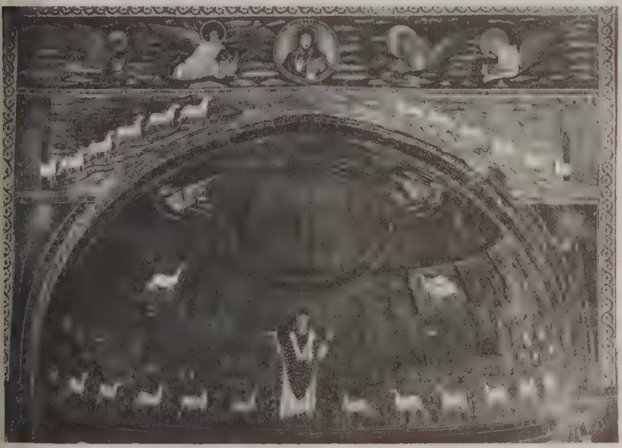
The mosaics of Ravenna belong to three main periods, that of Galla Placidia (*c.* 440), that of Theodoric (*c.* 500), and that of Justinian I (527–565). They thus illustrate the development of style throughout a very progressive hundred years. Wholly characteristic of the early phase is the depiction of Christ as the Good Shepherd over the entrance of Galla Placidia's mausoleum (*c.* 450). Christ is shown as a youthful, beardless figure standing in a picturesque landscape amid a flock of sheep, symbol o the faithful. The interpretatior may be contrasted with that ir the apse of SS. Cosmas and Damian at Rome (526–530), where Christ appears as an awesome, bearded figure; the forme interpretation is characteristic o the Early Christian style; the latter is wholly Byzantine.

In other mosaics of Galla Placidia's age at Ravenna, notably those in the Baptistery of th Orthodox (*c.* 440), where th Baptism occupies the centre o the dome, with a frieze of th apostles below it and a beautifu architectural composition on th walls, links with the classica world are again apparent, thoug in general the style is more formal. Most of the work don under Theodoric was rather les polished, though often it followe the same conception. The decoration of the Baptistery of th Arians (*c.* 520) for example, i similar to that of the Baptister of the Orthodox as regards disposition but is rather more rigid, while 13 scenes from the life o Christ and the same number from the Passion, which adorn th upper parts of the walls of S. Apollinare Nuovo (520–530), ar again in a somewhat rough style, though they are extremely expressive. There the number of figures in each scene is reduce to a minimum, but they tell the story vividly nonetheless.

These mosaics in S. Apollinare Nuovo contrast markedly wit those on the walls below which depict processions of male an female saints moving toward Christ and the Virgin at the eastern end of the building. They were added about 561 when th church was converted from the Arian cult to Orthodoxy. Her the figures are tall and elegant, and the mosaics are characterize by the subtle, repeated rhythms of the composition rather tha by expression or vividness. The same rather formal approac characterizes the portrait groups of Justinian and his consor Theodora in the church of S. Vitale (526–547). There the figures are disposed frontally, their costumes are rich and decorativ and the style is truly Byzantine. Similar panels may well hav existed in some of Justinian's churches at Constantinople. Th rest of the mosaics in S. Vitale, notably a decorative compositio on the roof of the presbytery and Old Testament scenes on it walls, are in a similar vein; only in the apse, where Christ appears in glory between archangels and saints, is there a hint o the old picturesque manner, for Christ is shown as a youthfu beardless figure, modeled on Orpheus or Apollo.

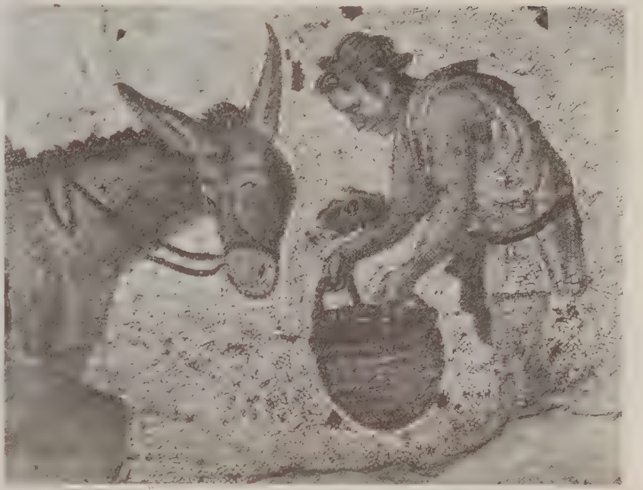
The old ideas of symbolism still dominate in the very fin mosaic in the apse of S. Apollinare in Classe (534–549), fo though the composition represents the Transfiguration, the fig ure of Christ is symbolized by a great cross, and those of the three apostles who accompanied him, by sheep; only the prophets appear in human guise. This essentially Early Christian rendering may be contrasted with the more truly Byzantine one in the monastery of St. Catherine on Mt. Sinai, done around 565, where Christ, the three apostles, and the prophets are all depicted realistically, with their names in large letters beside them. Work at Parenzo, the modern Poreć, Yugos. (530–535), on the eastern shores of the Adriatic, is very close to that at Ravenna, while some fragmentary mosaics at two places in Cyprus, Kiti and Lythrangomi, are more truly Byzantine. It is however at Salonika that the most important mosaics of this phase are to be found in the East.

The earliest of the decorations in Salonika is that in the rotunda of St. George; it has been assigned to a date as early as the reign of Theodosius I (379–395) but may be later. It comprises some superb ornamental work on the vaulted roofs of embrasures below and a great architectural composition in the dome, with figures, arms raised in prayer, before the buildings; above this there once stood great figures of angels. The work is grand and dignified, and despite its early date savours more of the official art of Byzantium than of the Early Christian style of Rome. The apse mosaics of a small church called Hosios David or the Virgin of the Stonemasons are more truly Early Christian, the Christ being youthful and beardless, while the ornamental mosaics under the arcade of the basilica of Hagia Paraskevi (5th century) again look back to the classical world. More important and more original are those in the basilica of St. Demetrius, where there are a number of rather unusual dedicatory panels depicting the saint and donors. The earliest are to be dated around 640, when the church was restored after a fire; the latest belong to the 8th century. The work, especially that of the 7th century, is very polished and sophisticated and conveys an idea of what was being done in Constantinople at the time. (*See* MOSAIC.)


ALINARI

MOSAIC REPRESENTING THE TRANSFIGURATION IN THE APSE OF S. APOLLINARE IN CLASSE, RAVENNA; 534–549

4. Ivories.—Though mosaics represent the most important art of the age, the so-called minor arts cannot be disregarded, partly because more is known about them and partly because some of he most able masters of the period preferred to work on small-scale objects, and patronage was ready to support them. Most mportant are the ivories. They comprise a wide variety of types, ranging from small pyxides—circular vessels used in the liturgy—o large-scale works made up of a number of separate panels, ike the famous throne of Maximian at Ravenna. Most usual, however, were the flat plaques used as diptychs, book covers, etc. Considerable numbers of these, dating mostly from the late 5th and early 6th centuries, have come down to us; after about the middle of the 6th century ivories become rarer: very few can be dated to between the reign of Justinian and the revival of Byzntine art in the 9th century.


HIRMER FOTOARCHIV MÜNCHEN

FLOOR MOSAIC (DETAIL) IN THE PERISTYLE OF THE GREAT PALACE OF THE EMPERORS, CONSTANTINOPLE; PROBABLY 6TH CENTURY

Diptychs, or two-panel ivories, seem to have been very popular both for use as book covers and for ceremonial purposes. The most impressive of them were imperial. In these each leaf was made up of five panels; on the central one was a portrait of the emperor, at the sides were standing figures of the consuls, below were scenes, usually of tribute bearers, and above angels upholding a bust of Christ. They thus illustrated the Byzantine ideas of hierarchy, Christ above and the world below, dominated by the emperor as Christ's vice-regent. The finest of them, known as the Barberini ivory, is in the Louvre and probably depicts Anastasius (491–518), while another, of the empress Ariadne, is divided between several collections.

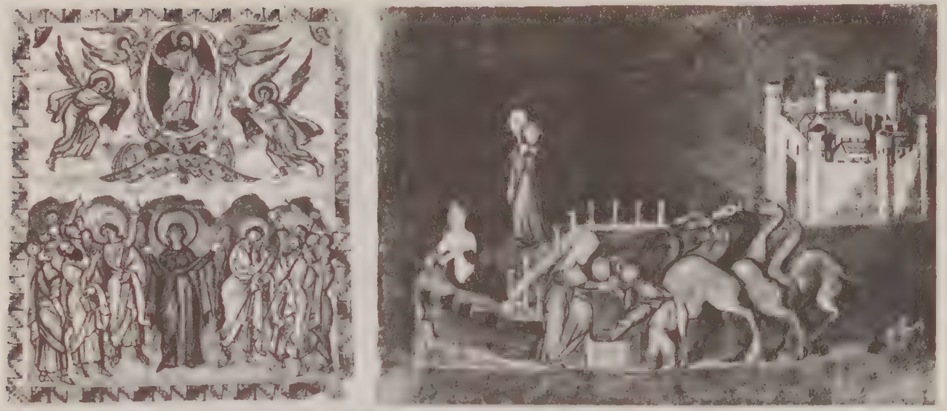
More numerous today are the diptychs that were issued by the consuls on coming to office. Their fabrication ceased when the office of consul was abolished by Justinian in 541, but though by no means all the consuls are portrayed before that, leaves of the diptychs issued by a large number of them survive. Each leaf consisted of a single plaque. The earlier ones, like that of Probus (408), are still Roman in style, but those dating from just before and just after 500, which constitute the majority, are in a different style, either more ornate or very much simpler. The more elaborate ones are well represented by leaves of Anastasius (517) in the Cabinet des Médailles, Bibliothèque Nationale, Paris; they show the consul enthroned, with lively circus scenes below. The plainer type is represented by a diptych of Justinian dated 521, now in the Castello Sforzesco at Milan, where the decoration is confined to rosettes at the four corners and a medallion with a Latin inscription at the centre.

Most of the official ivories were probably carved at Constantinople, but others, intended for more general use or for the

BY COURTESY OF (LEFT) THE METROPOLITAN MUSEUM OF ART, GIFT OF J. PIERPONT MORGAN, 1917; PHOTOGRAPH, (RIGHT) HIRMER FOTOARCHIV MÜNCHEN

SILVER DISHES, 610–630

(Left) David slaying the lion. In the Metropolitan Museum of Art. (Right) Satyr and a maenad. In the State Hermitage Museum, Leningrad

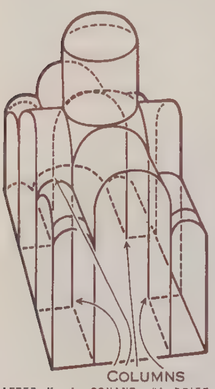


BY COURTESY OF (LEFT) BIBLIOTECA MEDICEO-LAURENZIANA, FLORENCE, (RIGHT) OSTERREICHISCHE NATIONALBIBLIOTHEK, VIENNA, PHOTOGRAPH, (LEFT) GUIDO SANSONI

(LEFT) MINIATURE OF THE ASCENSION FROM THE RABULA GOSPELS, COPIED AT ZAGBA; 586. (RIGHT) MINIATURE SHOWING REBEKAH AT THE WELL, FROM THE VIENNA GENESIS; 6TH CENTURY

church, may well have been done elsewhere. Rome, Milan, Alexandria, and Antioch were all important centres, and there has been a good deal of dispute among experts as to where many of the ivories were made. Maximian's throne, the most elaborate of them all, has been assigned to Alexandria, Constantinople, and even to Ravenna itself, while there has been argument as to whether the consular diptychs were carved at Constantinople, Rome, or Alexandria. There is however unanimity with regard to certain types. Thus a number of rather small plaques bearing decorations in a clumsy but expressive style can safely be assigned to the Holy Land, and probably to Jerusalem, while another group, characterized by a similar search for realism but by greater technical proficiency, can perhaps be attributed to Antioch. A leaf in the British Museum with the Adoration above and the Nativity below illustrates the first type, while a composite diptych used as a book cover and now at Ravenna represents the second. Each of its leaves is made up of five panels, like those of the imperial diptychs, but here Christ occupies the central one and there are scenes from the Gospels and the Old Testament all around.

Work of a more polished type, where classical scenes, single figures or, less often, events from the Bible are the subjects, has been associated with Alexandria. At one time this city was regarded as the primary centre of production, and numerous ivories of major importance were attributed to it, notably the throne of Maximian. The panels that compose it are in various styles and are certainly not all of the same school. Those on the sides, depicting scenes from the life of Joseph, are vivid and expressive, while those on the front, showing the Baptist, prophets, and ornamental scrollwork, are grand and elegant. It may be that the man who did the Joseph scenes was trained in Alexandria, but most of the rest of the work is now generally regarded as Constantinopolitan, and it was probably there that the throne was carved, wherever the craftsmen had been trained. Typical of Constantinople again is a large panel in the British Museum representing the archangel Michael; it indeed exemplifies the true Constantinopolitan style at the time of Justinian. (*See* IVORY CARVING.)



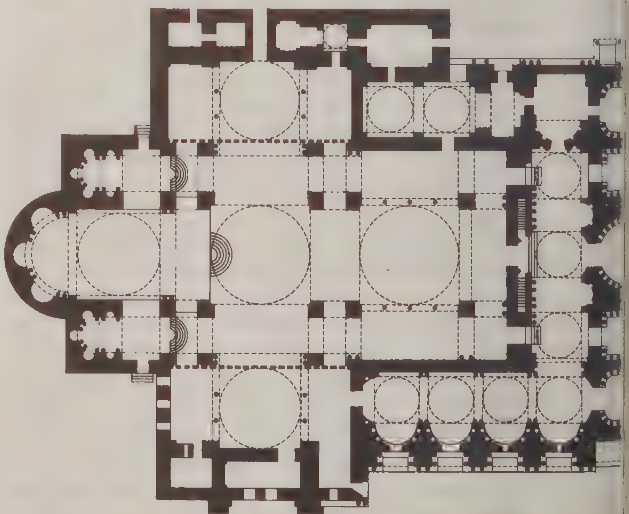
AFTER K. J. CONANT, "A BRIEF COMMENTARY ON EARLY MEDIEVAL CHURCH ARCHITECTURE"

FOUR-COLUMN CHURCH, A CHURCH TYPE OF THE SECOND GOLDEN AGE BASED ON THE DOMED CROSS ELEMENT

5. Secular Art.—A few ivories bearing secular scenes may also be assigned to the capital; one of the most important is a diptych in the Hermitage at Leningrad with depictions of animal combats in the circus. The decoration may be compared to that on a mosaic floor that belonged to part of the Great Palace at Constantinople, unearthed in recent years. It shows similar combats as well as scenes of country life, the chase, etc., most of them rendered very naturalistically. It probably dates from the reign of Justinian. The artists responsible for the floor favoured conservative motifs; but the style, where the figures appear as if silhouetted against an open background, already savours of the medieval. An important series of similar floors has been discovered at Antioch; the earlier ones, dating from the time of Constantine, are fine, but the later ones, belonging to the middle of the 6th century, are rather rough and clumsy and do not compare in technical quality with that at Constantinople. Other fine floors have been unearthed at Ahamea in Syria.

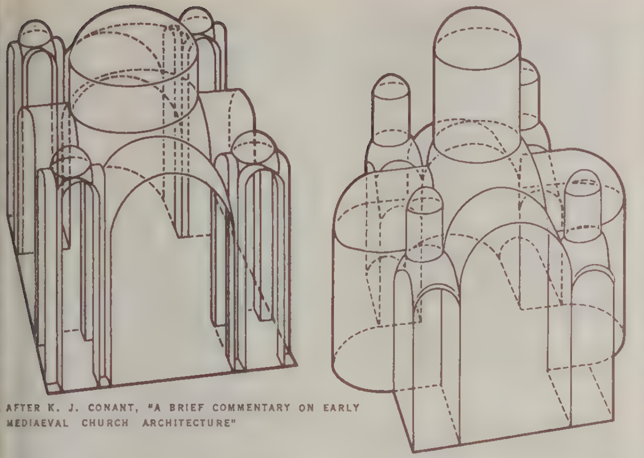
6. Silverwork.—A similar conservatism with regard to the choice of motif is to be seen in Byzantine silverwork. The finest examples of secular silver are in the Hermitage at Leningrad; vessels with religious themes are best represented by the collections in the Metropolitan Museum, New York, and the British Museum. Silver is of outstanding importance not only for its own sake, for much of it is very fine, but also because a large percentage of the pieces bear control stamps, the equivalent of western hallmarks, which enable them to be accurately dated. Technical factors show that the hallmarks were added after the completion of the decorations, and the stamps were imposed at the imperial workshops in Constantinople, so that there is good reason to believe that the stamped pieces were made there also. This is interesting, for the decorations are in varied styles and some of them show all the characteristics that would otherwise be associated with Syria or Palestine. It thus seems sure tha workers who were trained in distant regions moved to the capital either because they were summoned there by imperial authority or because there were better prospects of patronage.

Most of the metal vessels that have survived were intended for secular use. An outstandingly fine dish in the Museum of Antiquities at Istanbul bears a seated figure, the Personification o India, in an accomplished and very elegant manner which savours



FROM D. T. RICE, "THE BYZANTINES," PUBLISHED BY THAMES AND HUDSON LTD., LONDON AND F. A. PRAEGER, INC., NEW YORK (AFTER RUBACH)

PLAN OF ST. MARK'S, VENICE



AFTER K. J. CONANT, "A BRIEF COMMENTARY ON EARLY MEDIAEVAL CHURCH ARCHITECTURE"

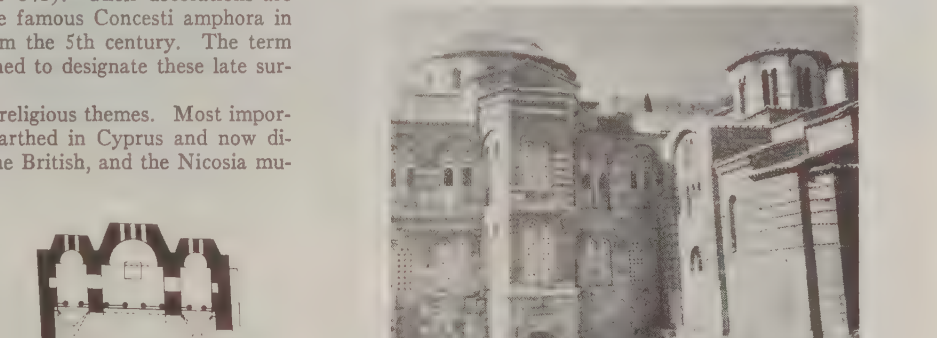
(LEFT) "FIVE-SPOT" OR QUINCUNX CHURCH, A CHURCH TYPE OF THE SECOND GOLDEN AGE BASED ON THE DOMED CROSS ELEMENT. (RIGHT) TREFOIL QUINCUNX CHURCH, A CONSPICUOUS CHURCH TYPE OF THE BYZANTINE RENAISSANCE

of the capital, though in this case there are no control stamps. In a more conservative style are a number of bowls and dishes in the Hermitage, all of which bear classical scenes. On most of them are stamps of Heraclius (610–641). Their decorations are little less classical than that on the famous Concesti amphora in the same museum which dates from the 5th century. The term "Byzantine Antique" has been coined to designate these late survivals of classical art.

Some vessels were adorned with religious themes. Most important among these are a series unearthed in Cyprus and now divided between the Metropolitan, the British, and the Nicosia museums. All bear scenes from the life of David and stamps of the reign of Heraclius which date them to between 620 and 629. Even there the style is still very classical despite the themes. More truly Byzantine is a silver cross in the Vatican which was presented to the pope of the day by Justin II (565–578); it bears a nonfigural design of stylized leaves. Two patens decorated with the Communion of the Apostles may also be noted, but here the style is more expressive, the work less elegant, even though one of them, now in the Archaeological Museum at Istanbul, bears a control stamp of the same emperor. Fine jewelry, most of it of gold and precious stones, was also important at this time, and a superb gold medallion of Justinian survived till 1831, when it was stolen from what is now the Bibliothèque Nationale in Paris; it is known from a cast. (*See* Silver and Gold Work.)

7. Illuminated Manuscripts.—Illuminated manuscripts must once have been among the most important products of the age; today only four religious texts and about the same number of classical ones survive. Of the latter a copy of Dioscorides is certainly Constantinopolitan, for it was done for Juliana Anicia, the founder of the church of St. Polyeuktos, and is dated 512. A copy of the *Iliad* at Milan may perhaps have been copied and illustrated in a Byzantine scriptorium. Two copies of Virgil in the Vatican are more probably to be regarded as Roman works, and they are, in any case, rather earlier in date. Of the religious manuscripts the most important is a copy of Genesis at Vienna; there is a fragmentary copy of the Gospels in the Bibliothèque Nationale, usually known as the Sinope fragment, for it came from Sinope, and another at Rossano in southern Italy. Finally there is another copy of Genesis in the British Museum, the Cotton Genesis, which was severely damaged by the fire that destroyed part of the Cotton Collection. There has been dispute among the authorities as to where all these manuscripts were written, but the miniatures of the Rossano Gospels are purely Byzantine in style, and there is reason to assign this manuscript at least to Constantinople. The Oriental style is represented by a fifth example, the Rabula Gospels, copied at Zagba in upper Mesopotamia in the year 586. (*See* Illuminated Manuscripts.)

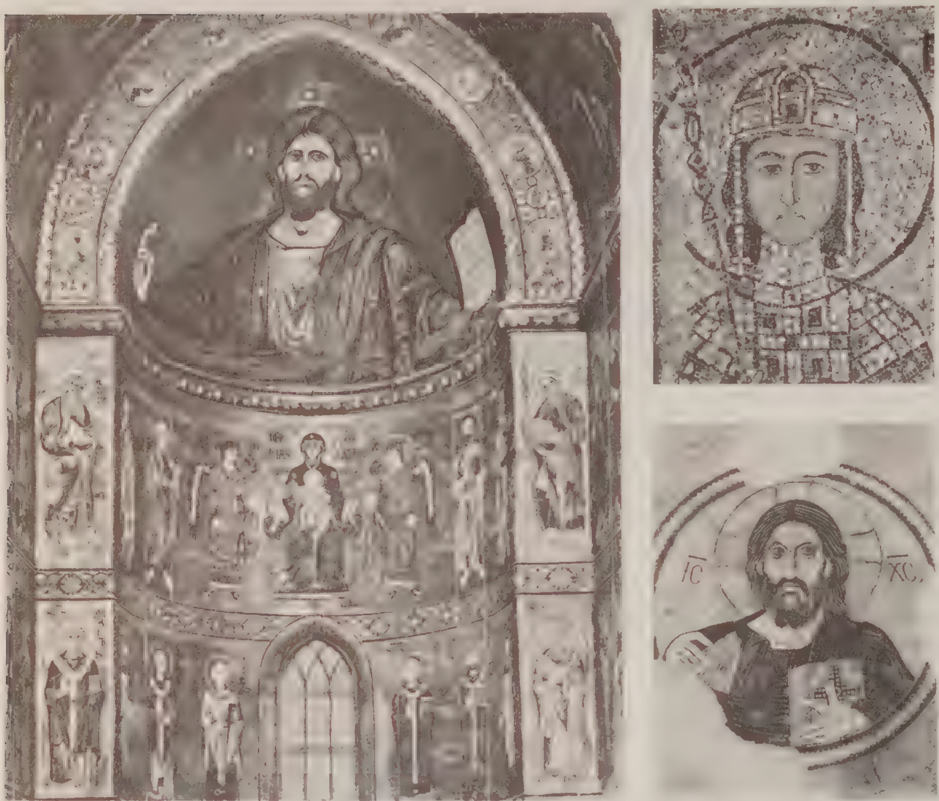
8. Icons.—Until quite recently very little was known about the painted panels of this age, but thanks to the cleaning of one or two examples in Rome and to the discovery of a hoard of panels in the monastery of St. Catherine on Mt. Sinai, much material is now available for study. Enough examples are now known not only to prove how important painted panels, or icons as they came to be known later, were at this time, but also to show that



(RIGHT) FROM D. T. RICE, "THE BYZANTINES," PUBLISHED BY THAMES AND HUDSON LTD., LONDON, F. A. PRAEGER, INC., NEW YORK (AFTER SCHULTZ), (TOP) DIMITRI, (FAR RIGHT) HOLLE VERLAG

CHURCHES OF THE MONASTERY OF HOSIOS LUKAS, NEAR DELPHI, GREECE, 11TH CENTURY

(Left) Plan of the churches: the smaller, dedicated to the Theotokos, above and the larger, dedicated to St. Luke of Stiris, below. (Top) Apse exterior of the two churches with Hosios Lukas at the left. (Right) Interior of Hosios Lukas looking toward the apse



(LEFT) ALINARI, (TOP RIGHT, BOTTOM RIGHT) COLORPHOTO HINZ, BASEL

(LEFT) APSE MOSAICS IN THE CATHEDRAL AT MONREALE, SICILY, WITH FIGURES OF CHRIST PANTOCRATOR, THE VIRGIN AND CHILD, AND SAINTS; 12–13TH CENTURIES. (TOP RIGHT) ALEXIUS, PORTRAIT MOSAIC IN THE SOUTH GALLERY OF HAGIA SOPHIA, CONSTANTINOPLE; *c.* 1122. (BOTTOM RIGHT) CHRIST PANTOCRATOR, MOSAIC IN THE DOME OF THE CHURCH AT DAPHNI; *c.* 1100

already a number of clearly defined schools are to be distinguished. The Roman work is quite different from the Eastern; a panel of the Virgin in Sta. Francesca Romana, Rome, may be noted. Among the Sinai finds some of the icons are clearly local, the work of the monks of the monastery, while others are in a very polished, sophisticated style, which must clearly have stemmed from Constantinople. One of the finest is a large icon representing St. Peter.

III. THE ICONOCLASTIC AGE, 726–843

In spite of the ban on the representation of saintly or divine personages, production in many branches of art during the iconoclastic period was apparently only little less active than in the years between the death of Justinian and the promulgation of the iconoclastic decree. A number of larger churches had been set up at this time, in spite of the reduced prosperity of the state, and at least two of these, the Church of the Assumption of the Virgin at Nicaea and that of Hagia Sophia at Salonika, were decorated with mosaics in iconoclastic times. Other churches were built during iconoclasm, which, as far as can be gathered, were of similar type. Hagia Sophia at Salonika was decorated with mosaics under the patronage of Constantine VI (780–797); his monogram survives, and in the apse there are indications that there was a great cross like that still preserved in the church of St. Eirene at Constantinople. At Nicaea a figural decoration, representing the Virgin in the apse and four archangels on the vault before it, was apparently set up during a lull in iconoclastic enthusiasm during the 8th century; it would appear to have been taken down thereafter, and replaced again much as before when the ban had been lifted. The survival of the 7th- and early 8th-century mosaics in St. Demetrius at Salonika suggests that the ban was not very strictly enforced everywhere. In any case it was strongly opposed in the monasteries, especially those in outlying areas. But in Constantinople it seems to have been universal, and religious mosaics and paintings in all the churches were removed, including virtually all those in Hagia Sophia. This does not mean, however, that the emperors were necessarily opposed to all art; the fine bronze doors of the south porch of Hagia Sophia bear the names of the emperors Theophilus and Michael, which indicates the date of *c.* 840, and we know from the texts that Theophilus was also responsible for numerous additions to the Great Palace, including the famous mechanical throne with golden lions that roared beside it and a tree with birds that twittered. The additions made to the palace must have been interesting architecturally, but unfortunately nothing survives.

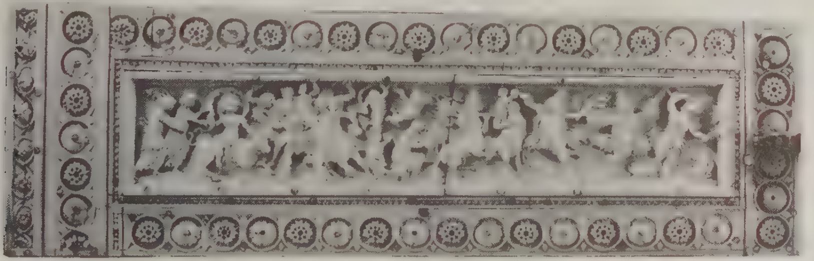
IV. THE SECOND GOLDEN AGE, 843–1204

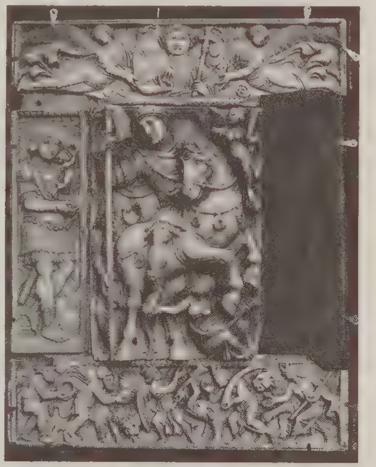
During the first two centuries after the end of iconoclasm Byzantine power was at its height. The empire's frontiers were far-flung, its wealth was enormous, and its general culture far in advance of the rest of Europe. After the death of Basil II (976–1025) a slow decline set in; power and economic prosperity waned equally. Art, however, was little affected; indeed its progress seems to have been continuous until the crusading attack of 1204 brought about a wholly new state of affairs. So it was throughout the whole of this age that Byzantine art saw its full and complete development. Though the classical heritage was still in many ways very important, other elements such as the Eastern heritage and even iconoclasm exercised an effect, and it was the fusion of these, under the controlling influence of the church, that produced the new and wholly distinctive mid-Byzantine style.

1. Architecture.—The most outstanding of the emperors in the years immediately succeeding iconoclasm was Basil I (867–886). Like many of his predecessors he built in the area of the Great Palace, his most interesting contributions being two churches, the Nea or New Church, and the church of the Theotokos of the Pharos. These set a fashion in church building and decoration which was to exercise an influence for many centuries. Neither survives, but something is known of them from written descriptions, and it would seem that both were typical of what was to be the mid-Byzantine style. Broadly speaking, the churches of this age conform to a single type, usually termed the cross-in-square. It is made up of three aisles, each one terminating in an apsidal chapel at the east, with a transverse nave, known as the exonarthex, at the west. Invariably there was a dome over the central aisle, supported on four columns, with four vaults radiating from it to roof the central aisle to the west, the sanctuary to the east, and the central portions of the side aisles to the north and south. These vaults rose above the roofs of the other portions of the building, so that the church was cruciform at roof level. Excluding the exonarthex the churches were usually almost as broad as they were long, making the basic plan virtually a square. Occasionally additional columns were used to extend the nave westward, producing a type known as the domed basilica; sometimes the walls separating the eastern ends of the side aisles from the central presbytery were extended westward as substitutes for the two eastern columns upholding the dome, but the essentials of the plan were always retained. Subsidiary domes were sometimes added, either in place of the vaults on the arms of the cross, producing a true five-domed type, like St. Mark's at Venice, or placed above the eastern and western extremities of the side aisles, producing a type called the quincunx. These domes were usually comparatively small and were set on drums which tended to become narrower and taller with the progress of time. The eastern extremities of the side aisles formed chapels which played an important part in the liturgy, that to the north being termed the prothesis and that to the south the diakonikon. Both the chapels and the main sanctuary were separated from the body of the church by a screen which also became taller and heavier as time went on until it developed into the massive iconostasis that constitutes such a characteristic feature of Orthodox churches today. As in earlier periods the lower portions of the walls were, in the richer churches, covered with marble slabs, while there were elaborately carved cornices and capitals, though ornament was always rather formal and in low relief. The main church, dedicated to St. Luke, at the monastery of Hosios Lukas near Delphi in Greece (*c.* 1050) is the most complete surviving example of the type.

2. Mosaics.—Basil I's churches at Constantinople were important not only architecturally but also because it was there that a system of decoration was first developed that was thereafter to reign supreme over the whole of the Byzantine world, whether the decoration was in mosaic or in paint. It was a symbolic system, in that the church was regarded as a sort of microcosm of the world: God in heaven above was represented by the figure of Christ Pantocrator, the Almighty, in the dome; the earth, by the floor of the church; while the region between was the sphere of the saints, who were depicted on the lower registers of the walls, and of Christ's life on earth, scenes from which were depicted above. The Virgin, recognized as Theotokos or Mother of God, appeared in the conch of the apse, the place of next importance to that occupied by Christ himself. Scenes from the Virgin's life, or from those of saints to whom church or chapels were dedicated, were shown in the side chapels, the selection varying according to the space available.

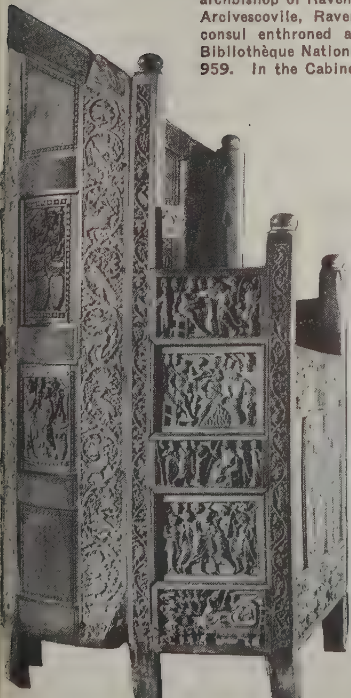
If the arrangement was basically symbolic, the figures and scenes were wholly representational, though they followed a rigid system of iconography that decreed how each subject should be depicted. Many of the compositions were of great beauty in themselves, and the rigidity of church rules, though it might imply a certain monotony, also served to maintain a high standard. We know from records that quite a number of churches in Constanti-

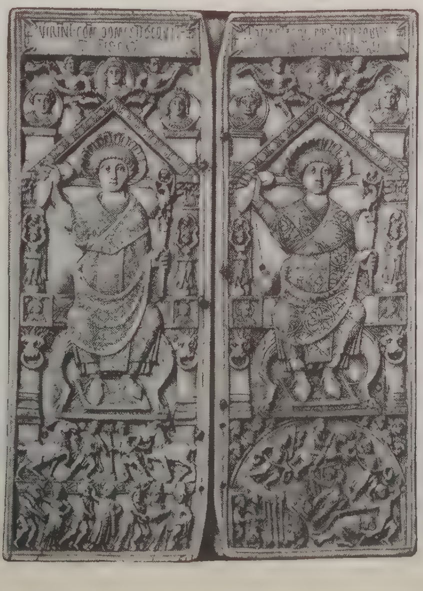


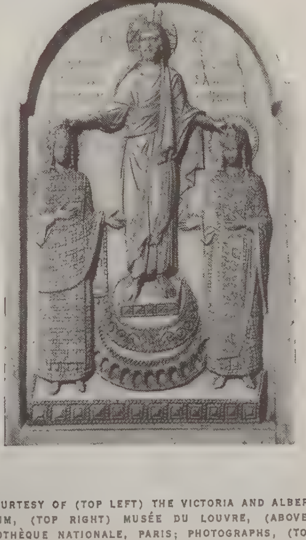


IVORY CARVINGS OF THE 6TH TO 11TH CENTURIES

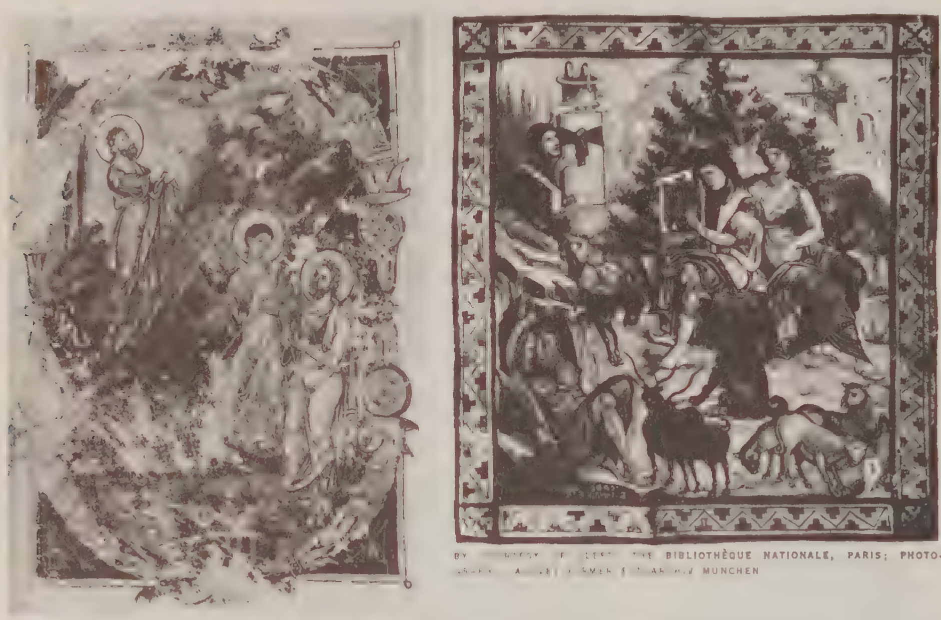
(Above) Veroli casket depicting the rape of Europa, Hercules playing the lyre with centaurs and maenads; late 10th or early 11th century. In the Victoria and Albert Museum. (Right) Barberini diptych, with mounted emperor with tribute bearers—Goths and Indians—below; *c.* 500. In the Louvre. (Below left) Throne of Maximian, archbishop of Ravenna, showing scenes from the life of Joseph; *c.* 546. In the Museo Arcivescovile, Ravenna. (Below centre) Diptych of Flavius Anastasius with the consul enthroned and circus scenes below; 517. In the Cabinet des Médailles, Bibliothèque Nationale, Paris. (Below right) Christ crowning Romanus and Eudoxia; 959. In the Cabinet des Médailles







BY COURTESY OF (TOP LEFT) THE VICTORIA AND ALBERT MUSEUM, (TOP RIGHT) MUSÉE DU LOUVRE, (ABOVE) BIBLIOTHÈQUE NATIONALE, PARIS; PHOTOGRAPHS, (TOP RIGHT) ARCHIVES PHOTOGRAPHIQUES, (BOTTOM LEFT) LEONARD VON MATT, (BOTTOM CENTRE) HIRMER FOTO-ARCHIV MÜNCHEN



BY COURTESY OF (LEFT) THE BIBLIOTHÈQUE NATIONALE, PARIS; PHOTOGRAPH (RIGHT) ALBERT HIRMER FOTOARCHIV MUNCHEN

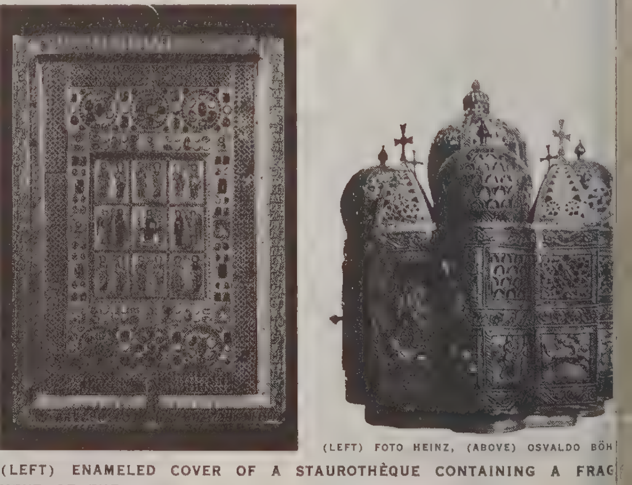
(LEFT) VISION OF EZEKIEL IN THE VALLEY OF DRY BONES, ILLUMINATION IN THE "HOMILIES OF ST. GREGORY OF NAZIANZUS," MADE FOR BASIL I; *c.* 870. (RIGHT) DAVID COMPOSING PSALMS, MINIATURE IN THE PARIS PSALTER: 10TH CENTURY. BOTH MANUSCRIPTS IN THE BIBLIOTHÈQUE NATIONALE, PARIS

nople were decorated with mosaics according to this system late in the 9th, or early in the 10th, century, but all have been destroyed. The practice was, however, universal, and churches like those at Hosios Lukas, the Nea Moni on Chios (1042–56) and that at Daphni (*c.* 1080) all contain remains of typical decorations of the age. The strange, awesome figure of Christ in the dome at Daphni is one of the greatest works of mid-Byzantine art.

The mosaics of Hagia Sophia at Constantinople followed a different system, for the cathedral was also the coronation church and was closely associated with the court and the palace. Happily quite a large proportion of the mosaic decoration that was set up there after iconoclasm survives. In the apse is the Virgin, with an archangel on either side of the vault before it; one of these survives, a figure of great dignity. Technical investigations have proved that all these mosaics date from 861, though the Virgin is so tender and delicate that the mosaic was at one time thought to be later. Over the door from the exonarthex to the church Leo VI (886–912) is shown at the feet of Christ, while over the south door Justinian and Constantine are portrayed presenting respectively models of the church and of the city to the Virgin; this mosaic is usually dated to around 1000. Busts of saints on the great curtain walls to north and south belong to much the same date, and there is a portrait of the emperor Alexander (912–913) in the north gallery. Portrait groups on the eastern wall of the south gallery represent Constantine IX Monomachus (1042–55) and the empress Zoe with Christ between and John II Comnenus (1118–43) and his consort Irene, with the Virgin between; beside them is a very expressive portrait of their son Alexius, done about 1122. Finally, facing these groups on a dividing wall of the south gallery is a rendering of the "Deesis" (Christ between the Virgin and St. John the Baptist, who intercede with him for the sins of the world). This mosaic probably dates from the first half of the 12th century.

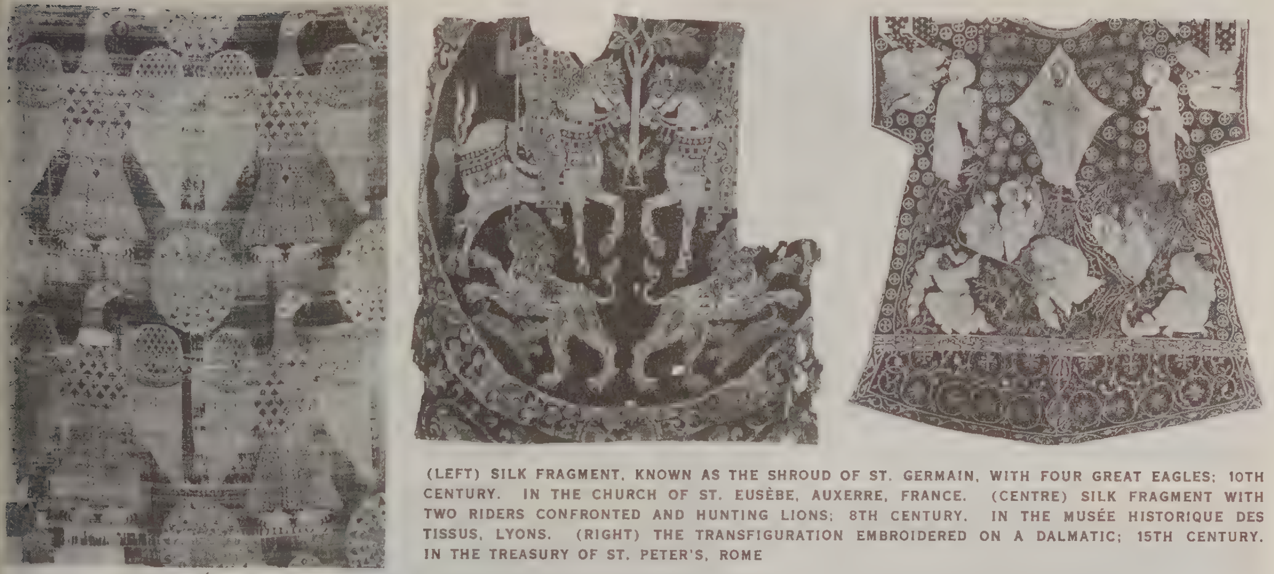
3. Wall Painting.—Wall paintings were extremely important during this period, but only one decoration by trained artists in a larger building is known, namely that in the church of St. Sophia at Ohrid, Macedonia. The majority of the scenes that survive are drawn from the Old Testament. They date from shortly before 1050. More numerous are the less sophisticated and accomplished paintings that decorate numerous rock-cut chapels in Cappadocia, done for, an often probably by, the monk who lived there in small communities or as solitaries. If some o these paintings are clumsy, al are sincere, and their importanc in the story of Byzantine art an iconography is considerable. I some of the chapels there are several layers of paint one abov the other, the earliest dating fro the iconoclastic period. Late the influence both of Syria an Constantinople may be seen i the figural work.

4. Illuminated Manuscripts.—The study of the manuscripts of this age may begi with two magnificent ones, psalter (the Paris Psalter) and book of homilies, both in the Bibliothèque Nationale, Paris. Th former (Gr. 139) contains 1 full-page miniatures in a grand almost classical style, which le scholars at one time to date i to before iconoclasm. The miniatures in the other book (G 510) are more varied in style some of them recalling the vivid narrative art of Cappadocia, bu it represents nevertheless the grandest type of Byzantine manuscript of the age. It was done for Basil I around 870. Durin the following centuries psalters, octateuchs (the first eight books o the Old Testament), homilies, and above all copies of the Gospel were produced in large numbers and were frequently illustrated Attention may be drawn to the Menologion of Basil II (976–1025 in the Vatican (Gr. 1613), to a psalter done for the same empero and now in the Marcian Library at Venice (Gr. 17), to the Bibl of Leo in the Vatican (Reg. Gr. 1) and to the homilies of St John Chrysostom in the Bibliothèque Nationale (Coislin Gr. 79 1078–81). But gospel books were the most numerous and examples exist in most big libraries. A few of them contain man small-scale illustrations, as in a famous copy in the Laurentia Library at Florence (Plut. VI. 23), where they follow what i called the Alexandrine tradition; the Constantinopolitan tradition is represented by Gospels in the Bibliothèque National (Gr. 74). But gospel books where no more than a few scenes wer



(LEFT) FOTO HEINZ, (ABOVE) OSVALDO BÖH

(LEFT) ENAMELED COVER OF A STAUROTHÈQUE CONTAINING A FRAGMENT OF THE CROSS, 10TH CENTURY. IN THE CATHEDRAL TREASURY LIMBURG, GER. (RIGHT) GILT SILVER RELIQUARY IN THE FORM OF DOMED EDIFICE, 12TH CENTURY. IN THE TREASURY OF ST. MARK'S, VENIC



(LEFT) SILK FRAGMENT, KNOWN AS THE SHROUD OF ST. GERMAIN, WITH FOUR GREAT EAGLES; 10TH CENTURY. IN THE CHURCH OF ST. EUSÈBE, AUXERRE, FRANCE. (CENTRE) SILK FRAGMENT WITH TWO RIDERS CONFRONTED AND HUNTING LIONS; 8TH CENTURY. IN THE MUSÉE HISTORIQUE DES TISSUS, LYONS. (RIGHT) THE TRANSFIGURATION EMBROIDERED ON A DALMATIC; 15TH CENTURY. IN THE TREASURY OF ST. PETER'S, ROME

BY COURTESY OF (CENTRE) MUSÉE HISTORIQUE DES TISSUS, LYONS, (RIGHT) MUSEI E GALLERIE PONTIFICIE; PHOTOGRAPHS, (LEFT) LAUROS-GIRAUDON, (CENTRE) GIRAUDON

illustrated, or where only the portraits of the evangelists appeared, were the most common. The work is usually of high quality. It may be contrasted with the more spontaneous marginal illustrations often included in the psalters, which frequently have a contemporary significance. (*See* Illuminated Manuscripts.)

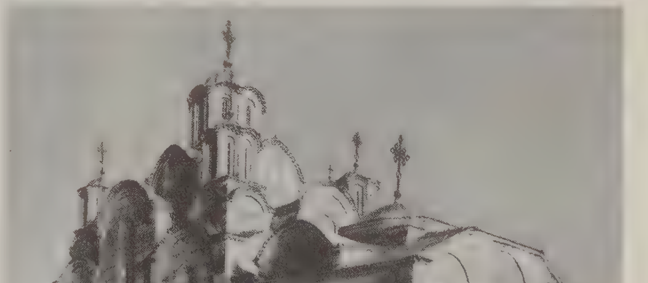
5. Ivories.—The small-scale works usually classed as minor arts reached a degree of excellence during the middle period which has been surpassed nowhere else in the world. The ivories are especially lovely. A few of them can be dated exactly, such as a fragment of a sceptre in the name of Leo VI (886–912) at Berlin, a panel showing the crowning of Constantine VII by Christ (944) in Moscow, and one with the crowning of Romanus II (959) in the Cabinet des Médailles, Paris. But in most cases dates can only be suggested on the basis of style. The ivories have been classified under a number of headings in a monumental survey made by A. Goldschmidt and K. Weitzmann. They term their first group that of Romanus, and associate a number of ivories with that showing his crowning, mentioned above; they include triptychs with the Deesis on the central panel in the Vatican, the Palazzo Venezia at Rome, and the Louvre, the last known as the Harbaville Triptych, as well as panels at Dresden, Venice, Vienna, and elsewhere.

Goldschmidt and Weitzmann's second group is built up around an ivory in the church of St. Francis at Cortona, Italy, which bears the name of Nicephorus II Phocas (963–969). It includes amongst others a fine triptych with the Virgin on the central panel at Luton Hoo, Bedfordshire, Eng. The faces are broader and heavier than those on ivories of the Romanus group. Other groups are distinguished not so much on the basis of date as by form or style, such as groups termed the "painterly" and the "framed," while a more obvious group is composed of caskets. The majority of examples are dated to the later 10th or earlier 11th centuries, but manufacture apparently continued at least until the early 12th century, the later ones being either more linear in style, like a panel with the Baptist and four apostles in the Victoria and Albert Museum, London, or the figures being very much elongated, as in a St. John at Liverpool. High relief and deep undercutting was apparently in special favour early in the 11th century.

Though the caskets were no doubt often carved by the same men who carved the plaques, they constitute an independent group, not only because of their form but also because they are nearly all adorned with secular motifs, drawn from classical literature. The panels bearing the scenes are framed in bands adorned with rosettes or sometimes human heads in profile; because of this the caskets are often termed rosette caskets. The finest is one in the Victoria and Albert Museum known as the Veroli casket. A few caskets of different type are also known; one at Florence has the rosette borders, but they frame panels bearing Christ, the Virgin, and saints; one at Troyes, France, has no rosette borders, while its side panels show confronted horsemen of Persian type and those at the ends, phoenixes that are distinctly Chinese. With the later 12th century, steatite plaques become more common than ivories, probably for economic reasons, but they bear low-relief decorations in a very similar style.

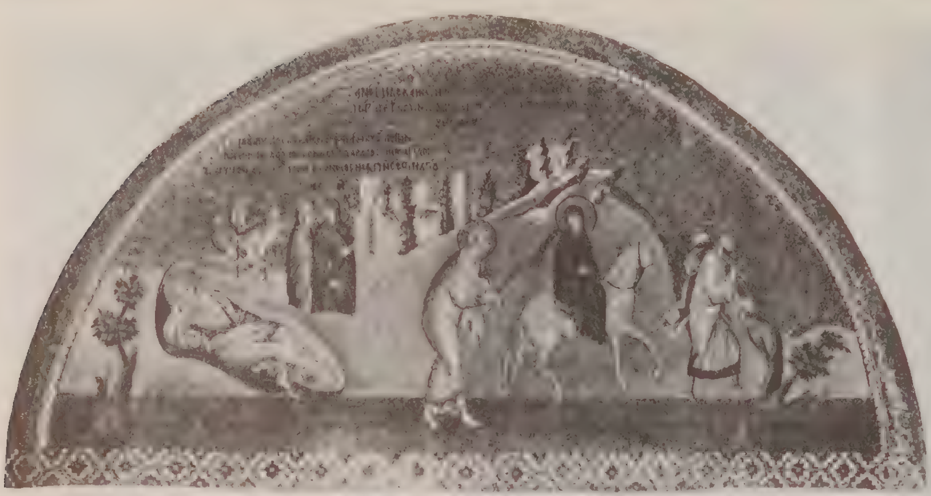
6. Metalwork and Enamels.—All the known examples of metalwork of this period are religious in character, but the texts speak of secular works, particularly vessels for the tables of the sumptuously furnished Great Palace. All this secular work must have been destroyed when the crusaders looted Constantinople in 1204, whereas some of the religious treasures, though by no means all, were saved for presentation to churches and monasteries at home. The largest share of the loot went to Venice, where it is preserved in St. Mark's and in the Marcian Library.

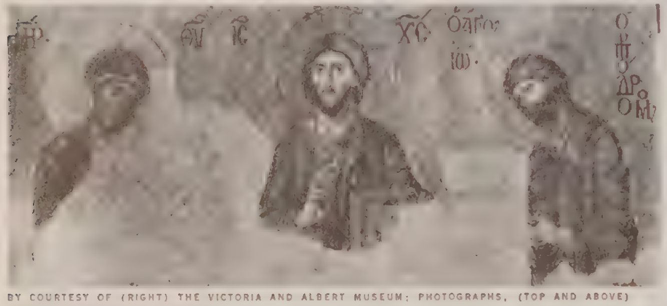
Works in metal alone usually bear decorations in the repoussé technique; that is to say, the designs were beaten out from the reverse side so that they stand out in relief on the surface. The effect is similar to ivory carving, and it is even possible that casts of the ivories were used as matrices. Plaques of copper, silver, and gold were produced in this way and were used as book

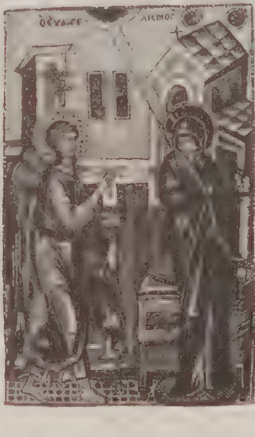


J. POWELL

CHURCH OF ST. JOHN THE BAPTIST, GRACANICA, SERBIA, *c.* 1320







BY COURTESY OF (RIGHT) THE VICTORIA AND ALBERT MUSEUM; PHOTOGRAPHS, (TOP AND ABOVE) HIRMER FOTOARCHIV MUNCHEN

(TOP) JOSEPH'S DREAM AND THE FLIGHT INTO EGYPT. MOSAICS IN THE CHURCH OF THE SAVIOUR IN CHORA (KAHRIYE CAMII), CONSTANTINOPLE; c. 1320. (ABOVE) DEESIS PANEL IN HAGIA SOPHIA, CONSTANTINOPLE; 12TH OR 13TH CENTURY. (RIGHT) MINIATURE MOSAIC OF THE ANNUNCIATION; c. 1310. IN THE VICTORIA AND ALBERT MUSEUM

covers or mounted on wood to adorn church screens. The finest individual plaque is probably one with the Virgin in the Victoria and Albert Museum. Plaques of a more complicated shape formed what are known as staurothèques; on these there is a compartment in the form of a Latin cross at the centre, into which a piece of the true cross was inserted; on either side there were usually the figures of Constantine and Helena. There is an especially fine example at Urbino, Italy. Occasionally, though so far as we can tell, not very often, designs of a similar character, produced by casting, are found. There is a fine gilt-bronze triptych in this technique in the Victoria and Albert Museum.

Very frequently metal served as a mount for decorations in other techniques, and these were often associated with repoussé work. Book covers, staurothèques, patens, chalices, and other objects were adorned in this way. The grandest example is no doubt the great staurothèque at Limburg in Germany, which came like so many of the treasures as loot from Constantinople after the Fourth Crusade. It consists of an inner compartment which houses the relic; its border is repoussé, while the framing for the cross is in enamel; the cover bears enamels showing the Deesis, two archangels, and the 12 apostles; on the back is a repoussé cross. Another fine staurothèque at Esztergom in Hungary is framed by fine enamels of the 11th century, enclosed in a repoussé mount, which is probably to be dated to the 13th century. Enamels set on metal grounds were also used to form book covers; some outstandingly fine examples are in the Marcian Library at Venice. There precious stones add additional glory and are important in producing the effect of the luxury typical of mid-Byzantine art. Most impressive of all, however, were the ecclesiastical vessels, made from such semiprecious stones as agate, jasper, or chalcedony and adorned with jewels, enamels, and precious metals. There are numerous chalices and patens in the treasury of St. Mark's. Most date from the 11th century.

The art of enameling has history of its own, independen of that of the metalwork object with which it was so often associated. The Byzantines favoure a special technique known a cloisonné, where thin metal wire soldered to a metal base serve like the pencil lines of a drawin to outline the details of a composition; the areas they bounde were filled with coloured paste or powders which vitrified on firing to glorious, jewellike colours Usually the compartments wer quite small, but occasionally, a in the case of an icon of th archangel Michael in St. Mark's entire surfaces were covered wit enamel, in this instance above repoussé ground.

There has been some disput as to when the art was first developed in the Byzantine worl and one of the earliest example we know, a small reliquary cros in the Victoria and Albert Museum known as the Beresfor Hope Cross, has been assigne both to the 7th and to the 9t century; as it bears the crucifie Christ on one face and the Virgi on the other, it could hardly hav been made during the intervenin iconoclastic period (726–843) A 9th century date seems mor likely. A book cover in th Marcian Library with the Crucifixion, a number of small medallions, and a decorative enamel border must date from about th same time; fine enamels from Stavelot, in the Ardennes, France now in the Pierpont Morgan Library, are to be dated somewha later. The most impressive series, however, forms what is know as the *Pala d'Oro*, in St. Mark's at Venice, a magnificent Gothi screen serving as a mount for numerous enamel plaques of varying forms, sizes, and dates. In the earlier enamels the colour are deep and bright and the compartments are comparatively large while the drawing is forceful and strong; in the later ones th colours tend to be paler, the compartments smaller, and the go lines more numerous, at times taking on the character of paralle hatchings. A fine more or less exactly dated example representing a halfway stage in development is afforded by the enamel from the crown of Constantine IX Monomachus (1042–55) no at Budapest, while the latest phase is illustrated by a cross a Cosenza in Italy. The most important workshops in early time were no doubt at Constantinople, but enamels were also made i Italy—there is a fine Italian plaque bearing a figure of Christ i the Palazzo Venezia at Rome. From the later 11th century excellent work was done in Georgia; examples are to be found in th museum at Tbilisi. (*See* METALWORK, DECORATIVE; ENAMEL.)

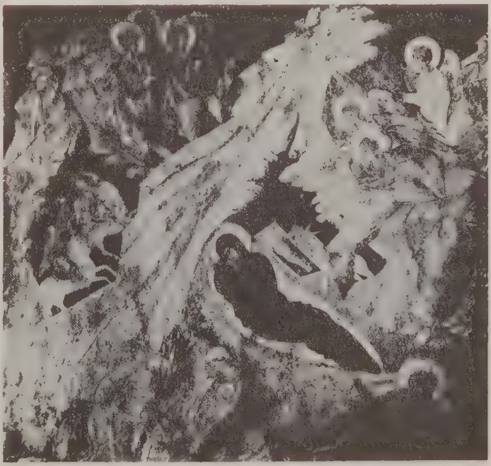
7. Textiles.—Textiles of every type were always importan but the luxury craft of silk-weaving was developed to a degre unsurpassed elsewhere, especially just before iconoclasm an during the Second Golden Age. The weaving of silk from imported materials had probably begun even before Justinian obtained the secret of its cultivation in 552; thereafter it continue as a strictly guarded monopoly almost until the time of th Turkish conquest (1453). One of the earliest of the silks tha can be dated with comparative certainty bears a design o quadrigae in medallions; it came from the tomb of Charlemagn (d. 814) at Aachen, and probably formed a part of the origina grave furniture, though the similarity of parts of the design t consular diptychs at one time suggested an earlier dating. A textile showing Samson struggling with a lion has again sometimes been attributed to the 6th or 7th century, but it, too, can hardly have been made before the 8th, though a silk in the Vatican with the Annunciation and the Nativity in roundels is perhaps as early as the 7th. Thereafter, whether because of iconoclasm or of Oriental influence, which affected textiles considerably, representational patterns of this type tended to disappear, the weavers turning rather to a repertory of stylized animals, birds, or formal patterns, often enclosed in medallions. Fine textiles of this type from the Constantinopolitan looms reached the West in considerable numbers, and there they have been preserved, having been used as shrouds for the burial of emperors or sainted bishops. One of the finest, bearing an inscription stating that it was made in the imperial factory at Constantinople, comes from the tomb of Charlemagne, where it was apparently introduced when the tomb was opened by Otto III in the year 1000. It is decorated with elephants in roundels, each more than half a metre (about 20 in.) in diameter. Textiles bearing heraldic-like lions, which are to be found in more than one collection, have similar inscriptions; in two cases they give dates in the 10th century. The largest collection is that in the treasury at Sens, France, where four or five magnificent silks are preserved, in addition to a large quantity of smaller fragments; one of the larger ones is a damask bearing a griffin of a type ultimately derived from Persia. More truly Byzantine is a silk at Auxerre, France, showing four great eagles with spread wings, the very epitome of Byzantine grandeur. These great silks were used in Byzantium as hangings in the palace, or in the churches, or for imperial and courtly costumes. Those with a purple ground were reserved for imperial use. Most of the examples date from the 10th century, but similar textiles are reproduced in paintings, more especially in manuscript illustrations, at a much later date, and there is evidence that their manufacture continued until the Turkish conquest. The Italian textile industry owed a considerable debt to Byzantium and so perhaps did that of the Turks, which flourished at Bursa not far from Constantinople until the 19th century. (*See* TEXTILES.)

8. Icons.—Despite the profusion of enamels and other treasures, panel paintings were in regular production throughout the middle period, more especially toward its end, when expensive materials were less easily procurable. The largest number are to be found in the Sinai monastery, where Weitzmann has isolated a particular group done at the time of the Crusades in a mixed Byzanto-European style. Others exist in various museums in the U.S.S.R. where they have been brought from outlying churches and monasteries for cleaning and conservation. Many of these were imported from Constantinople; one of the finest, an icon of the Virgin known as Our Lady of Vladimir, was painted there for a Russian patron about 1130. It is of considerable importance in the history of painting, for it is not only a work of outstandingly high quality but is also in a new, more humanist style, heralding developments that were to take place in the final phase of Byzantine art between 1204 and 1453. It was at this time that the cult of the icon really came into its own, partly because richer materials became rare, but more because of the growth of new ideas in art and thought.

9. Ceramics.—Another art that grew in importance in later times was that of ceramics. Of the earlier periods but little is known, and it would seem that wares of Roman type continued in use till at least the 8th century, for it is not until then that new and more sophisticated types of glazed pottery began to appear, notably one with a body of white clay covered with a thin yellowish-green glaze. Often there was no decoration, but in the finer examples inscriptions were sometimes scratched into the clay before firing or a design in relief was made by pressing the soft clay into a mold. Slightly later vessels with a somewhat similar white body were adorned with polychrome decoration, done in vitrifiable colours under a transparent glaze. The motifs of the decoration were either very Hellenistic, or, more often, showed the influence of Islamic or Sassanian art. Some of the known examples are of very high quality, and it is in this group that the entry of Byzantium into the field of fine ceramics is seen. Examples have been found in Bulgaria, in Russia, and in Greece, as well as at Constantinople, but those found in Russia and Greece are probably to be regarded as imports. There must have been workshops in or near Constantinople, but up to now it is only at Patleina in Bulgaria that kilns have been found; several variants of the ware were made there in the 9th and 10th centuries.

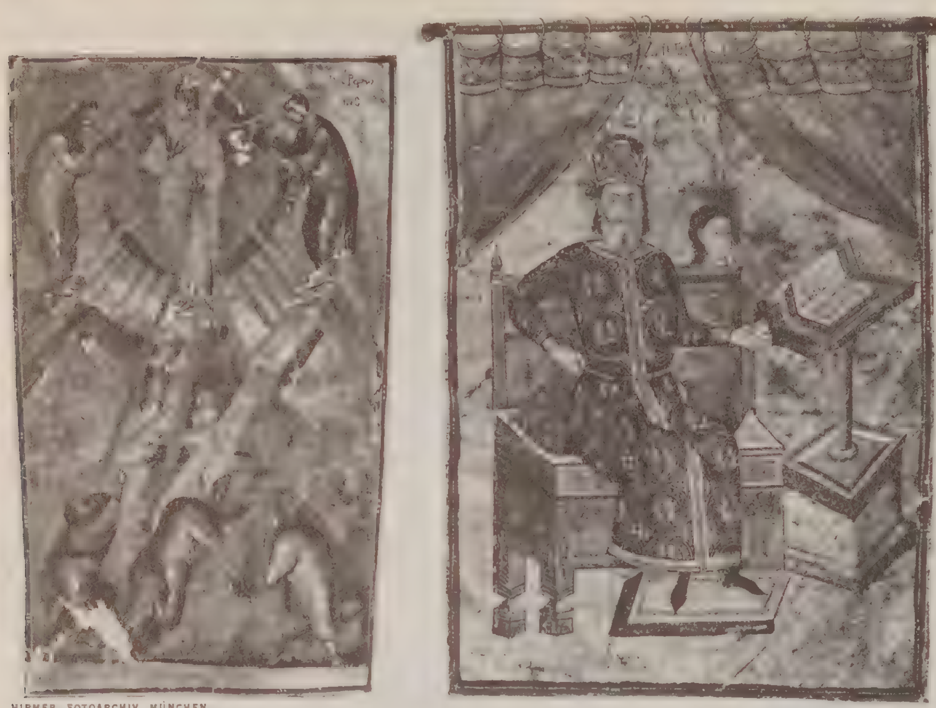
With the 12th century a new type became prominent; this had a body of red clay covered with thin white slip through which the decoration was scratched; the whole was then covered with glaze, which turned to a darker colour over the engraved area. In the earlier examples only one colour was used, usually cream; later, yellow and green glazes were added to produce a polychrome effect. The type is known as *graffito* ware. The technique came to Byzantium from the Islamic world, and affinities with Islamic pottery are often very close. The ware remained important till the time of the Turkish conquest, numerous variants being developed both in the course of time and according to the tastes of the different localities; kilns were numerous and vessels were even manufactured in quite small villages.

10. The Diffusion of Byzantine Art.—Though the power and economic prosperity of the empire were progressively reduced from the later 11th century onward, the influence of Byzantine art outside the frontiers of the empire became more and more important. The mosaics of Kiev in Russia, which date from about 1045, were the work of Byzantine craftsmen, and other Byzantine artists and artisans worked intermittently in Russia from that time onward, so that Russian art as a whole was founded on a Byzantine basis. In Sicily the majority of the mosaics set up by the Norman kings from just before the middle of the 12th



BY COURTESY OF (LEFT) THE BYZANTINE INSTITUTE, WASHINGTON; PHOTOGRAPH, (ABOVE) DIMITRI

(LEFT) FRESCOES IN A SIDE CHAPEL OF KAHRIYE CAMII, CONSTANTINOPLE, *c.* 1310–20. (ABOVE) THE NATIVITY, FRESCO IN THE CHURCH OF THE PERIBLEPTOS, AT MISTRA, GREECE, *c.* 1350



HIRMER FOTOARCHIV MÜNCHEN

(LEFT) THE TRANSFIGURATION. ILLUMINATION IN A MANUSCRIPT OF THE GOSPELS MADE FOR JOHN VI CANTACUZENUS, 1347–55. (RIGHT) PORTRAIT OF THE HIGH ADMIRAL ALEXIUS APOCAUCOS IN A COPY OF HIPPOCRATES, 14TH CENTURY. BOTH MANUSCRIPTS IN THE BIBLIOTHÈQUE NATIONALE, PARIS

century onward were the work either of Greek masters or of the local apprentices whom they had taught. In Venice and its neighbourhood Greek craftsmen played a similar role in establishing the Venetian mosaic industry. Finally in the Balkans, where at this time independent empires were springing up, the arts were developed in a wholly Byzantine style, craftsmen from Constantinople playing a prominent part in establishing them. Even in the arts of the West, Byzantine elements are frequently to be discerned, and they seem to have been more to the fore in the later 11th and 12th centuries than at any other time, with the exception of the early 11th century, when the Ottonian emperors constantly turned toward Byzantium.

V. THE FINAL PHASE, 1204–1453

It was at one time held that the crusading conquest of Constantinople in 1204 spelled the end of Byzantine art. This was however most emphatically not the case. True, the production of sumptuous works in metal and enamel ceased, but architecture, wall mosaics, wall and panel paintings, and textiles were all important; ceramics were produced in very large quantities; and two new arts were developed, those of embroidery and miniature mosaics; in all of them work not only of high quality but also in a new idiom was produced.

1. Architecture.—Quite a number of buildings from this age survive in Constantinople, there are many in Salonika, and even larger numbers are to be found all over Greece and the Balkans. In general they are on a small scale and follow the plan of those of the Second Golden Age. But their appearance changed quite considerably, the domes becoming smaller and higher, while the wall surfaces of the exterior were usually elaborately decorated, either with intricate patterns in brickwork or by setting glazed pottery vessels into the wall to form friezes similar to tile-work. In Constantinople elaborate blank arcading also played an important role, as for example in the church of the Virgin Pammacaristos (Fethiye Camii; *c.* 1315). The actual building material varied with the locality, though generally brick was preferred to stone. In the details of planning and in the handling there was considerable variation from region t region, and numerous local style may be distinguished. Grandeu was generally lacking, except perhaps in the churches set up fo the Comnene emperors of Trebizond (1204–1461), but all th buildings have considerabl charm and deserve fuller consideration than they have sometime received. Good work was don even after the Turkish conquests especially on Mt. Athos and i Moldavia, where the large-scal painted churches, which mostl date from the 16th and 17th centuries, are often both magnificen and very beautiful.

Even at this period little i known of secular architectur but a portion of the Blacherna palace at Constantinople, usuall given its Turkish name of Tekfu Sarayi, may be noted, and attention must also be drawn to th monasteries, more particularly t those on Mt. Athos; though the have been much restored or eve wholly rebuilt, the general layou of most of them follows a Byzantine scheme.

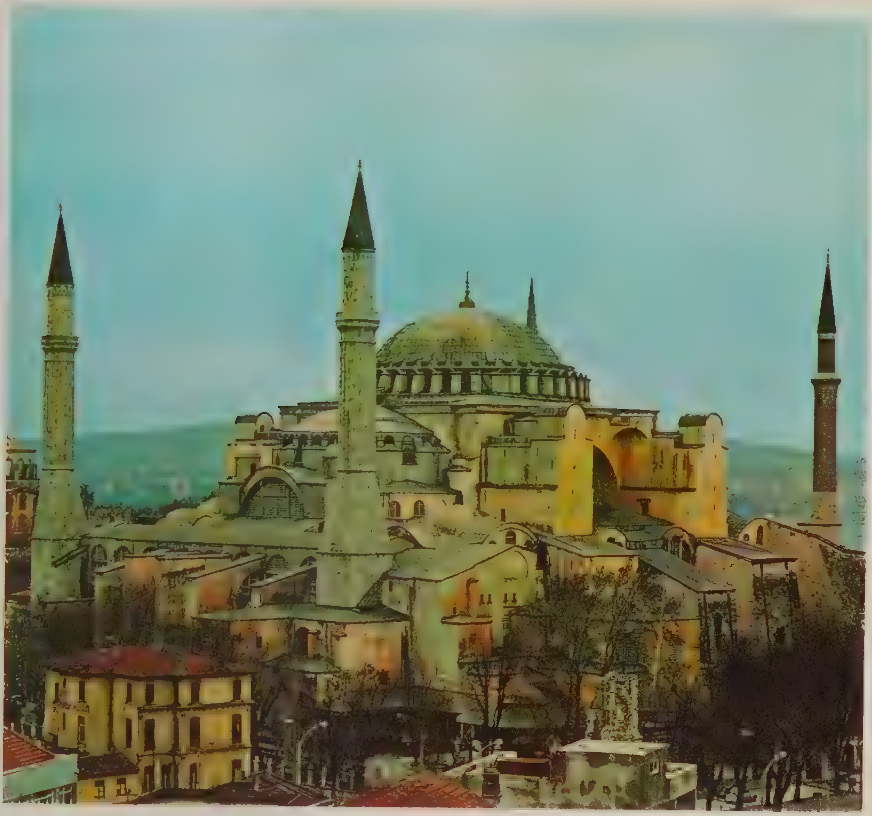
2. Mosaics.—Of the mosaic the first to be considered is th Deesis panel in Hagia Sophi noted above. Like the icon Ou Lady of Vladimir it is in a new, more personal style; Christ ha lost the awesome aspect of mid-Byzantine renderings, like tha at Daphni, and has become essentially human; the Virgin is tende and intimate, and the conception is idealistic rather than emotional. There has been some argument as to the date of thi panel; by some it is regarded as the first monument to be se up in Constantinople after the return of the Orthodox rulers i 1261; by others it is dated to the 12th century, on the ground that so monumental a work could hardly have been undertake after the Latin interregnum. If it is of the 12th century, it admittedly precocious in style, but no more so than the ico while other work of this century shows something of the sam humanist approach, notably the wall paintings at Nerez in Macedonia, dated to 1164. On the whole a 12th century date seem more probable than one at the end of the 13th century.

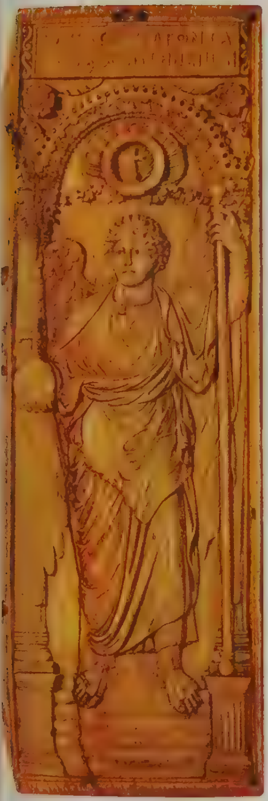
Other mosaics of the last phase are happily more closely date The most important are those in the church of the Saviour i Chora at Constantinople, better known by its Turkish name Kahriye Camii. The mosaics were set up on behalf of a grea nobleman of the day, Theodore Metochites, shortly before 132 he appears as donor, offering a model of the church to Chris The mosaics are in a lively, picturesque style, full of human interest, but they nevertheless remain essentially religious in spiri There are many close resemblances to the almost contempora work of Giotto (*q.v.*) at Padua (*c.* 1303), but Giotto's searc for realism is absent. The interior of the church is a veritab jewel, and the decoration as a whole stands out as one of t truly great masterpieces not only of Byzantine but also of Eur pean art. Mosaics of much the same date and style, but clearl produced by different workshops, survive in two other church at Constantinople, that of the Virgin Pammacaristos (Fethiy Camii) and that of St. Theodore Tyro (Kilisse Camii), as we as in the church of the Holy Apostles at Salonika; all date fro the second decade of the 14th century. The mosaic in the ap of the church S. Donato on the island of Murano near Veni is also probably a Byzantine work of this period.

Stylistically and iconographically the miniature mosaics a

BYZANTINE ART AND ARCHITECTURE

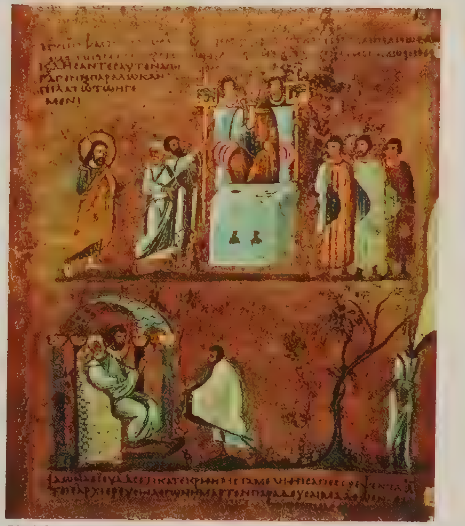
Cathedral of Hagia Sophia, Constantinople, built 532–537. The main dome (rebuilt 558–563) covers a central space of 107 ft. The Turkish minarets were added in the 15th and 16th centuries



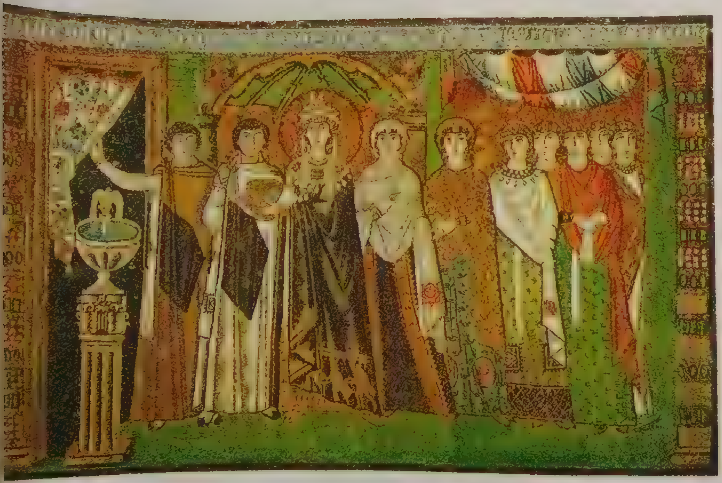


THE FIRST GOLDEN AGE, 6th CENTURY

The archangel Michael, leaf of an ivory diptych from Constantinople, 519–527. In the British Museum



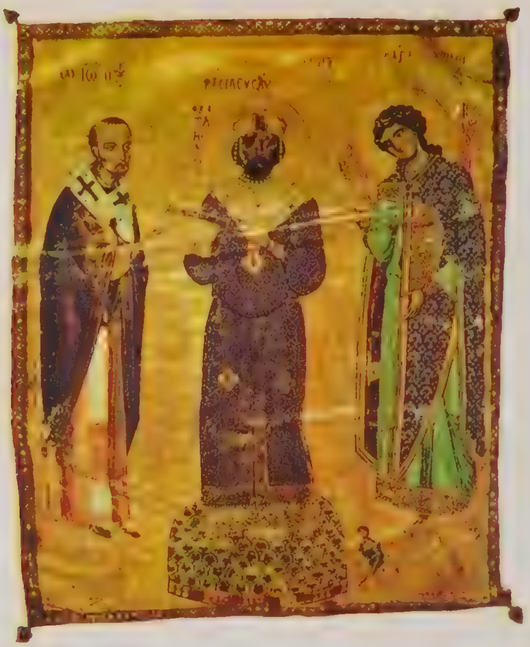
Christ before Pilate and the repentance and death of Judas, miniatures from the Rossano Gospels, possibly from Constantinople, 6th century. In the Cathedral Treasury, Rossano, Italy



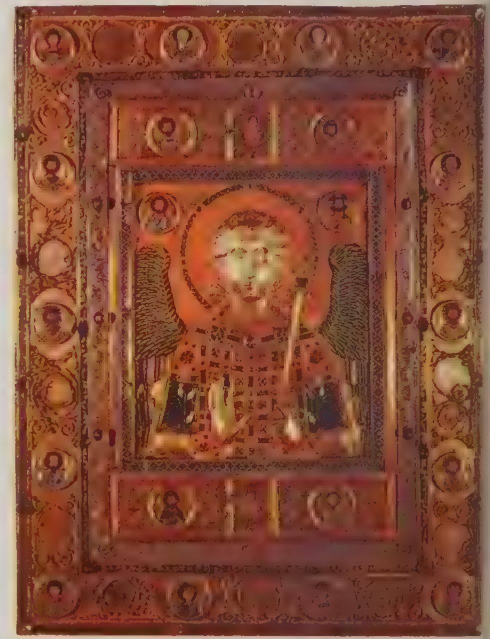
The empress Theodora and her retinue, mosaics in the choir of the church of S. Vitale, Ravenna, Italy, before 547

COURTESY OF (TOP LEFT) THE TRUSTEES OF THE BRITISH MUSEUM; PHOTOGRAPHS, (TOP RIGHT) ARA GÜLER, (BOTTOM LEFT) SCALA, (BOTTOM RIGHT) HIRMER FOTOARCHIV

BYZANTINE ART AND ARCHITECTURE

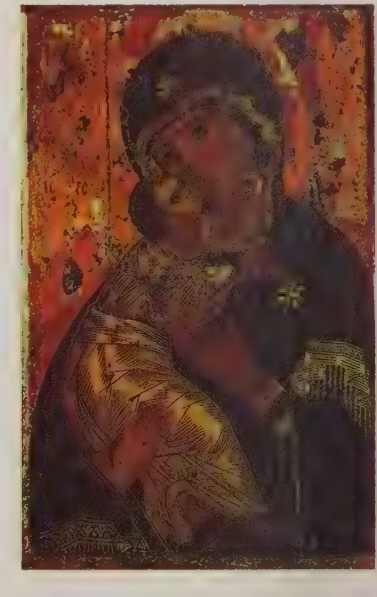


St. John Chrysostom presenting his collected sermons to the emperor Nicephorus III Botaniates; on the right is the archangel Michael. Miniature from the "Homilies of St. John Chrysostom," 1078-81. In the Bibliothèque Nationale, Paris

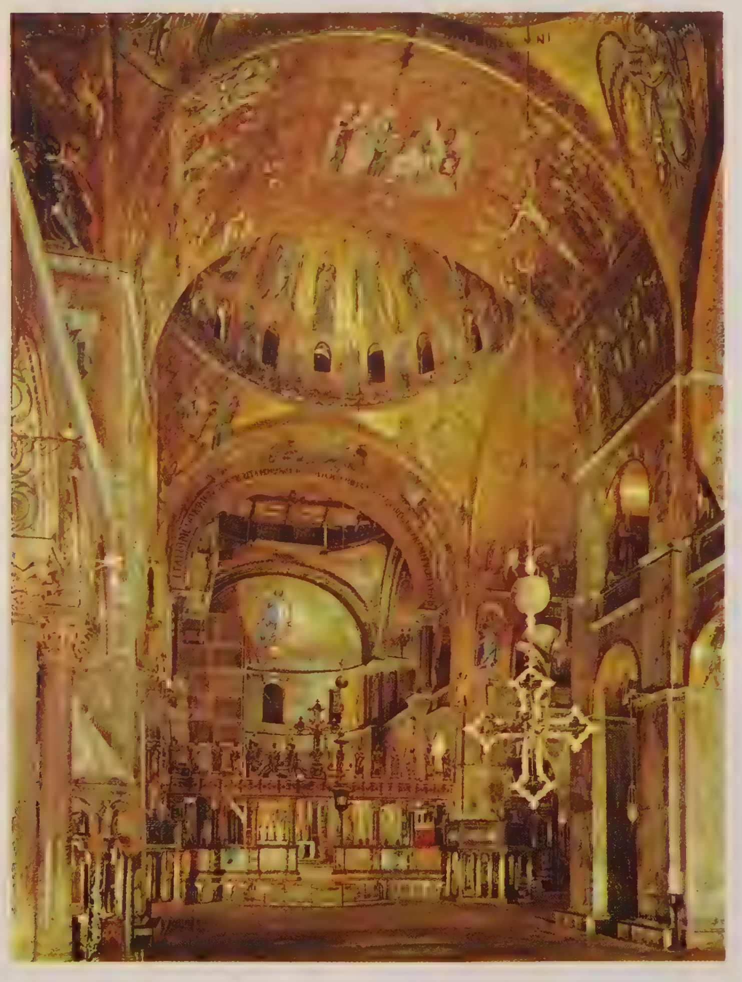


The archangel Michael, repoussé gold and enamel icon from Constantinople, 10th century. In the Treasury of St. Mark's Venice

THE SECOND GOLDEN AGE, 843–1204

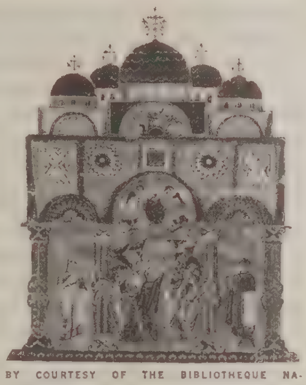


'Our Lady of Vladimir,' an icon of the Virgin and Child painted in Constantinople, *c.* 1130. In the State Tretyakov Gallery, Moscow



Basilica of St. Mark's, completed in 1073. The walls and ceilings are covered with mid- and late-Byzantine mosaics depicting biblical scenes

BY COURTESY OF (TOP LEFT) THE BIBLIOTHÈQUE NATIONALE, PARIS; PHOTOGRAPHS, (TOP RIGHT) OSVALDO BÖHM, (BOTTOM LEFT) SCALA, (BOTTOM RIGHT) NOVOSTI PRESS AGENCY



BY COURTESY OF THE BIBLIOTHEQUE NATIONALE, PARIS

THE ASCENSION, MINIATURE FROM "SERMONS ON THE VIRGIN" BY JACOBUS KOKKINIBAPHOS, 12TH CENTURY. IN THE BIBLIOTHÈQUE NATIONALE, PARIS

closely related to those on the walls; technically they are distinct in that the tesserae are mounted not in plaster but in wax on a wooden ground. They vary in size from panels three or four feet high to very small ones, perhaps six inches high, where the cubes are no larger than a pin's head. The majority of examples are to be assigned to the first half of the 14th century. There are quite a number in the monasteries of Mt. Athos; among the most beautiful are a panel with the Annunciation in the Victoria and Albert Museum and one with St. John Chrysostom at Dumbarton Oaks, Washington, D.C., and one of the most important is a diptych with the Twelve Feasts of the Church (the principal scenes of our Lord's life and passion) in the Opera del Duomo at Florence.

3. Wall Paintings.—The story of wall paintings of the last phase also begins in the 12th century with the decoration at Nerez in Macedonia (1164). It was done for a Byzantine patron, and is in the same humanist style at the Deesis mosaic in Hagia Sophia; it was certainly the work of a man trained in the metropolis. Work in a similar metropolitan style is to be found at Vladimir in Russia (1193), and these models were followed by local craftsmen, as for example at Kurbinovo in Macedonia (1191) and Spas Nereditsa near Novgorod in Russia. But in the 13th century the metropolitan style predominated in such paintings as those at Mileševa (1135) and Sopoćani (1165) in Yugoslavia and in the church of Hagia Sophia at Trebizond (*c.* 1160).

Since Constantinople was at this time in the hands of the Latins it must be concluded that artists who had fled the capital after the Latin conquest of 1204 had established schools in a number of different areas, and that such paintings as these were the work of men they had trained. By the end of the century, however, local schools had begun to assert their independence, especially one broadly termed the Macedonian; its products were forceful and more dramatic than those of the Metropolitan school. Early work of this school is to be found in the chapel of St. Eugenius, attached to the church of St. Demetrius at Salonika, in the Protaton (*c.* 1300), at Kariai (Karyes) on Mt. Athos, and in some of the monasteries there, as well as in a number of churches in Serbia and Macedonia that were decorated under the patronage of King Milutin at the end of the 13th and in the early years of the 14th century. There has been some dispute among authorities as to whether King Milutin's masters were Greeks from Salonika or local Slavs. Throughout the 14th century a great deal of work was done by painters of the Macedonian school over the whole of Yugoslavia and in Greece, and somewhat similar work was done in Bulgaria.

At Constantinople some paintings of outstanding quality, closely related to the mosaics, were done in a side chapel of Kahriye Camii, and it is known from the texts that similar paintings existed in a number of other churches there. Several were painted in the third quarter of the 14th century by Theophanes, who then moved to Russia and became a prominent figure in Russian painting. The same style was also introduced to Mistra in the Peloponnese, and the wall paintings of the Brontocheion (early 14th century), the Peribleptos (*c.* 1350), and the Pantanassa (1428) there are all of high quality. Paintings in the monasteries of the Morava Valley done at the end of the 14th and beginning of the 15th centuries are in the same refined style, which is quite distinct from that of the Macedonian school.

4. Illuminated Manuscripts.—Illuminated manuscripts of this last age are not as numerous as those of the middle period, but their quality is often just as high. A few seem to have been produced during the 13th century, both at Constantinople and in the cities where Orthodox nobles established themselves while the Latins were in the capital, notably Nicaea and Trebizond. After the return to Constantinople in 1261, however, the noble families seem to have played a greater role as patrons than the emperors, and many of the more important works of art of the age were produced on their behalf. A copy of Hippocrates now in the Bibliothèque Nationale (Gr. 2144) was made for the high admiral Alexius Apocaucos and a beautiful copy of the gospels in the same library (Gr. 1242) was done for John VI Cantacuzenus between 1347 and 1355. Manuscripts were, of course, also copied and illuminated in the monasteries, and this continued until printing made them no longer necessary. Few of the later ones contain illuminations of great quality. In the Slav lands, however, fine work continued, and in Rumania excellent manuscripts were executed in the 16th century.

5. Icons.—Painted panels assumed a new importance in this last phase. The most sophisticated work was done at Constantinople, some of it for patrons from elsewhere, notably Russia, and a number of icons survive that can be associated with the city on the basis of literary evidence or inscriptions. A particularly fine double-sided icon, with the Virgin on one face and the Annunciation on the other, now in the museum at Skopje, Yugos., was presented to the bishop of Ohrid by John Cantacuzenus about 1350.

However, schools of painting were growing up in numerous other places also, notably at Salonika, on Mt. Athos, and in many centres in Bulgaria, Greece, and Yugoslavia. In a few instances icons can be assigned to a definite centre, thanks to inscriptions or other records, but the study of these panels has not yet progressed far enough to permit any reliable classification under localities on the basis of style alone. Icons continued to be painted in large numbers after the Turkish conquests of the mid-15th century in every part of the Orthodox world and, though few of the later ones are of the very first quality from an artistic point of view, many are of interest. In the 16th century Crete became an important centre, and many Cretan painters worked also in Venice, where there was a large Greek colony; many of the products of this school are to be found today in the museum attached to the church of St. George of the Greeks there.

6. Textiles.—The woven silks which are frequently depicted on paintings of the last phase would appear to have been very similar to those of the middle period, but practically no actual textiles of this type survive. However, there exist a large number of ecclesiastical embroideries, the earliest of which date from the end of the 14th century. They are in a very special technique, with the faces done in silk with great exactness and delicacy, the costumes of the figures and details of the background worked rather more coarsely in metal threads, and the borders made of small pearls. All were done for use in the church either as vestments or as altar cloths. An example is an *epitaphios*, or altar frontal for use on Good Friday, dated 1407 and now in the Victoria and Albert Museum. After the fall of Constantinople the production of embroideries of this type flourished especially in Greece and Rumania, and there is a rich collection of examples of the 16th and 17th centuries in the monastery of Putna in Moldavia.

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(D. T. Ri.)

BYZANTINE EMPIRE. The Byzantine or east Roman empire was in essence the Roman empire in its medieval form; and its early beginnings can already be discerned in the reign of Constantine the Great, who profoundly influenced the course of European and imperial history. There was no break in continuity, for the Roman imperial tradition and Hellenistic civilization continued to be essential elements of the Byzantine polity. But Constantine's adoption of Christianity and his foundation of Constantinople marked a new epoch.

The empire of the *Rhomaioi* with its emphasis on its Greek heritage was to be a Christian empire centred in the eastern half of the Mediterranean. The foundation of Constantinople provided an admirable base for the administration and defense of the eastern and Balkan provinces, as well as a first-rate centre for international trade.

During its long life of 1,130 years the Christian empire had various roles; in particular, it acted as the defender of Europe against the great powers of western Asia and it introduced the young Slav peoples of the Balkans and Russia to Christianity and the heritage of the Greco-Roman world. It faced a continuous succession of enemies on its northern frontier in Europe—Germanic, Slav and Turkic peoples—and in the case of the Slavs and Bulgars had to accept them as permanent inhabitants in the Balkans. It also observed perpetual vigilance in the east, where it was in almost continuous conflict with the powers which successively inherited the dominion of Cyrus and Darius. From this point of view the external history of the empire was marked by four great struggles, each with a different Asian power: with Persia, ending *c.* 630 in the victory of Constantinople; with the Muslim Arabs, who ceased to be formidable in the 11th century; with the Seljuk Turks, in the 11th and 12th centuries; and with the Ottoman Turks, who emerged triumphant by the 15th century. It should, however, be emphasized that from the 11th century onward the hostility of certain Latin powers, notably the Normans and then Venice, culminating in the Latin capture of Constantinople in 1204, was a strong contributory factor in weakening the empire's resistance to the Turks.

Up to the middle of the 11th century the Byzantine empire was in actual strength and prestige the first power in Europe, and under the Comneni it still had considerable authority in the 12th century. And until the rise of the Italian maritime cities it was supreme in commerce. Throughout the medieval period until its capture by the Latins in 1204, Constantinople was in fact the foremost city in the Christian world. But the significance of the Byzantine empire consisted in far more than mere political strength As the heir of antiquity it was undoubtedly superior in civilization and was largely responsible for introducing the rest of Europe to its Greek heritage. The needs of the Christian church gave fresh impetus to creation in building, the visual arts and music, and to a lesser degree in literature.

This account of the Byzantine empire is treated as follows:

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  D. The North Syrian Dynasty (Isaurians)
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    2. Success Against the Muslims
    3. Events in Italy
    4. Home Affairs
  F. Imperial Decline; Normans and Seljuk Turks
  G. The Comneni, the Angeli and the Crusades
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I. HISTORY

A. Christian Roman Empire; Barbarian Migrations

By their administrative and financial reforms Diocletian an Constantine immeasurably strengthened the empire. Its vast extent made subdivision essential, but Diocletian's experiment o two Augusti and two Caesars proved a failure; after Constantine had destroyed his last rival and restored peace, he remained sol ruler for the rest of his life. On his death his son Constantiu ruled the eastern part with its capital at Constantinople, and Constans (after the death of Constantine II in 340) governed the western half, only to be killed by the usurper Magnus Magnentius i 350. Constantius then defeated Magnentius and was left the onl sovereign of the whole empire.

Constantine the Great had firmly supported the Christian churc in its pronouncement against heresy, but after his death Arianis openly rent the imperial house. The Arian Constantius, who ha no children, was succeeded by his cousin Julian (361–363), wh openly attempted to revive paganism. He was, however, kille fighting against Persia, and the eastern struggle was temporarily suspended by a treaty negotiated by his successor, the Christian Jovian (363–364), whereby the empire renounced territory in Mesopotamia as well as its claims in Armenia.

This period was also characterized by wars against the Germans, who were pressing against the northern frontiers. Pushed forward by the Huns (*see* Goths; Huns), the Visigoths crossed the Danube; at the battle of Adrianople (378) Valens, ruler of the eastern half of the empire, was defeated and killed. This signal victory marked a new stage in the relations between Roman and German. Theodosius the Great temporarily saved the situation by his arrangement with the Goths whereby Visigoths and Ostrogoths were allowed to settle in the Balkan provinces as *foederati.* The efforts of a series of exceptionally able and hard-working rulers had thus preserved the empire intact throughout the 4th century, but the dangers which they weathered were fatal to their weaker successors in the western half of the empire. After the death of Theodosius I (395) the empire, now ruled by his two sons, was still regarded as a unity, but the tension between the east (under Arcadius) and the west (under Honorius) developed into antagonism verging on hostility, and in the west many provinces were rapidly lost to the Germans (*see* Roman History).

After the death of Honorius' nephew, Valentinian III (455), the Theodosian dynasty ended in the west, and the authority of the western emperors who succeeded him in rapid succession barely extended beyond Italy. In 472 the western throne was usurped by Romulus Augustulus, set up by the general Orestes against the legitimate Augustus, Julius Nepos, who was acknowledged by the eastern emperor. But in 476 this temporary government was overthrown by a Germanic military revolution headed by Odoacer, who appropriated part of the soil to his German soldiers and founded an Italian kingdom under the nominal supremacy of the emperor at Constantinople, who, however unwilling, recognized Odoacer's position after the death of Nepos in 480.

The very different fate of the eastern provinces shows the extent to which the strength of the empire lay in the east. These provinces were more populous and presented greater obstacles to the invaders, who followed the line of least resistance. But it was of considerable importance that for the greater part of this period the empire was able to maintain at least intermittent peace with its great eastern rival. The struggle with Persia, terminated in 364 by the peace of Jovian, was not renewed on any scale until the beginning of the 6th century. It was of even greater importance that the eastern rulers pursued a wise policy both in internal and in foreign affairs. Under the weak Theodosius II (408–450) the government was ably conducted by his ministers and by his sister Pulcheria. His reign was important for the Armenian question. Theodosius I had agreed to a division of this buffer state into Roman and Persian spheres of influence, Persia having much the larger. The Sassanian government persecuted the Christians and tried to suppress the use of the Greek language, but the government of Theodosius II intervened on behalf of the Christians and war broke out which was ended by a treaty in 422. The Byzantines also officially supported the translation of the Bible into Armenian (the Armenian alphabet had just been invented), thus facilitating the development of the Christian church there and initiating numerous translations from the Greek which ensured the connection of Armenia with European rather than oriental culture (*see* Armenian Literature). This reign is also distinguished by the building of the great land walls of Constantinople, by the foundation of a university there in 425, and by the collection of the imperial laws in the *Codex Theodosianus,* which is a mine of information on the social condition of the empire (*see* Roman Law).

In the second half of the 5th century in the east, as in the west, the empire had to face renewed inroads from the Germans, and during the reigns of Marcian (450–457) and Leo I (457–474) the government of Constantinople was largely under the control of the Alan leader, Aspar. Leo I however called in the hardy native warriors of Isauria in south Asia Minor. Strong anti-German feeling drove out Aspar, and the Isaurian chief Zeno married Leo's daughter and took control, first as co-emperor with his son Leo II and then as sole emperor. A further threat from the Ostrogoths in the Balkans was met by diverting them to Italy, where their leader Theodoric founded a kingdom which was, in its constitutional aspect, a continuation of Odoacer's regime. Theodoric, like Odoacer and Alaric, held the double position of German king and Roman official. He was *magister militum* as well as *rex.* His powers were defined by capitulations which were arranged with the emperor Anastasius I in 497 and loyally observed. The right of legislation was reserved to the emperor, and Theodoric never claimed it; but for all practical purposes he was independent. Thus by the end of the 5th century the east had successfully warded off the Germans, while the western provinces had virtually been lost to them.

Byzantine Rulers

324–337	Constantine I the Great
337–361	Constantius
361–363	Julian
363–364	Jovian
364–378	Valens
379–395	Theodosius I the Great
395–408	Arcadius
408–450	Theodosius II
450–457	Marcian
457–474	Leo I
474	Leo II
474–475	Zeno
475–476	Basiliscus
476–491	Zeno (again)
491–518	Anastasius I
518–527	Justin I
527–565	Justinian I the Great
565–578	Justin II
578–582	Tiberius II Constantinus
582–602	Maurice
602–610	Phocas
610–641	Heraclius
641	Constantine III and Heracleonas
641	Heracleonas
641–668	Constans II Pogonatus
668–685	Constantine IV
685–695	Justinian II Rhinotmetus
695–698	Leontius
698–705	Tiberius III
705–711	Justinian II (again)
711–713	Philippicus Bardanes
713–715	Anastasius II
716–717	Theodosius III
717–741	Leo III the Isaurian
741–775	Constantine V Copronymus
775–780	Leo IV the Khazar
780–797	Constantine VI
797–802	Irene
802–811	Nicephorus I
811	Stauracius
811–813	Michael I Rangabe
813–820	Leo V the Armenian
820–829	Michael II the Amorian
829–842	Theophilus
842–867	Michael III the Amorian
867–886	Basil I
886–912	Leo VI the Wise or the Philosopher
912–913	Alexander
913–959	Constantine VII Porphyrogenitus
920–944	Romanus I Lecapenus
959–963	Romanus II
963–969	Nicephorus II Phocas
969–976	John I Tzimisces
976–1025	Basil II Bulgaroctonus
1025–28	Constantine VIII
1028–34	Romanus III Argyrus
1034–41	Michael IV the Paphlagonian
1041–42	Michael V Calaphates
1042	Zoe and Theodora
1042–55	Constantine IX Monomachus
1055–56	Theodora (again)
1056–57	Michael VI Stratioticus
1057–59	Isaac I Comnenus
1059–67	Constantine X Ducas
1068–71	Romanus IV Diogenes
1071–78	Michael VII Ducas (Parapinaces)
1078–81	Nicephorus III Botaniates
1081–1118	Alexius I Comnenus
1118–43	John II Comnenus
1143–80	Manuel I Comnenus
1180–83	Alexius II Comnenus
1183–85	Andronicus I Comnenus
1185–95	Isaac II Angelus
1195–1203	Alexius III Angelus
1203–04	Isaac II (again) and Alexius IV Angelus
1204	Alexius V Ducas
1204–22	Theodore I Lascaris
1222–54	John III Vatatzes or Ducas
1254–58	Theodore II Lascaris
1258–61	John IV Lascaris
1259–82	Michael VIII Palaeologus
1282–1328	Andronicus II Palaeologus
1328–41	Andronicus III Palaeologus
1341–91	John V Palaeologus
1347–54	John VI Cantacuzenus
1376–79	Andronicus IV Palaeologus
1390	John VII Palaeologus
1391–1425	Manuel II Palaeologus
1425–48	John VIII Palaeologus
1449–53	Constantine XI Palaeologus

B. Justinian and His Immediate Successors

The conception of the empire as a single unit still firmly persisted, and in the 6th century Justinian I (527–565) made a bold attempt to recover the lost western provinces. He had already dominated imperial policy under his uncle Justin I (518–527) and he sponsored the repudiation of the monophysite policy (*see* Monophysites) of Anastasius I (491–518), thus enabling the resumption of ecclesiastical relations with Rome. The proposed expeditions against the Ostrogoths in Italy and the Vandals in north Africa afforded him the opportunity of delivering native Catholic Christians from their pro-Arian Germanic rulers. The

Vandal power had declined and the able general Belisarius (*q.v.*) won back Africa in a single expedition in 533. In Italy the Ostrogothic kingdom was rent by internal dissension and weak rule after the death of Theodoric (526), but its conquest was long drawn out, partly because of the rise of the Gothic leader Totila. Begun in 535 by Belisarius, the conquest was completed by Narses, but not until 555. The corner of southeast Spain was also won from the Visigoths so that the Romans again commanded the western straits. At the same time Justinian was engaged in a series of Persian wars with Kavadh and then his successor Khosrau I. Justinian also had to protect the Danube against the Slavs and Bulgars who constantly threatened the Balkan provinces and he spared no expense in strengthening fortifications. In addition he had an extensive building program of public works and churches.

Justinian, inspired by his high conception of the imperial office and well served by his generals and administrators, was a great conqueror, a great lawgiver, a great diplomat and a great builder. He was also the protector and leader of the church. His legal work alone, or the building of Hagia Sophia, the "great church" of Constantinople, would be sufficient to justify his title of "the Great." His name is always associated with that of the gifted Theodora (*q.v.*), an actress of dubious fame in her early life, who shared his throne. Their mosaic portraits are preserved in the contemporary church of San Vitale at Ravenna. Theodora possessed great political influence, and the fact that she was a champion of the monophysites, while Justinian was devoted to orthodoxy, did not affect their good relations, even though until her death in 548 she secretly favoured heretics who were publicly condemned. The monophysites were particularly strong in Syria and Egypt, provinces which were hostile to Roman rule, and Justinian failed to devise any ecclesiastical compromise which would conciliate them without alienating the rest of the empire. In view of his Italian policy it was particularly important for him not to have any break with Rome.

Justinian's attempt to restore the imperial boundaries made severe demands and was not permanently successful. But it did at least reintroduce Roman rule into the north African provinces for more than a century, and it was from north Africa that help was sent to save Constantinople in its hour of need in the early 7th century. Justinian renewed direct links between Italy and Constantinople which were not broken until the Norman conquest of the last remaining Byzantine provinces in the 11th century. At the same time he held his own against the Persians on the eastern frontier and successfully asserted Byzantine influence in the important territory of Lazica (*see* Colchis) in the southeastern Black sea area. (*See* also Justinian I.)

During the half-century after Justinian's death the empire had to cede ground on the west and the north and was attacked by the Persians on the east. In 568 the Lombards invaded Italy and soon established themselves in the north and centre of the peninsula, though the empire still retained important areas linking Ravenna and Rome, as well as the south Italian lands. In the north the Avars, a Turkic people who had advanced from the Caspian, took possession of Pannonia and Dacia and formed an empire, consisting of Slav and Bulgar subjects, which endured for about 60 years. Their chief occupation was to invade the Balkan peninsula and extort tribute and ransoms from the emperors. So far as the Avars themselves were concerned, these incursions had no permanent significance, but the Slavs who overran the provinces did more than devastate. These years saw the beginning of the Slav settlements which changed the ethnic character of the peninsula and infused fresh blood into the Byzantine empire. Slavs occupied Moesia and a large part of Macedonia, even close to Thessalonica (Salonika), which they besieged but never took; they penetrated southward into Greece and settled in parts of the Peloponnesus. They occupied the northwestern provinces, which became Croatia and Serbia, as well as the hinterland of the Dalmatian coast. In the northern part of the peninsula the Slavs remained dominant, but in Greece they were eventually assimilated. At the same time that the Lombards and Slavs were invading the empire, it was engaged in its perennial warfare with Persia. Maurice (582–602), who had ably organized the exarchates of Ravenna and Carthage, was able to make an advantageous treaty with Persia, and he secured the alliance of Khosrau II by helping him to dethrone a usurper. Maurice himself was deposed and killed by Phocas, during whose incompetent reign (602–610) the eastern provinces were overrun by the Persians, and the Balkans by the Slavs.

C. The Heraclians

The tyrannical and unsuccessful rule of Phocas ended in 610 when the exarch of Africa sent his son Heraclius with the African fleet to Constantinople. Phocas was deposed and killed and the coronation of Heraclius on Oct. 3, 610, inaugurated a dynasty whose work during the 7th century was to save the empire from disintegration and to lay the foundations of medieval Byzantium. Heraclius found the Balkans and Greece overrun by the Slavs and Avars; Asia Minor, Syria and Egypt by the Persians. The desperate nature of the situation and also the appeal which the west still made are shown by Heraclius' proposal to transfer the imperial capital from Constantinople to Carthage. This was keenly opposed in Constantinople and Heraclius therefore abandoned the idea. He set about restoring morale in the capital and in the provinces. Most of the Balkans and Greece was at the time virtually lost to the Slavs and Bulgars, and Heraclius and his immediate successors concentrated on the territory which was still under imperial control in Asia Minor. These provinces were now grouped into large themes or military zones, each under a single military governor (*strategos*) to whom the civil administrators were responsible. This system was gradually extended throughout the 7th and succeeding centuries as the Byzantines recovered control over their Balkan and Greek provinces and then expanded their eastern frontier. Within the themes soldiers were given inalienable grants of land on condition of military service which passed from father to eldest son. This provided an efficient and relatively inexpensive native army and strengthened the class of small independent farmers. New developments also occurred in the central administrative departments which were to characterize the middle as distinct from the early Byzantine period (see *Administration* below).

Partly as a result of these changes, partly by reason of able diplomacy, Heraclius and his successors were able to defeat the Persians and at least hold back the Arabs on the eastern front. In the early years of Heraclius' reign the Persians had made spectacular advances. Syria was invaded; Antioch and Damascus fell and in 614 Jerusalem was captured and the holy cross was carried off to Ctesiphon. The conquest of Egypt followed. Armenia was successfully attacked, and the victorious Persians advanced into Asia Minor. By 627, however, Heraclius, who ha now gained as an ally the powerful khan of the Khazar kingdom i the north Caucasus and lower Don-Volga regions, was able boldl to take the offensive. In Dec. 627 he defeated the Persians a Nineveh, and in 628 drove Khosrau from Dastagerd. The murde of the Persian king in the spring of 628 was followed by a peac treaty by which all Byzantine territory was restored, and in 62 Heraclius in person restored the holy cross to Jerusalem.

This victorious affirmation of Christian imperial rule did not however, secure the eastern provinces. From 634 onward the Byzantines were challenged by the rising forces of Islam (*see* Caliphate; Mohammed). Weakened by the bitter struggle wit Persia and handicapped by the political and religious hostility o its provinces in Syria, Palestine and Egypt, Byzantium was force to cede ground. The Arab caliph Omar advanced into Syria i 634, and by 636 had conquered it, having defeated the Byzantine at Yarmuk (636). Palestine was next subjected, and the Arab then drove into Persia, Byzantine Mesopotamia and Armeni (639–640). By 646 Egypt had been finally lost and the Arab were penetrating into the north African provinces and into Asi Minor, while the growth of an Arab fleet under Mu'awiya I, governor of Syria, brought the loss of Cyprus, Rhodes and Cos an constant raids on the Aegean islands and coast. Civil war amon the Muslims enabled Constans II to make peace in 659, and fron his base in Sicily he was concentrating on offensives against th Lombards in south Italy and the Arabs in north Africa when h was assassinated (668). His successor, Constantine IV (668–685), had to face renewed attacks on Asia Minor under Mu'awiya I, now caliph. These culminated in the siege of Constantinople (674–678). The Byzantines withstood the attacks and their victory was followed by an advantageous peace with the Muslims. This was the first of the three decisive checks on Arab advance nto Europe during this period (the others were the second siege of Constantinople in 718 and the defeat at Poitiers in 732); it was therefore an event of world significance.

The second major problem of the Heraclian era was the Slav occupation of the Balkans which from the 7th to the 9th centuries also extended into Greece. The defeat of the Avars besieging Constantinople in 626 had resulted in revolt against their domination, first by the Slavs and then by Bulgars north of the Black sea and the Caspian sea. Henceforth the Avars were not a factor in Byzantine politics, and a fresh influx of Slavs (the Serbs and Croats) settled in the Balkans, apparently with Heraclius' consent, though there was evidently little substance to later claims that Byzantine suzerainty was at this time recognized by the Slavs. The Balkans and Greece were dominated by the Slav settlers and these regions were known by the Byzantines as the "Slavinias." Fully occupied in defending the empire against the Muslims, the Heraclians could only give occasional attention to the Slavs. In 658 Constans II attacked the "Slavinias," probably in Thrace and Macedonia, compelling them to acknowledge his suzerainty. A number of Slavs were taken prisoner and settled in Asia Minor and ncorporated into the army.

Under Constantine IV some of the Bulgar tribes from the north of the Black sea moved southwest under pressure from the Khazars, and one band under Asparukh settled round the Danube mouth, dominating the Slavs already there and forming a state which was to become far more dangerous to Byzantium than the "Slavinias." Constantine IV's expedition against the Bulgars in 680 failed and it was not until 1018 under Basil II Bulgaroctonus that their principality in the northeast Balkans was finally incorporated into the empire.

Justinian II in 688/689 led an expedition against the Slavs in Thrace and Macedonia and succeeded in making his way into Thessalonica, which had remained in Byzantine hands though urrounded by Slav-occupied lands. Captured Slavs were again ettled in Asia Minor and the claims of Byzantine overlordship sserted. But by the end of the 7th century effective Byzantine ontrol in Greece and the Balkans was confined to Thrace and cenral Greece (Hellas) where the imperial government had set up he theme organization in the latter years of the century.

The 7th century thus saw the emergence of the middle empire s distinct from the early Byzantine empire. The provinces of gypt and Palestine and Syria, as well as north Africa, were lost to he Muslims. The Lombards retained northern and central Italy, hile Byzantine control over the exarchate of Ravenna was precarious—only in south Italy did it maintain its hold for several enturies to come. In the Balkans the Slavs and Bulgars, though hey were eventually brought under Byzantine influence and to ome extent control, were the predominant factor. Further, he Slav occupation created a barrier between Byzantium and the atin west which probably did more to interrupt communications han did Arab piracy in the Mediterranean. In spite of the obvious terest of 7th-century emperors in Italy and Africa, the ties beween the Greek east and the Latin west were being continually osened, and it was clear that Justinian I's policy of restoration ad failed. But a smaller and more manageable empire emerged. eorganized by the Heraclians and revitalized by the vigorous avs, it stood as an effective barrier against Islam until the mid-8th century.

D. The North Syrian Dynasty (Isaurians)

The last of the Heraclians, Justinian II, lost his throne in 711, nd after a series of struggles the commander of the Anatolikon eme, Leo III, took control in 717. He and his family were assoated with the policy of iconoclasm which brought them into scredit with later generations as heretics. But both their adinistrative and their foreign policies carried a step further the constructive work of the Heraclians. In 726 Leo III issued the *Ecloga*, a legal handbook which was to take the place of the more cumbersome *Corpus iuris* of Justinian and incorporated changes in customary law since Justinian's day. In spite of being the work of a heretic emperor, this manual was an important influence in the future development of Byzantine, as well as Slav, law. The main change in administration was the reorganization and subdivision of certain of the overlarge Heraclian themes in Asia Minor. The western region of the Anatolikon theme was made into the new Thracesion theme. At some time between 710 and 732 the maritime theme of the Carabisiani was subdivided into the theme of the Cibyrraeots and the drungariate (later the theme) of the Aegean sea. By the middle of the 8th century Crete had also been organized as a theme.

The imperial religious policy had important political repercussions. In forbidding the veneration of icons the iconoclast emperors had considerable support in Asia Minor and from the army, but they roused the European provinces and incurred the implacable opposition of Rome. It was probably during Leo III's reign that the provinces of Calabria, Sicily and Illyricum (the western Balkans and Greece) were transferred from Roman jurisdiction to that of the patriarch of Constantinople, though not with papal acquiescence. At the same time the Byzantine position in north and central Italy weakened owing to Lombard encroachments, and in 751 Bari, the seat of the exarch, was lost. Both the danger of the Lombard advance and the rift with Constantinople caused the papacy to look west instead of east for help, with the consequence that the Carolingians became a major factor in Italian politics. Byzantine authority in Italy survived only in the southern provinces which it kept until these fell to the Normans in the 11th century.

Though Byzantium lost ground in the west and at the peripheries in the south and east, it held its own against the Arabs in Asia Minor. At the opening of Leo III's reign the capital was once more invested (717–718), but with the help of the Bulgars under Khan Tervel the Byzantines forced the Muslims to lift the blockade. In Asia Minor the perpetual Arab raids were checked by a series of campaigns and a signal victory at Acroinon (740), while the Byzantine allies, the Khazars, proved invaluable in stirring up trouble for the Arabs in the Caucasian and Armenian districts. The conflict between the Omayyads (Umayyads) and Abbasids and the removal of the caliph's capital from Damascus to Baghdad in 750 also temporarily created a situation favourable to Byzantium. Constantine V (741–775) was able to take the offensive, but his attacks in north Syria, Armenia and Mesopotamia did not result in permanent acquisitions; Cilicia and the Taurus region also remained in Arab hands until the 10th century. But the main core of Asia Minor, the stronghold of medieval Byzantium, had been secured.

In the Balkans the Byzantine position was precarious and the chief enemy was the expanding Bulgar state now threatening Thrace. The Bulgars were checked in a series of campaigns undertaken by Constantine V. Both naval and military operations were successful, culminating in the victory of 763 at Anchialus on the Black sea. Internal conflicts in Bulgaria brought a temporary respite, and war was only resumed after the accession of Telerig in 770. During the last years of his reign (773–775) Constantine V was again campaigning in the Balkans, but, though Telerig was defeated, the Bulgars remained hostile and unsubdued.

Leo III and Constantine V were the outstanding rulers of the north Syrian dynasty. Despite their iconoclast policy they showed their recognition of the essential needs of the empire by their constructive internal administration and by their concentration on the two key problems of the Balkans and Asia Minor. Unfortunately their successful military policy was not continued during the last quarter of the century under Leo IV (775–780) and his wife Irene (797–802) together with their son Constantine VI (780–797). Leo IV's short reign was marked by a policy of procrastination in religious matters. On his death, Irene took control as Constantine VI was a minor. She strongly opposed iconoclasm, and in 787 the use of icons was restored at the seventh ecumenical council held at Nicaea (*see* COUNCIL).

Neither Irene nor Constantine VI succeeded in organizing successful military resistance to the Bulgars and the Arabs. Irene appears to have deliberately weakened the army, which was known to be iconoclast in sympathy, and she played for popularity by remitting taxes needed for the expenses of defense. Consequently the Muslims again raided far into Asia Minor, and the imperial forces in the Balkans were defeated by the Bulgars who successfully demanded the payment of tribute. In the west the diminishing prestige of the Byzantine empire in Italy was reflected in Pope Leo III's coronation of the Carolingian Charlemagne as emperor in Rome on Dec. 25, 800. This symbolized the separation of what had once been the eastern and western halves of a single empire, and, though the western assumption of imperial authority was indignantly repudiated by the east, it remained a fact which in practice had to be accepted.

On the deposition of Irene in 802, financial economy and imperial defenses were the main concerns of Nicephorus I (802–811). As a former logothete of the treasury he was well fitted to stabilize finance. His measures for the protection of the soldier-farmer and his colonization of districts in Thrace and Macedonia made it possible to take the offensive against Bulgaria and to strengthen Byzantine control in the south Balkans and in Greece. Though Nicephorus actually lost his life in a campaign against the Bulgar ruler Krum (811), the gradual re-establishment of Byzantine control is reflected in the extension of the theme organization. About the end of the 8th century and beginning of the 9th, themes of the Peloponnesus, Macedonia (which included part of western Thrace) and Cephalonia were probably established, and soon afterward Dyrrachium and Thessalonica. In spite of temporary setbacks the administrative and military work of the iconoclast emperors, particularly Leo III and Constantine V, was to bear fruit in the steady expansion of Byzantine authority and prestige from the mid-9th century onward, not only in the Balkans but also on the eastern frontier. Because these rulers were heretics, their solid achievements were often glossed over by Byzantine historians. (*See* ICONOCLASTIC CONTROVERSY.)

E. AMORIANS AND MACEDONIANS

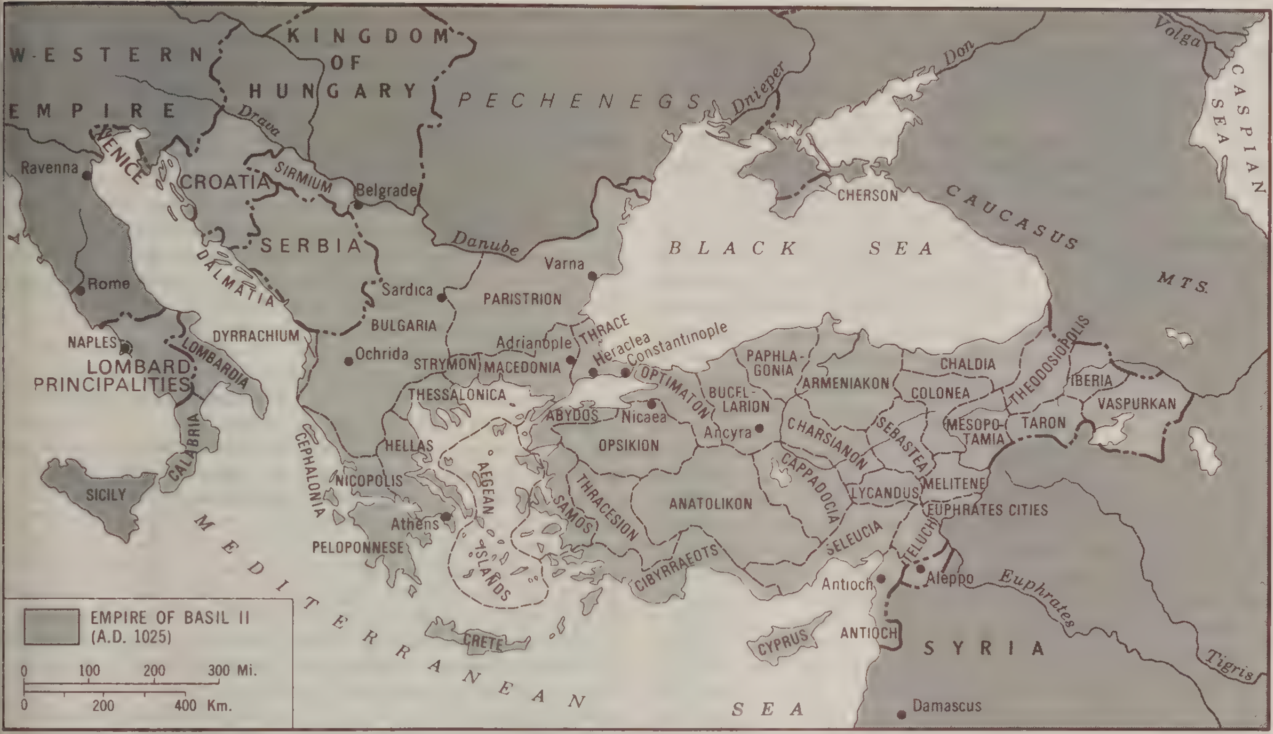
The attempts of Leo V (813–820) and the early Amorians Michael II (820–829) and Theophilus (829–842) to revive iconoclasm failed, and under Michael III (842–867) a new era was inaugurated. Iconoclasm was finally renounced in 843 and the able administrative, cultural and foreign policy of Michael III's regents and generals, and his uncle Caesar I Bardas, was continued by the Macedonian dynasty established by Basil I on the murder of Michael in 867.

1. Relations With the Slavs.—One of the most pressing problems was the penetration of the Balkans by the Slavs. Both Rome and Constantinople sent missionaries to the south Slavs, but by the end of the 9th century it was clear that Slavs had been won for the Orthodox Church and drawn into the orbit of Byzantine civilization, partly as a result of the able work of the scholar missionaries Cyril and Methodius. For Byzantium it was a matter of urgent policy to establish some control over the young Slav principalities, particularly Bulgaria, which by the end of the 9th century was expanding west and south. The Bulgar ruler Simeon took advantage of the unwarlike Leo VI and the minority of his son Constantine VII and in 913 threatened Constantinople. Simeon failed to take the capital and he came to terms with the regents whereby he was crowned *basileus* of Bulgaria and his daughter was to marry Constantine VII. He was, however, subsequently outwitted by the Byzantine co-emperor Romanus I Lecapenus (920–944), and after his death in 927 a period of peace followed. During the last quarter of the 10th century the Bulgars again threatened the empire and there was the further menace of Kievan control in Bulgaria. This time the problem was solved by conquest. John I Tzimisces (969–976) drove out the Russians, captured the Bulgarian ruler Boris, abolished the Bulgarian patriarchate and incorporated eastern Bulgaria into the Byzantine empire. During Basil II's reign (976–1025) an attempt to revive the Bulgarian kingdom in western Macedonia with Ochrida (Ohrid) as its capital was made by Samuel, a Macedonian of Armenian stock. He was defeated by Basil II, whose ruthless campaign earned him the title of "Slayer of the Bulgars" (Bulgaroctonus) Thus by 1018 Bulgaria was completely absorbed and its patriarchate replaced by a virtually autonomous archbishopric.

The Russians, like the Balkan Slavs, were indebted first to the missionaries and then to the ecclesiastics of the Orthodox Church They also came into contact with Byzantium first as raiders, then as traders, allies and mercenaries. In 860 they first attacked Constantinople, and it is from this period of Photius' patriarchate that Byzantine missionary work among the Russians dates. In 907 Prince Oleg of Kiev led an expedition to Constantinople and in 911 a commercial treaty was signed between the Russians and Byzantines. An attack on the Bosphorus in 941 was decisively defeated by the Byzantine general John Curcuas. In 944 Prince Igor of Kiev advanced to the Danube and was bought off by money and a new commercial treaty. Friendlier relations were inaugurated by the newly baptized regent princess Olga of Kiev, who visited the imperial court at Constantinople in 957. Her son Svyatoslav's attempt to establish his ascendancy in Bulgaria failed and under Vladimir, not yet a Christian, the Russians allied with Basil II in 988. A Russian (Varangian) contingent remained in Byzantine service and in 989 Vladimir was rewarded by the hand of Basil's sister Anna. This marriage symbolized the ecclesiastical and cultural links between the two countries. Vladimir and his people formally adopted Christianity and the new Russian churc developed with the help of the Byzantine patriarchate.

2. Success Against the Muslims.—On the eastern front and in the east Mediterranean from the mid-9th century on the Byzantines, in spite of intermittent setbacks, successfully took the offensive. In 863 the Muslims under the emir of Melitene wer annihilated when they attacked the Armeniakon theme. Under Basil II's generals the Byzantines penetrated into the Euphrates territory. But during the early 10th century the empire was occupied by the struggle against Bulgaria, and Leo of Tripoli was abl to ravage the Asia Minor coast and in 904 to sack Thessalonica With the accession to power of the able Romanus I and the defea of Bulgaria, the Byzantines under the leadership of generals suc as John Curcuas, Nicephorus Phocas and John Tzimisces bega their spectacular advance into Mesopotamia and Armenia, an then into Cilicia, Syria and Palestine. In 934 Melitene fell to Joh Curcuas, who advanced into Mesopotamia (943) and then captured Edessa. In alliance with Baghdad and Egypt, the Byzantine pushed home their attack on the formidable Hamdanid emir o Mosul and Aleppo, Saif-ud-Daulah. In 960–961 Nicephoru Phocas took Crete and advanced in Cilicia and north Syria. I 962 Aleppo surrendered, though it did not remain in Byzantin possession. Under Nicephorus, now emperor, Cyprus was occupied (965), Antioch fell (969) and Aleppo was taken. John Tzimisces penetrated further into Mesopotamia and drove sout through Syria into Palestine. Although he took Nazareth he di not reach Jerusalem, nor did he establish the Byzantine positio in Palestine. But by the beginning of the 11th century the measure of the Byzantine advance can be seen in the establishment o new themes in the east—Melitene, that of the "Euphrates cities (later named Edessa), Mesopotamia, Taron, Teluch and particularly Antioch, the seat of the patriarchate. To these Basil I added Armenian and Caucasian territory over which he had established control—the themes of Vaspurkan, Theodosiopolis an Iberia. He arranged for the Armenian kingdom of Ani to laps to Byzantium on the death of its king, Yovhannes-Smbat. Th remarkable expansion on the eastern front was due partly to imperial statesmanship and military brilliance and partly to factio among the Muslim rulers, but also to the desire for further expansion which spurred on the Byzantine landed families of Asia Mino

3. Events in Italy.—By contrast, the Byzantines made litt advance in the west. They retained their province of Longobard in south Italy (Apulia and Calabria), but by the end of the 10th century they had lost Sicily to the Muslims. They were aware o Italian problems, though priority had to be given to the Balkan and the east. Although Syracuse had been lost to the Muslims 878, during Basil I's reign, the general Nicephorus Phocas the eld began a successful offensive and reinforced the Byzantine positic


WESTERN EMPIRE
KINGDOM OF HUNGARY
PECHENEGS
Volga
Don
Dnieper
CASPIAN SEA
Drava
Ravenna
VENICE
CROATIA
SIRMIUM
Belgrade
CHERSON
CAUCASUS MTS.
SERBIA
Danube
Varna
BLACK SEA
DALMATIA
Rome
Sardica
PARISTRION
BULGARIA
DYRRACHIUM
THRACE
Adrianople
Heraclea
Constantinople
NAPLES
LOMBARD PRINCIPALITIES
LOMBARDIA
Ochrida
STRYMON
MACEDONIA
OPTIMATON
PAPHLAGONIA
ARMENIAKON
CHALDIA
THEODOSIOPOLIS
IBERIA
THESSALONICA
ABYDOS
Nicaea
BUCELLARION
COLONEA
VASPURKAN
Ancyra
CHARSIANON
SEBASTEA
MESOPOTAMIA
TARON
CALABRIA
HELLAS
OPSIKION
CEPHALONIA
NICOPOLIS
AEGEAN ISLANDS
SAMOS
THRACESION
CAPPADOCIA
LYCANDUS
MELITENE
SICILY
ANATOLIKON
EUPHRATES CITIES
Athens
PELOPONNESE
SELEUCIA
TELUCH
CIBYRRAEOTS
Antioch
Aleppo
Euphrates
MEDITERRANEAN SEA
CRETE
CYPRUS
ANTIOCH
SYRIA
Tigris
Damascus
EMPIRE OF BASIL II (A.D. 1025)
0 100 200 300 Mi.
0 200 400 Km.

BYZANTINE EMPIRE IN THE TIME OF BASIL II

in south Italy. In spite of the troubles connected with the patriarch Photius (*q.v.*) relations were maintained with the papacy. During the 10th century the political situation was affected both by the German intervention in Italian affairs and by Otto I's assumption of the imperial title first claimed by Charlemagne. Nicephorus II, on the crest of his eastern successes, rejected out of hand Otto I's offer of a marriage alliance. John I Tzimisces more prudently came to terms; though he did not recognize any German claim to Byzantine territory in south Italy, in 972 he sent Theophano (probably his niece) as wife for Otto II. Neither Otto II nor Otto III achieved any real success in their attempts to consolidate their hold on Italy, while their contemporary Basil II strengthened his position by reorganizing the Byzantine provinces in south Italy under the control of a single governor, the catapan. Basil was preparing to take the offensive against the Arabs in Sicily when he died in 1025.

4. Home Affairs.—Byzantine prestige abroad during the years 842–1025 was paralleled by achievements at home. Under Basil I and Leo VI commissions were set up to revise the legal system, and during the latter's reign the Byzantine legal code known as the *Basilica* (*q.v.*) was issued. Under the patronage of Caesar Bardas the university of Constantinople was revived. Countless scholars, such as Photius and Leo the mathematician in the 9th century or Constantine VII and his circle in the 10th century, carried on and developed cultural traditions of ancient Greece and of medieval Byzantium. In purely domestic affairs one striking feature of the 10th century was the imperial agrarian policy designed to keep in check the power of the great landed families ("the powerful") and to bolster up the smallholders ("the poor"), many of whom held their land on condition of hereditary military service. Romanus I and Basil II were the chief promoters of legislation to prevent smallholders from being bought out by "the powerful." But even Basil II with his policy of ruthless severity toward the aristocracy was unable to ensure any permanent security to the small farmers who in the past had been a source of manpower for the army and navy.

F. Imperial Decline; Normans and Seljuk Turks

Certain aspects of Byzantine life continued to develop as long as the empire lasted; there was no break in Byzantium's cultural and religious life either now or in the later middle ages. The achievements of its monasticism and its spirituality, its art and literature, reflect its continued vitality in these fields, particularly in the 11th century. But in other respects both at home and abroad the years 1025–81 mark the beginning of political decline. After Basil II there was no ruler who could compare with him in stature until the accession of Alexius I Comnenus in 1081. The Macedonian dynasty petered out with his two elderly and incompetent nieces Zoe (d. 1050) and Theodora (d. 1056). It proved difficult to enforce earlier agrarian laws against the magnates, and under Zoe's first husband, Romanus III, the law making the rich responsible for the taxes due from unworked land was repealed. Her second husband, Michael IV (1034–41), was a moderately competent general, but her third husband, Constantine IX Monomachus (1042–55), took little part in military activities.

After the death of Theodora in 1056 the disastrous struggle between the court aristocracy and the military families was accentuated. Except for the short reigns of Isaac I Comnenus (1057–59) and Romanus IV Diogenes (1068–71) the civil party held the field, usually with disastrous results. Extravagance led to unfortunate expedients, such as debasement of the coinage, which set in under Constantine IX Monomachus and perhaps even earlier, while the civil service was expanded at considerable cost particularly under Constantine X Ducas (1059–67), who is also said to have filled the senate with artisans and traders. More disastrous still, the civil party's fear of the military families led to deliberate neglect of imperial defenses. Further, within the military party there was a marked antagonism between the Asian and European troops which on occasion prevented united action against the civilians.

Unfortunately this internal struggle coincided with the appearance of new enemies on all fronts. The conquest of Bulgaria had brought the Byzantine frontier to the Danube and the empire now felt the full force of attacks from the tribes to the north, particularly the Pechenegs (Patzinaks), who proved a scourge in the Balkans until their final defeat by Alexius I in 1091. In the Bulgarian provinces themselves there was discontent and sometimes rebellion, while the Bogomil heresy of these regions spread south into the very capital itself (*see* Bogomils). In the western Balkans the growing Slav principalities became increasingly difficult to control, particularly Croatia and Zeta (*see* CROATIA; SERBIA), and aware of the strength of their position and the weakness of Byzantium under the Ducas emperors (1059–78) the rulers of these two states even turned to the papacy and received their crowns from Gregory VII.

It was particularly important for Byzantium to retain control of, or at least diplomatic relations with, the west Balkan rulers because of their proximity to western powers. During the 11th century the Byzantine hold on its south Italian provinces steadily deteriorated in spite of some success during the 1140s under the brilliant general George Maniaces. The death blow to Byzantine authority came not from the Arabs or the Lombards but from the Normans, who established themselves in south Italy from the mid-11th century onward. In 1059 they forced the papacy to recognize them and by 1071 they had taken Bari and pushed the Byzantines out of the peninsula. Shortly after they mastered Sicily, and then turned eastward and attacked the mainland of Greece in the early years of Alexius I.

Simultaneously the Byzantine frontier on the east was subjected to intermittent attacks from the Turkic peoples who had gained control over the caliphate of Baghdad (*see* SELJUKS). Throughout the 11th century there were raids and infiltration. In 1068 Romanus IV, who came from a Cappadocian military family, with difficulty mustered an army to stem the Turks. By now they controlled Syria, the Armenian lands and were seriously devastating the central provinces of Asia Minor. The Seljuk leader Alp Arslan defeated Romanus IV at Manzikert (Malazgirt), north of Lake Van, in 1071, aided by treachery among the Byzantine troops. Alp Arslan was, however, willing to come to terms with the empire and to maintain the *status quo*, but when Romanus was deposed and blinded by the civil faction at Constantinople the proposed treaty fell through. A member of the Seljuk house established himself in the heart of Asia Minor as the sultan of Iconium (Konya) or Rum, and the Turkish rivals of the Seljuks, the Danishmends, set up the principality of Melitene in northeast Asia Minor. This marked the end of Byzantine control over the whole of Asia Minor. Neither the Comneni nor later emperors could recover more than a fraction of the provinces which had formed the heart of the medieval Roman empire.

G. THE COMNENI, THE ANGELI AND THE CRUSADES

The accession of Alexius I Comnenus (1081–1118) put an end to the struggle between the military and civil parties and inaugurated a period of almost a century during which the statesmanship of father, son and grandson temporarily restored imperial prestige. But even the powerful Comnenian dynasty, itself belonging to a landed military family, could only delay the final decline, and even so it had to use those elements in the polity which the more powerful rulers of the Macedonian period had tried to check. From now on the empire was characterized by the increasing predominance of the military aristocracy as well as by strong separatist tendencies.

Alexius' main concern was to drive back the Seljuk Turks from Asia Minor, to maintain some control over the growing Slav principalities in the Balkans and to expel the ambitious Normans of south Italy from his western provinces. His army and navy were seriously depleted and his finances low. But he succeeded in coming to terms with Suleiman, the sultan of Rum, virtually recognizing the *status quo*, and he obtained mercenaries from this source. He enlisted the help of the Venetian navy at the cost of trade privileges. Thus reinforced, he turned against the Normans who were advancing from Dyrrachium (Durazzo). But the withdrawal of the Normans after the death of Robert Guiscard in 1085 halted the duel between Norman and Greek, which continued intermittently throughout the 12th century.

Alexius' temporary lull, achieved by astute diplomacy supported by military campaigns, came abruptly to an end when the situation was radically changed by the first crusade (*see* CRUSADES). Alexius indeed asked the west for help against the Turks, but what he wanted was troops to serve under him. The Latin feudal armies, however, who set out against the infidel in 1096 acted independently, in spite of the Byzantine emperor's attempt to exact oaths of allegiance and to assert his right to former imperial territory. From the outset the Holy Land was their goal. There and in Syria they set up independent principalities, introducing a further complication into east Mediterranean politics. For Byzantium it was essential to begin by expelling the Seljuks and Danishmends from Asia Minor. Instead it had to deal with the petty intrigues of a disunited Christian front in Syria and Palestine; the most bitter blow of all was the establishment of the Byzantines' archenemy Bohemund, son of Guiscard, in Antioch, which had been regained for the empire in the late 10th century and only comparatively recently lost to the infidel. Bohemund, forced to return to Italy for help, spread false stories of Alexius' treachery toward the crusaders, and then in 1107 he turned once again to attack the Greek provinces of the empire. Defeated by Alexius, he was forced by the treaty of Devoll (1108) to recognize Byzantine overlordship and to agree to the re-establishment of a Greek patriarch in Antioch. But Tancred, acting as regent in Antioch, refused to implement this treaty.

Alexius' prestige steadily grew. In the Balkans he held the balance between Rascia and Zeta, and strengthened his position by marrying his son John to a Hungarian princess. In 1091 he decisively crushed the marauding Pecheneg (Patzinak) bands who periodically ravaged the lands south of the Danube. In western Asia Minor he regained ground and checked further aggression by playing off one Muslim power against the other. At home Alexius' main problems were of defense and finance. Here he was unable to reverse the developments of the 11th century. He attempted to check debasement and inflation but apparently only at the cost of devaluation which specially hit the poorer classes. He continued to grant frequent immunities, sometimes in the form of the *pronoia* or the *charisticium*, thus strengthening further the magnates at the expense of the central authority (see *Administration* below). For defense he relied mainly on mercenaries and the Venetian navy.

The main lines of Alexius I's policy were continued by his son John II Comnenus (1118–43) and his grandson Manuel I (1143–80). It was essential to watch, and, if possible, come to terms with, the Normans of Sicily, to win over the papacy by holding out hopes of patching up the ecclesiastical rift of 1054 (see *The Church* below), and to gain allies among the Italian cities. At the same time growing Serbian power had to be controlled and Hungary's interests south of the Danube checked if possible by diplomatic advances or even military force. In the east the main aim was the re-establishment of Byzantine control over the Norman principality of Antioch.

John II in spite of some reverses exercised a measure of control over Rascia, and in 1128 forced Hungary to come to terms with him. He allied with the German emperor Conrad III and the Pisans as a counterpoise to Roger II (crowned king of Sicily in 1130). Though he was not able to reduce the extensive trading privileges of Venice, he balanced this by confirming similar concessions granted to Pisa by Alexius I. In Asia Minor he defeated the emir of the Danishmends (1132–35) and reconquered Little Armenia in the southeast (1136–37). He then advanced on Antioch and asserted his rights of suzerainty (1137). He evidently intended to make good this claim and then to advance south, but he died unexpectedly in 1143.

Manuel I, faced by hostility from Norman Sicily and Norman Antioch and by the disturbances caused by the unfortunate second crusade (1147), counterattacked with boldness and originality while keeping open the door to any possible alliance. He drove off the Norman invasion of Greece and Corfu (1147–49). He married his daughter (and at that time heiress) Mary to the heir apparent (later Béla III) of Hungary, cleverly gaining certain Balkan lands claimed by Hungary which he retained after the marriage had fallen through. He was a firm ally of Conrad III and, when this German ruler was succeeded in 1152 by Frederick Barbarossa, Manuel still hoped to maintain this understanding. For a time he even attempted a military offensive in south Italy but had to withdraw and come to terms with Sicily in 1158. He maintained cordial relations with the papacy, again holding out the bait of ecclesiastical reunion and playing on Alexander III fear of Barbarossa and his antipope. He relied too on the help of Pisa and Genoa, bought with trading concessions, and used the general Byzantine resentment at the arrogance and privileged position of Venetian merchants to organize a concerted attack on them throughout the empire (1171) which incensed the republic and was one of the underlying reasons for the later attack of the fourth crusade. In the east, Manuel continued his father's policy in Cilicia and Antioch, but he was not able successfully to organize either Christian or Muslim resistance to the growing menace of Saladin, and his own defeat by the Seljuk Killij Arslan II of Iconium at Myriocephalon in 1176 greatly shook his own position which was now openly challenged by Barbarossa.

Manuel himself had been open to Latin influence and, though maintaining Byzantine imperial tradition, had freely used Latins within the empire; it is even maintained that he had a deliberate policy of invigorating Byzantium with an infusion of Latin blood. But on his death the anti-Latin feeling of the populace and the weakness of the empire were only too apparent. The regency of the Latin empress-mother, Mary of Antioch, for her young son Alexius II (1180–83) was speedily ended by a terrible massacre of all Latins in Constantinople. Alexius himself was overthrown by his cousin Andronicus I Comnenus (1183–85), an able and unscrupulous man who attempted in vain to check the power of the magnates and to restore the effective control of the central government. He thus lost the support of the military families, and his brutal methods (though in a good cause) made him hated. Hungary under Béla III regained its lost Balkan lands; the Serbian Stephen Nemanya repudiated Byzantine overlordship; the Normans of Sicily once again attacked the western provinces, took Thessalonica and advanced on Constantinople; and Isaac, the Comnenian governor of Cyprus, declared himself independent.

Andronicus was brutally killed by a Constantinopolitan mob and from 1185 to 1204 the Angeli took control. This short-lived dynasty was ineffective in the face of internal disorder and external hostility. Extortion and oppression crept back into the adminstration and the dominance of the landed magnates continued unchecked. Under two local leaders, Peter and Asen, the Bulgarians and Vlachs seceded to form the second Bulgarian empire. The German contingent of the third crusade, led by Frederick Barbarossa, passed through the Balkans, allying with Byzantine enemies and even threatening the capital itself. Isaac II Angelus (1185–95) staved off Barbarossa and came to terms with Stephen Nemanya. He was, however, blinded and deposed by his brother Alexius III, who took control until 1203. Isaac's son Alexius IV appealed to the west for help, thus giving Byzantine enemies the pretext for the Latin capture of Constantinople (1204) and the partition of an empire which they had long feared and coveted.

H. The Latin Empire

The commercial ambitions of Venice, the mistrust between Latins and Greeks engendered by the crusades, the papal desire o reunite the churches of Rome and Constantinople, western ovetousness of Byzantine wealth and even of Greek ownership f Christian relics—such reasons account for the deliberate diversion of the fourth crusade from Jerusalem to Constantinople, stensibly to restore Isaac II and his son Alexius IV as puppets f the crusaders. Alexius III was driven out in 1203, but Isaac nd Alexius IV, unable to fulfill their promises to the western powers and most unpopular with their anti-Latin Byzantine subjects, were in turn deposed by Alexius V. This incited the crusaders to take the city by assault and Alexius V fled. Constantiople was sacked by the victors, and many manuscripts and works f art perished or were seized by the looting westerners. The rchitect of the Latin empire was the doge Enrico Dandolo, who ensured that Venice should have a major share in the spoils. The atin emperor, Baldwin I, was from the outset too ineffective to establish any real control over the Latin principalities which were set up in Greece and the islands, and in Thrace and Thessalonica.

Three Byzantine states emerged from the wreck. Even before he fourth crusade separatist tendencies were reflected in the sing kingdom of Trebizond (modern Trabzon; *q.v.*), founded on he shores of the Black sea with the help of Georgia by members of the Comnenian family who continued to rule there until their final conquest by the Turks in 1461. In western Greece Michael Angelus set up the despotate of Epirus which in the course of the 13th century was to lose much of its territory before Latin, Serbian and Nicene attacks. In Asia Minor a third Greek state was founded by Theodore Lascaris, the son-in-law of Alexius III. Both Epirus and the Lascarid rulers claimed to be the true successors of the displaced imperial rulers. At the same time the able Bulgarian John Asen II also made a bid for the capital.

Theodore I Lascaris had been crowned emperor by a patriarch in 1208, and at Nicaea his court continued the Byzantine imperial traditions. By skilful diplomacy he consolidated and enlarged his kingdom. His successor and son-in-law, John III Vatatzes or Ducas (1222–54), continued Theodore's work and secured the predominance of the Lascarid kingdom. He practically drove the Latins out of Asia Minor and he regained a foothold in Europe. Cleverly allying with John Asen II, Vatatzes struck at the weakened Latin empire and also at the rule of the Angeli in Thessalonica and Epirus. In Asia Minor he further secured his position by alliances with Trebizond and Iconium. Theodore II Lascaris (1254–58) lacked his father's statesmanship, and on his death control was seized by Michael Palaeologus, ostensibly as regent for the young John IV (1258–61). Michael reaped the fruits of Lascarid policy and captured Constantinople in 1261. There he was crowned Michael VIII and founded the dynasty which was to rule until the final fall of the empire in 1453.

Michael's restored empire consisted of the Nicaean lands of northwest Asia Minor, the capital, most of Thrace and Macedonia, with some of the islands, as well as control over Epirus; as the result of his victory at Pelagonia (1259), he also gained certain strategic fortresses in the Peloponnesus. His main problems were inadequate resources for a policy of expansion and a new enemy in Charles of Anjou, the successor of the Normans and Hohenstaufen in south Italy. But Michael was a diplomat in the best Byzantine tradition, and he adroitly met the Angevin coalition of western powers by allying with the papacy, once again promising the reunion of the two churches which was actually attempted at the second Council of Lyons (1274). As usual this union between Rome and Constantinople was violently repudiated by the Greek clergy and people, and again Charles of Anjou prepared for an attack on the empire only to be foiled by bitter Sicilian hostility which in 1282 came to a head in the Sicilian Vespers (*q.v.*) and the establishment of the Aragonese house in the island. Michael VIII had a hand in these events and an understanding with Peter of Aragon.

I. Decline of the Empire

After the downfall of Charles of Anjou no powerful Latin enemy ever again threatened the restored Byzantine empire, but its position nevertheless steadily worsened and it was menaced first by a vigorous Serbian kingdom and then by the Ottoman Turks (*see* SERBIA; TURKEY). Internally the empire was hampered by civil wars and by diminishing resources as well as by local and separatist feeling. Andronicus II (1282–1328) could not prevent the deterioration of the situation in Asia Minor, where as a result of the 13th-century Mongol invasions the sultanate of Rum had given way to a number of small emirates. These attacked the Byzantines by land and sea and by 1326 the Ottomans had established their capital at Brusa (Bursa) in Bithynia dangerously near to Constantinople. Andronicus had also to endure the inroads of the Catalans, originally called in as mercenaries, who had become the rulers of an independent principality in Greece. From the end of Andronicus II's reign onward civil war and bitter family quarrels continued intermittently until the 15th century. First Andronicus II was forced to abdicate by his heir and grandson, Andronicus III (1328–41), and then dissension arose between the able Cantacuzenus (crowned co-emperor as John VI in 1347) and the young John V Palaeologus (1341–91). These were not merely political or personal struggles, but on either side different social classes and religious parties were ranged, and the partisans did not hesitate to support their own cause by allying with foreign powers, Muslim as well as Christian. John VI, who had married his daughter to John V (1348), was largely responsible for increasing the imperial hold on the Peloponnese and in Thessaly; this was achieved by an appanage system which was continued by the Palaeologan rulers after John Cantacuzenus' abdication in 1354.

During the second half of the 14th century Byzantine possessions in Thrace and Macedonia steadily diminished. The danger from the powerful and ambitious Serbian ruler Stephen Dushan, who apparently hoped to found a new Roman empire of Serbs and Byzantines, was averted by his early death and the subsequent disintegration of his greatly enlarged kingdom, which had included Thessaly and Macedonia (though not the city of Thessalonica), as well as Epirus and Albania. On the other hand this meant that there was no one Christian leader able to give a strong lead against the rapidly encroaching Ottomans. Adrianople in Thrace became the capital of Murad I and Bayazid I. The Ottomans defeated the Slavs at the battle of Kosovo (1389) and the western crusaders at Nicopolis (1396); Bulgaria was virtually under Ottoman control; Thessaly and the Morea (*i.e.*, the Peloponnese) were constantly raided. Political rifts and religious dissension prevented the Greek and Latin Christians from any united effort, and Byzantine resources alone were hopelessly inadequate. Neither Manuel II's courageous but pathetic tour of western capitals, nor the unexpected lull following Bayazid's defeat at the battle of Ankara (1402), could save the Byzantine empire. The Byzantine emperors were in fact Ottoman vassals.

The situation became critical with the accession of the sultan Murad II; the capital was more closely invested and frequent attacks were made on the comparatively flourishing despotate of the Morea, where a member of the Palaeologan family ruled from Mistra. In desperation John VIII (1425–48) turned once more to the papacy. He himself, with the patriarch and other representatives of the Orthodox Church, took part in the Council of Ferrara-Florence (*q.v.;* 1439) and the union was agreed upon. Once again it was repudiated by the Greek rank and file, and it also bitterly antagonized the Slav churches. In any case Pope Eugenius IV could not have mustered any western military force capable of retrieving the situation for the Byzantines. An army led by the Hungarian king was crushed by the Turks at Varna (1444).

In April 1453 Murad II's successor, Mohammed II, began a close blockade of Constantinople by land and sea. Constantine XI, with the loyal support of the Genoese, defended the city bravely, but it was finally stormed on May 29–30. Shortly after, the Ottomans made themselves masters of the Peloponnese and of Trebizond, and by the end of the 15th century they had set up their successor-state. Constantinople, magnificently rebuilt, became the capital of their empire; at the same time it remained the centre of Christian Orthodoxy which survived under Ottoman domination.

II. GOVERNMENT

A. IMPERIAL AUTHORITY

1. Emperor.—With Diocletian the principate of Augustus had become undisguisedly an absolute monarchy, and this constitution prevailed to the end. There is virtually no constitutional history in the proper sense of the term in the Byzantine empire. The monarchical system remained in all its essential points unchanged, and presents a remarkable example of an autocracy of long duration which perfectly satisfied the ideas of its subjects. No attempt was made to alter it—to introduce, for instance, a limited monarchy or a republican government; all revolts and conspiracies were aimed at the policies of particular autocrats, not at autocracy itself; generally they only represented sectional antagonisms and personal ambitions, though often combined with opposition to tyranny. The emperors inherited a deeply rooted instinct of legality as a tradition from old Rome; and this respect for law which marked their acts, along with the generally good administration of justice, was a safeguard of the monarchy. They were supreme in legislation, as well as in the administrative and judicial spheres; but they were on the whole moderate in wielding legislation as an instrument of policy. There were however recognized constitutional principles which it would have been exceedingly difficult for the emperor to override.

Election.—The elective principle, inherited from the republic, was never changed. A new emperor had to preserve the formality of election by the senate and acclamation by the people and army. The succession never became automatic. But even Augustus had indirectly introduced the dynastic principle. Theodosius the Great, by causing his two sons, Arcadius and Honorius, to be elected Augusti in their infancy, practically elevated the dynastic idea into a constitutional principle; henceforward it was regarded as in the regular course that the son born to a reigning sovereign should in his infancy be elected Augustus. After the acceptance of Christianity the electors were regarded as expressing by their acclamation the will of God.

Religion.—When in the course of the 4th century the position of Christianity was assured, it followed that the profession of that religion would in future be a necessary qualification for election to the throne. This was formally and constitutionally recognized when the coronation of the emperor by the patriarch of Constantinople was introduced. The first emperor to be crowned in this way was Leo I (457–474), and from the 7th century on it was customary for this ceremony to be performed in Hagia Sophia. Originally the patriarch acted as the representative of the electors, but the ceremony gradually took on increasing ecclesiastical significance. The emperor, who was regarded as the protector of the church and the guardian of orthodoxy, had to make a profession of faith. Anastasius I is know to have made a statement recognizing his obligations to his electors, and by the 9th century there was in existence a regula coronation oath binding the new sovereign to keep the Christia faith and traditions.

Personal Sovereignty.—The sovereignty of the emperor wa personal, not territorial. In this respect it always retained th character which it had inherited as the offspring of a Roma magistracy. Hence no Roman territory could be granted by th emperor to another power. For instance, the western empero Conrad III could promise to hand over "Italy" (*i.e.*, certai Italian lands) to Manuel Comnenus as the dowry of his promise bride, but it would have been constitutionally illegal for Manu to have made such a promise to any foreign prince; a Byzantin emperor had no right to dispose of the territory of the state. Th Palaeologan custom of granting appanages to members of th imperial family was not a concession to western custom but th only way of governing widely scattered lands in a period whe the central authority at Constantinople was weakened and financial straits.

2. Senate.—While the senate of Rome generally lost its importance and at last became a mere municipal body, the new senat of Constantinople for a time preserved its position as an orga of the state. For the imperial elections it was constitutionall indispensable, and it was able sometimes to play a decisive pa when the throne was vacant—its only opportunity for independen action. The abolition, under Diocletian's system, of the senatori provinces deprived the senate of the chief administrative functio which it exercised under the principate; it had no legislative power and it lost most of its judicial functions. It was, however, still judicial court; it tried, for instance, political crimes.

In composition it differed from the senate of the principat The senators in the 4th century were chiefly functionaries in th public service, divided into the three ascending ranks of *clarissim* *spectabiles* and *illustres*. The majority of the members of th senatorial order lived in the provinces, forming a provincial ari tocracy, and did not sit in the senate. Then the two lower ran ceased to have a right to sit in the senate, which was confined the *illustres* and men of higher rank (patricians). The senatori order must therefore be distinguished from the senate in a na rower sense. The latter did on occasion have considerable i fluence as a consultative assembly, and its political weight w increased by the fact that the inner council of imperial advise was practically a committee of the senate. Its power was great diminished by the 10th century, but it did play a more importa part when the civil party was in power during the 11th centur

3. People.—The memory of the power which had once belonged o the *populus Romanus* lingered in the part which the inhabitants of New Rome, and their representatives, played in acclaiming ewly elected emperors, and in such ceremonies as coronations. In the 6th century the factions ("demes") of the circus, Blues nd Greens, appeared as political parties, distracted the city by heir quarrels and broke out in serious riots. On one occasion hey almost shook the throne (the "Nika" revolt, 532). The mperors finally quelled this element of disturbance by reorganizng the factions and assigning them a definite quasi-political posiion in the public ceremonies in the palace and the capital where hey were responsible for the "acclamations."

4. Court Ceremonial.—The court ceremonial of Constantiople, which forms such a marked contrast to the ostentatiously imple establishments of Augustus and the Antonines, had in its rigin a certain constitutional significance. It was introduced y Aurelian and Diocletian, probably not from any personal love f display but rather to dissociate the emperor from the army, t a time when the state had been shaken to its foundations by he predominance of the military element and the dependence f the emperor on the soldiers. It was the object of Diocletian o make the emperor independent of all, with no more particular elation to the army than to any other element in the state; the oyal court and the inaccessibility of the ruler were calculated o promote this object.

The etiquette and ceremonies were greatly elaborated by Jusinian and were carefully maintained and developed. The public unctions, which included processions through the streets to varius sanctuaries of the city on the great feast days of the church, upplied entertainment of which the populace never wearied; and t did not escape the notice of the rulers that the splendid funcions and solemn etiquette of the court were an effective means of mpressing the imagination of foreign visitors with the majesty nd power of the emperor.

5. Co-emperors.—The imperial dignity was collegial. There ould be two or more emperors (*imperatores;* Gr. *basileis*) at the ame time; edicts were issued, public acts performed, in their oint names. During the 4th and 5th centuries, when the adminstration of the eastern half was generally separate from that of he western, the imperial authority was also collegial. But after his period the system of divided authority came to an end and as never renewed. There was frequently more than one emeror, not only in the case of a father and his sons, or of two rothers, but also in the case of a minority, when a regent or comander in chief might get himself elected emperor (as did Roanus I, Nicephorus II or John I Tzimisces). But one colleague lways exercised the sole authority, was the real monarch, the great" or "first" *basileus;* the other or others were only junior artners. Until the Palaeologan period the title "autocrator" was served for the senior emperor.

B. LEGISLATION

The history of the legislation of the Byzantine empire is disnguished by three epochs associated with the names of Justinian; eo III; Basil I and Leo VI.

1. Justinian I.—For Justinian's legislation, *see* JUSTINIAN I.

2. Leo III.—Justinian's reign was followed by a period in which ristic studies appear to have been neglected. The 7th century, time of internal and external crisis, is a period for which little s survived and it is not known how far the law of Justinian, hich had been translated into Greek, was studied or understood. ractice at least was modified by principles in accord with the blic opinion of Christian society and influenced by ecclesiastical nons. In the Quinisext or Trullan council held at Constantinople 692 in the reign of Justinian II numerous rulings were made, ffering from the existing laws and based on ecclesiastical docne and Mosaic principles, and these were sanctioned as laws of e realm by the emperor. Certain surviving legal codes may long to the late 7th or early 8th century, such as the "Farmer's w" (*Nomos georgicos*) and the "Rhodian sea law" (*Nomos hodion nauticos*). The period of the north Syrian rulers was rtainly characterized by legislative activity.

In 726 the *Ecloga* was issued in the name of Leo III and Constantine V. Written in Greek, this "Brief Selection of Laws" marks a new era and reflects the changed ideas of the community; it may in fact be described as a Christian law book. In regard to the *patria potestas* increased facilities were given for emancipation from paternal control when the son came to years of discretion, and the paternal was to a certain extent replaced by parental control over minors. The law of guardianship was considerably modified. The laws of marriage were transformed under the influence of the Christian conception of matrimony; the institution of concubinage was abolished. Impediments to marriage on account of consanguinity and of spiritual relationship were multiplied. While Justinian had regarded marriage as a contract, and therefore, like any other contract, dissoluble at the pleasure of the parties, Leo III accepted the church view that it was an indissoluble bond. Ecclesiastical, as well as oriental, influence was written large in the criminal law, of which a prominent feature was the substitution of mutilation of various kinds for the capital penalty. Death was retained for some crimes, such as murder and high treason; other offenses were punished by amputation of, for instance, the hand or nose, and the tendency to avoid capital punishment increased. The same spirit, it may be noted, is apparent in the practice of Byzantine emperors to render dethroned rivals or members of a deposed dynasty innocuous by depriving them of eyesight or forcing them to take monastic orders, instead of putting them to death. The church, which had its own system of penalties, exercised a great influence on the actual operation of criminal law, especially through the privilege of asylum (recognized by Justinian, but with many reserves and restrictions), which was granted to Christian churches and was admitted without exception in the *Ecloga.*

3. Basil I and Leo VI.—The last period of legislative activity under Basil I and Leo VI represents a reaction, in a certain measure, against the *Ecloga* and a return to Justinian. Basil aimed at a revival of legal studies which was to be based on the law books of Justinian or their Greek versions. These books were now treated somewhat as Justinian and his lawyers had treated their own predecessors. A handbook of extracts from the Institutes, Digest and Code was issued in 879 (*Procheiros nomos,* "law as it is"), to fulfill something of the same function as the Institutes. Then a collection of all the laws of the empire was prepared by means of two commissions, and completed under Leo VI. It was entitled the *Basilica* (*q.v.*). In many points (in civil, but not in criminal, law) the principles of the *Ecloga* were set aside in favour of the older jurisprudence. Thus Justinian's ordinances on the subject of divorce were revived, and there remained henceforward a contradiction between the civil and the canon law (*see* GREEK LAW).

After this there was no legislation on a grand scale; but there was a marked revival of legal study under Constantine IX, who founded a new faculty of law in the reorganized university of Constantinople, and there were many learned specialists who wrote important commentaries, such as John Xiphilinus (11th century), Theodore Balsamon (12th century), Harmenopulus (14th century). The young Slav principalities in the Balkans were influenced by Byzantine legal codes; and modern Greece, although in framing its code it took the Napoleonic for its model, professes theoretically to base its civic law on the edicts of the emperors as contained in the *Hexabiblus* of Harmenopulus.

C. ADMINISTRATION

Three principles underlay the administrative reform of Diocletian: the separation of civil from military functions; the formation of small provincial units; and the hierarchical structure which depended on the interposition of the vicar of a diocese and the praetorian prefect between the provincial governor and the emperor. This system lasted unchanged for three and a half centuries. The few unimportant alterations that were made were in harmony with its spirit, until the reign of Justinian, who introduced certain reforms that pointed in a new direction. He combined some of the small provinces into large units, undermining the hierarchical system by doing away with some of the dioceses and vicars, and placing in some cases military and civil authority in the same hands. These changes, some of which were soon canceled, would hardly in themselves have led to a radical change; but they prepared the way for an administrative revolution, brought about by stress of external necessities.

1. Themes.—In the 7th century all the energies of the empire, surrounded by active enemies, were centred on war and defense; everything had to give way to military exigencies, and a new system was gradually introduced which led ultimately to the disappearance of the old. The change began in Italy and Africa, at the end of the 6th century, where operations against the Lombards and the Berbers were impeded by the friction between the two co-ordinate military and civil authorities (masters of soldiers and praetorian prefects). The military governors were made supreme with the title of exarchs, and the civil authority was subordinated to them. The change is an index of the dangerous crisis through which these provinces were passing. In the east similar circumstances led to similar results. The Muslim danger threatening Asia Minor imposed a policy of the same kind. And so by the end of the 7th century the empire had been divided into eight great military provinces or themes: exarchate of Africa; exarchate of Italy; strategia of Thrace; strategia of Hellas; county of Opsikion (*obsequium*), including Bithynia, Honorias, Paphlagonia, parts of Hellespontus and Phrygia; strategia of the Anatoliki, most of west and central Asia Minor; strategia of the Armeniaki, eastern Asia Minor; strategia of the carabisiani (Gr. *carabos,* "vessel"), the naval theme including the southern coastland of Asia Minor, and the Aegean (*see* below, *Defense*). The lands of the old prefecture of Illyricum were not included in the system, because this part of the empire was then virtually outside Byzantine control owing to the Slav invasions. There military powers were committed to the prefect of Illyricum, whose actual sphere extended little beyond Thessalonica, which was surrounded by Slav tribes.

The changes in provincial organization in Asia Minor began under the Heraclians in the 7th century, who also extended this system to the European provinces. The system was further developed by their successors. Leo III, for instance, partitioned the dangerously large Anatolikon theme, and the western part became the Thracesion theme; similarly he divided the Carabisian theme into the two themes of the Cibyrraeots and the Aegean islands. This reorganization was greatly extended during the 9th and 10th centuries. As the frontiers expanded the conquered lands were incorporated into the empire, sometimes initially as military frontier zones (clisurarchies), later to become themes or duchies. In the early 10th century there were in Asia Minor Anatolikon, Armeniakon, Thracesion, Opsikion, Bucellarion, Cappadocia, Charsianon, Colonea, Paphlagonia, Chaldia and Optimaton; in Europe Thrace, Macedonia (both ranking with the Asian themes), Peloponnese, Nicopolis, Hellas, Sicily, Strymon, Cephalonia, Thessalonica, Dyrrachium, Dalmatia, Cherson and Longobardia; and the maritime themes of the Cibyrraeots, the Aegean sea and Samos. The themes of Mesopotamia, Lycandus, Sebastea, Seleucia, Leontocomis and Cyprus (made into a theme by Basil I but then lost to the Arabs until its reconquest in 965), are mentioned in either the *De thematibus* of Constantine VII or in the 10th-century *Tacticon.* Further themes had been added by the mid-11th century, and even after the empire contracted the number of themes grew owing to a policy of subdivision.

The name theme (Gr. *thema,* "corps") denotes the military origin of these provinces. Their governors combined military and civil powers and they generally had the title of *strategos,* though there were exceptions, such as the Opsikion, governed by a *comes,* or the Optimaton, by a *domesticus.* The old hierarchical system had disappeared, including the vicars and the praetorian prefect of the east (some of whose functions were merged in the prefect of the city) and no authority interposed between the emperor and the *strategoi.* But as the armies of the themes declined in importance from the late 10th century on, while the army of the *tagmata* came to the fore, so the chief civil official (the *krites* or *praetor* of the theme) emancipated himself from military control and became directly responsible to the central government at Constantinople. The central government did in fact exercise considerable control over provincial administration, particularly in financial matters, and it was always possible for provincials to appeal to the central courts for legal redress.

2. Central Administration.—In the central administration the heads of the great administrative departments retained the palatine character which belonged to most of them from the beginning. But over a millennium there were many changes in these offices, in their nomenclature and in the delineation of their functions. The following tendencies may be noted: an increase in the number of ministers directly responsible to the emperor, caused by subordinate offices in the administrative departments bein raised to the rank of independent ministries and the creation o new offices, the old ones becoming merely titular; changes in nomenclature; substitution of Greek for Latin titles; changes in the relative importance and rank of the high officials, both civi and military.

The prefect (eparch) of the city controlled the police organization and administration of justice in the capital; he was presiden of the imperial court of justice in the emperor's absence, and when the office of prefect of the east was abolished, he inherited the functions of that dignitary as judge of appeals from the provinces. But the *praefectus vigilum,* commander of the city guards, who was subordinate to him, became an independent officer, entitled the drungary of the watch, and in the late 11th century superseded him as vicepresident of the imperial court The eparchy of Constantinople, originally one of the most important of civil offices, described by Michael Psellus in the 11th century as the equal of the emperor except for the purple, graduall declined in power, its functions passing to others, so that by th time of the Palaeologi the name only survived as a court title.

Instead of the quaestor of the sacred palace, whose duty wa to draft the imperial laws and rescripts, there was in the 9t century a quaestor who possessed certain judicial and police functions and was far lower in the hierarchy of rank. It has been supposed that the later quaestor really inherited the duties of anothe officer, the *quaesitor,* who was instituted by Justinian. The offic of quaestor survived until the Latin conquest, but by the lat middle ages had become only a title of rank.

The master of offices (*magister officiorum*), who supervised th departments in the palace and was master of court ceremonies also performed many functions of a minister of foreign affairs was head of the imperial post (*cursus*) and of the corps of imperial couriers (*agentes in rebus*). This ministry disappeared probably in the 8th century, but the title was retained as a dignit at least until the end of the 9th. The most important function pertaining to foreign affairs, were henceforward performed by th logothete of the drome. In the 12th century this minister w virtually the chancellor of the empire, but after the Latin conque his office seems to have disappeared and to be simply a title of ran Under Andronicus II the title of the first minister was that of th grand logothete.

The two chief financial ministers of the early Byzantine perio were the *comes sacrarum largitionum* and the *comes rerum priv tarum,* though the *annona,* the provincial tax, was controlled l the praetorian prefect who had indeed also tended to appropria from the *res privatae* and *largitiones.* When the praetorian pr fecture lost its importance, different financial arrangements we made. From the 7th century onward there were new and ind pendent financial departments controlled by logothetes. Oth financial officials were named *secretici* or *chartularii,* and the chi financial officer was the *sacellarius,* sometimes called the gra *sacellarius.* The head of the imperial chancery was the *protoas cretic,* an office usually filled by a legal official.

The employment of eunuchs as high ministers of state was feature of the Byzantine empire from the end of the 4th centur It was laid down as a principle (A.D. 900) that all offices we open to them, except the prefecture of the city, the quaestorsh and the military posts which were held by "domestics." The were also at that time eight high posts which could only be he by eunuchs, of which the chief were the *parakoimomenos* (gra chamberlain) and *protovestarios* (master of the wardrobe).

The orders of rank (which must be distinguished from titles of office) were considerably increased in later times. In the 4th and 7th centuries there were the three great classes of the *illustres, spectabiles* and *clarissimi,* and above the *illustres* a small, higher class of patricians. In the 9th century a different system is found, the number of classes being largely augmented, and the nomenclature different. Instead of epithets, such as *illustres,* the names were titles which had designated offices; "patrician" alone survived. The highest rank was now the *magistri;* then the patricians in two classes, proconsular patricians and respectable patricians; below these were *protospatharii, dishypati* (*i.e., bis consules*), *spatharocandidati, spatharii* and other lower ranks. Whoever was promoted to one of these ranks received its insignia from the emperor's hand, and had to pay fixed fees to various court officials.

3. Justice.—In the provinces ordinary justice was administered by judges who were distinct from the governors of the themes and inherited their functions from the old provincial governors of Diocletian's system. In Constantinople higher and lower courts of justice sat regularly and frequently. The higher tribunals were those of the city prefect and the quaestor, before whom different kinds of cases came. Appeals reached the emperor through the bureau of petitions; he might deal with the case immediately, or might refer it to the imperial court of the "divine judges," which was instituted by Justinian. In the 12th century there were four imperial courts of justice in Constantinople, and in 1166 rulings on appeal were laid down by Manuel I. After the Byzantine reconquest of Constantinople Michael VIII set up a single imperial court, and further changes introduced by Andronicus II in 1296 and Andronicus III in 1329 show the growing power of the church. Two of Andronicus III's four "chief justices of the Romans" were clerics. There were also the ecclesiastical courts to which certain cases involving the laity were reserved, such as marriage, or cases in which the defendant was a cleric. This close association of church and state continued to the end, and indeed the distinction between ecclesiastical and civil jurisdiction grew increasingly blurred.

4. Finance.—The Byzantine fiscal system, like the administration of justice, was inherited from the late Roman empire. One main source of revenue was the land. The direct taxes levied on this were the land tax proper and the *annona,* a tax on the products. The land tax (*capitatio terrena*) was based not on the yearly produce but on the capital of the proprietor, the character and value of the land being taken into account. In later times this seems to have become the *capnicon* or hearth tax, a capitation tax first mentioned in measures of Nicephorus I. In Diocletian's time the *annona* consisted of a combined poll tax and land tax, the *capitio-iugatio.* An important element in the Byzantine fiscal system was the *epibole,* whereby land which fell out of cultivation was compulsorily assigned to other landowners in the district who were obliged to pay the tax due from it as an additional charge. This responsibility was transferred to the rural community by the late 7th or early 8th century, as is evident from the "Farmer's law," though it was later reimposed on the powerful landowners by Basil II in the form of the *allelengyon,* but soon repealed by Romanus III. Whether this form of taxation, the *epibole,* or extra tax, did survive into the later period is a matter of controversy. The city population was also subject to direct taxes, such as the burdensome *auri lustralis collatio,* which was abolished by Anastasius I, who also made officials of the prefecture responsible for collecting city taxes in place of the inefficient *curiales.* Customs and excise duties were an important source of revenue throughout the middle ages and bore heavily on city populations. In the countryside there were a number of additional tax burdens in the shape of labour services for public works, or the provision of military transport and billets, as well as the additional financial contributions exacted by the tax collectors or district officials.

With the development of the Byzantine civil service, fiscal administration was supervised by departments under the various logothetes, and the local taxes were collected by *praetores,* and sometimes farmed out, especially from the 11th century onward. Byzantine state expenditure was on a large scale and its diplomacy, defense and internal administration were only made possible by a highly complex monetary system.

5. Landed Property.—The history of landed property and agrarian conditions in the eastern empire is a somewhat controversial subject. Individual hereditary proprietorship was normally the rule, whether of the large estate with its cultivators attached to the soil, or the small freeholder depicted in the "Farmer's law." Conditional grants sometimes were made, such as the small farms given in return for hereditary military service (*stratiotica ktemata*) which may have been part of the reorganization undertaken by the Heraclian and subsequent dynasties. They were evidently a well-established source of recruitment in the middle Byzantine period and they featured prominently in the 10th-century legislation which attempted to prevent their being bought up by the powerful landowning magnates. Such measures failed, and from the 11th century on military holdings, if they can be so called, were of a different nature. From Alexius I's day grants were made in *pronoia,* sometimes in return for military service from the recipient, the pronoiar or "soldier," as he was often called. Originally a grant for life only, this had become hereditary by Michael VIII's reign. When lands were granted, or confirmed, to monasteries or laymen, the number of tenants (*paroikoi*) permitted on the estate was carefully stated because of the fiscal obligations of such tenants. An estate, whether imperial or private, would have not only its permitted number of *paroikoi* but also slaves and hired labourers; but existing evidence points to a surveillance over the *paroikoi* which grew stricter, particularly as both the labour problem and financial difficulties increased in the later middle ages.

D. Defense

The general principle of the military defense of the empire in the 4th century consisted in large forces stationary on the frontiers, and reserve forces, stationed in the interior provinces, which could be moved to any point that was in danger. Thus the army was composed of the *limitanei,* frontier troops (under *duces*), and reserve forces (under *magistri militum*) of two denominations, *palatini* and *comitatenses.* In the 6th century the fundamental principles of the system were the same; but the cavalry had become a much more important branch of the service, and in the wars of Belisarius the *foederati,* barbarian mercenaries of various races, commanded by their own chiefs, played a great role. The peasants of Illyria and Thrace and the mountaineers of Armenia and Isauria in Asia Minor still supplied an important part of the army, but the number of barbarians (Vandals, Goths, Slavs, Arabs, etc.) was much larger. Solidity and a corresponding lack of mobility characterized at this time both cavalry and infantry; their great merit was straight and rapid shooting: Belisarius ascribed his success in Italy to the excellence of the archery.

Justinian carried out on the frontiers and in the exposed provinces a carefully devised and expensive system of defensive works. Fortified towns along the *limes* were connected by intervening forts, and at some distance behind was a second line of more important fortresses more strongly garrisoned which furnished both a second barrier and places of refuge for the inhabitants of the open country. There was an elaborate system of signals by which the garrisons of the frontier stations could announce not only the imminence of a hostile invasion but also the number and character of the enemy. In north Africa there are abundant remains of the forts of the 6th and 7th centuries, displaying the military architecture of the period and the general frontier system.

1. Army.—The disasters and losses of the 7th century led to a radical change in the military organization, and the division of the empire into themes (see *Administration: Themes* above). The preponderant influence which Asia Minor won and retained until the 11th century is reflected in the military establishment, which at any rate until the mid-10th century mainly depended on the Asian provinces. The *strategos* of a large theme commanded a corps of 10,000, and the scheme of the divisions and subordinate commands has a remarkable resemblance to the organization of some of the armies of modern Europe.

The recorded scheme was probably not uniform in all the themes, and varied at different periods. The *thema* (corps) consisted of two *turmai* (brigades) under *turmarchai;* the *turma* of five *banda* (regiments), each under a *drungarios* (colonel); the *bandon* of five *pentarchiai* (companies) under a *cometes* (captain). The *pentarchia,* containing 200 men, had five subdivisions under *pentecontarchai;* and there was a smaller unit of 10 men under the *decarches* (corporal).

Distinct from the military forces (*themata*) of the provinces were the forces (*tagmata*) stationed in or near the capital. The most important of these were the *scholae* and the *excubitores.* The scholarian troops were in early times under the master of offices, but subsequently their chief officer, the domestic of the schools, became the highest military commander in the empire. In war, when the emperor did not assume the chief command himself, he might entrust it to any commander, and he often entrusted it to the domestic. In the 11th century, after the conquest of Bulgaria, there were two domestics, one for the east and one for the west, and under Alexius I Comnenus the domestic of the west received the title "grand domestic." Under the Palaeologi the grand domestic was superior in rank to all other ministers.

Besides the scholarians and the *excubitores* (who had been organized in the 5th century), there were the regiments of the *hicanatoi,* the *arithmos* and the *numeroi.* The *numeroi* were foot soldiers. The *optimatoi,* also infantry, properly belonged to the same category, though they were constituted as a theme. The demes or corporations of Constantinople were partly organized as militia and were available for purposes of defense.

The great difference between this Byzantine army and that of the earlier empire is that its strength (like that of the feudal armies of the west) lay entirely in cavalry, which the successors of Heraclius and the north Syrian emperors developed to great perfection. The few contingents of foot were subsidiary. The army was maintained in Asia Minor, which was the great recruiting ground, by a system of military holdings of land (an extension of the old Roman system of assigning lands in the frontier districts to federate barbarians and to veterans). The conditions of the marauding expeditions and guerrilla warfare, continuously carried on against and by the Arabs in the 8th, 9th and 10th centuries, were carefully studied by generals and tacticians, and the theory of the Byzantine methods is set out in various military treatises including the *Tactica* of Leo VI based on the so-called *Strategicon* of Maurice.

The loss of a great part of Asia Minor to the Seljuks and the disorganization of the provinces which they did not acquire seriously weakened the army, and the emperors had recourse more and more to foreign mercenaries and barbarian auxiliaries. The employment of Russians had begun in the 10th century, and in 988 the Varangian (Russian) guard was formed. Under Michael IV the Norwegian prince Harald III Hardraade fought for the empire in Sicily and in Bulgaria. During the 11th century foreign mercenaries, including Turks, Normans and English, greatly increased in numbers and importance.

The keynote of the Byzantine army was efficiency, and nowhere is the immeasurable superiority of the civilization of the eastern empire to the contemporary states of Europe more apparent. The theory of military science was always studied and taught: constant practice, interpreting and correcting theories safeguarded it against pedantry; and a class of magnificent staff officers were trained who in the 10th century were the terror of the army. The particular tactics of the various foes whom they had to face were critically studied. There are extant various military textbooks, from the time of Anastasius I to that of Basil II, which set out their principles and methods. In this army there was plenty of courage and distinct professional pride, but no love of fighting for fighting's sake, nor the spirit that in western Europe developed into chivalry. The Byzantines despised such ideas as characteristic of barbarians who had physical strength and no brains. The object of a good general, as Leo VI shows in his *Tactica,* was not to win a great battle but to attain success without the risks and losses of a great battle. The same author criticizes the military character of the Franks; paying a tribute to their fearlessness, he points out their want of discipline, the haphazard nature of their array and order of battle, their eagerness to attack before the word was given, their want of faculty for strategy or tactical combinations, their incapacity for operations on difficult ground, the ease with which they could be deceived by simple artifices, their carelessness in pitching camps and their lack of a proper intelligence department. These criticisms illustrate the contrast between a western host, with its three great "battles," rushing headlong at the foe, and the Byzantine army, with its large number of small units, co-operating in perfect harmony, under a commander who had been trained in military science, had a definite plan in his head, and could rely on all his subordinates for strict and intelligent obedience.

2. Navy.—Under the early empire, as Rome had no rival in the Mediterranean, it was natural that the navy and naval theory should be neglected. When Constantine the Great decided to besiege Byzantium by sea, both he and his opponent Licinius had to create fleets for the struggle. Even when the Vandals in Africa made transmarine conquests and became a naval power, the Romans did not seriously concern themselves with building an efficient navy. The Vandals harried their coasts; their expeditions against Africa failed. And even when the Vandal power was in its decline and Belisarius set forth on his successful expedition of conquest, his fears for the safety of his squadron in case he should be attacked at sea suggest that the Vandal fleet was superior to his. The conquest of Africa secured for Justinian I the undisputed command of the Mediterranean, but he did nothing for the naval establishment. It was not until the Arabs, aspiring to conquer all the Mediterranean coastlands, became a naval power that the empire was forced to organize an efficient fleet. This was begun by the Heraclians. The naval forces, designated as the *carabisiani,* were placed under the command of an admiral with title of *strategos.* They consisted of two geographical divisions, each under a *drungarios:* the province of the Cibyrraeots (probably named from the smaller Cibyra in Pamphylia) which included the southern coast districts of Asia Minor, and the Aegean province, which consisted of the islands and part of the west coast of Asia Minor. It was a new principle to impose the burden of naval defense on the coast and island districts. Distinct from these fleets, and probably organized on a different principle, was the naval contingent stationed at Constantinople. Leo III change the naval administration, abolishing the supreme command, an making the Cibyrraeot and Aegean provinces separate independen themes under a *strategos* and a *drungarios* respectively. The charge was due to two motives. There was a danger lest a commander of the whole navy should become overpowerful (indicated by the political role played by the navy before Leo' accession).

In this and the following reigns, the tendency was to negle the fleet; the interest of the government was concentrated on th army. For a time this policy was prosecuted with impunity, sinc the Omayyad dynasty was growing weak, and then under th Abbasids, who transferred the capital from Damascus to Baghdad the seapower of the caliphate declined. But the neglect of th fleet was avenged in the 9th century, when Crete and Sicily wer wrested from the empire, the loss of south Italy was imminen and Muslim squadrons sailed in the Adriatic—losses and danger which led to a reorganization of the navy under Michael III an Basil I. After this reform the navy consisted of two main contingents: the imperial fleet stationed at Constantinople, and th provincial fleets, three in number, of the Cibyrraeot theme, th Aegean theme and the theme of Samos. Naval service was als exacted from the European coastal themes, as the Peloponne and Cephalonia. When the fleets acted together, the *drungari* of the imperial fleet usually took supreme command. The wa ships (Gr. *dromones*) were mainly biremes, but there were al ships with single banks of oars built for speed called galleys (G *galaiai*). Pyrotechnic was an important department in the nav establishment; the manufacture of the terrible explosive know as liquid or sea fire (*see* GREEK FIRE) was carefully guarded as state secret. The navy, active and efficient in the 10th century, described by Cecaumenus, a military and perhaps therefore u prejudiced officer of the 11th century, as the glory of the empi

By the late 11th century Byzantine naval resources had however declined. Alexius I united the imperial and provincial fleets under the command of a grand admiral (*megas dux*), but neither his efforts nor those of his successors could create a force capable of holding its own with the Italian maritime cities. On the contrary it was only with Venetian naval help that Byzantium repulsed Norman attacks and for this Venice exacted extensive commercial privileges which injured Byzantine trade and excited the jealousy of other Italian cities, particularly Genoa. In the Palaeologan period, though emperors, such as Michael VIII, appreciated the importance of naval power, they lacked resources with which to implement such a program and were virtually pawns in the hands of the maritime rivals Venice and Genoa.

E. Diplomacy

In foreign policy diplomacy was a weapon as important in the eyes of the Byzantine government as soldiers or fortifications. Peace on the frontiers was maintained not only by strong military defenses, but by skilful management of frontier peoples. In the Byzantine empire this kind of diplomacy was practised as a fine art and had certain underlying principles. One people was kept in check by means of another, and the imperial government fomented rivalry and hatred among them. Thus Justinian I kept the Gepidae in check by the Lombards, the Kutriguri by the Utiguri, and the Huns by the Avars. Subsidies were given to the peoples on the frontiers, in return for which they undertook to defend the frontier adjacent to them and to supply fighting men when called upon to do so. The chiefs received honours and decorations. Thus the Berber chiefs on the African border received a staff of silver encrusted with gold, white cloak, embroidered tunic, etc. More important potentates were invested with a costlier dress. In these investitures precedence was carefully observed. The chiefs thus received a definite position in the empire, and in some cases they were admitted to posts in the official hierarchy, such as that of patrician or master of the soldiers. They were extremely fond of such honours and considered themselves half-Roman.

Another mode of winning influence was to marry barbarian princes to Byzantine wives and to bring up their sons in the more civilized environment of the capital. Dissatisfied pretenders and defeated candidates for kingship were welcomed at Constantinople. Thus there were generally some princes, thoroughly under Byzantine influence, who at a favourable opportunity could be imposed on their compatriots. Methods of this kind had long been employed by the Roman government. Then with the imperial adoption of Christianity and the close connection between church and state, the mission field offered endless opportunities for the extension of Byzantine influence. Newly converted countries were brought into touch with the civilization and court of the empire, and this was maintained both by personal contacts in princely circles and through the ecclesiastical hierarchy, particularly the bishop, who would normally be appointed by the patriarch of Constantinople. Diplomacy of this kind was fostered not only by the central government but by local officials, who thus exercised considerable influence over neighbouring peoples or states (*e.g.*, the catepan of Italy or the *strategos* of Kherson).

One particularly important state in the early middle ages was hat of the Khazars, between the Caucasus and the Don, with which the empire had long maintained relations. Heraclius, to win its co-operation against Persia, promised his daughter in marriage to the khan, and later two Khazar princesses became Byzanine empresses, the wives of Justinian II and Constantine V. Their tate steered skilfully between the contending influences of Islam and Christianity, and their rulers avoided suspicion of partiality or either creed by embracing the religion of the Jews (*c.* 800). Commercial and political relations with the Khazars were mainained through the important outpost of the empire at Kherson in he Crimea, which had been allowed to retain its republican contitution under a president and a municipal board, though this freedom was limited by the appointment of a *strategos* in 833, a moment when the Khazars were seriously threatened by the Pechenegs (Patzinaks). The danger to be feared from the Khazars was an attack upon Kherson, and it seems probable that this was a leading consideration with Leo III when he married his son Constantine V to a Khazar princess. In the 9th century it was an object of the government to maintain the Khazars (whose army consisted mainly of mercenaries) against the Pechenegs; and hence, if it should become necessary to hold the Khazars in check, the principle was to incite against them not the Pechenegs but other less powerful neighbours, the Alans of the Caucasus and the people of "Black Bulgaria" on the middle Volga (a state which survived until the Mongol conquest).

In the 10th century it can be observed how the government conducted its foreign policy on carefully thought-out principles. The empire was then exposed to constant danger from Bulgaria, as well as to attacks from the Russians. The key to the diplomatic system, designed to meet these dangers, was the cultivation of friendly relations with the Pechenegs, who at that period did not menace the provinces by land or by sea and could be incited to act against Russians or Bulgarians. The system is explained by the emperor Constantine VII Porphyrogenitus in his *De administrando imperio*.

The policy had its dangers, and was severely criticized by one of Justinian's contemporaries, the historian Procopius. Concessions encouraged greater demands; the riches of the empire were revealed. It was a system which could not be permanently successful without military power behind it, and was not infallible, but in principle it was well-founded and proved of immeasurable value, particularly during the periods when the empire enjoyed great prestige.

For this systematic diplomacy it was necessary to collect information about the peoples whom it concerned. Ambassadors reported everything of interest they could discover, and sometimes information was provided by missionaries. Priscus left a famous graphic account of the embassy which he accompanied to the court of Attila, and there exists an account of an embassy sent to the Turks in central Asia in the second half of the 6th century, derived from an official report. Peter the Patrician, in Justinian I's reign, drew up careful reports of his embassies to the Persian court. When foreign envoys came to Constantinople, information was elicited from them as to the history and domestic politics of their own countries. Some of the accounts of the history and customs of neighbouring peoples in the *De administrando imperio,* furnishing numerous facts not to be found anywhere else, were derived from ambassadors who visited Constantinople. Diplomatic relations with the west were also important, and frequent embassies went to the rulers who established themselves in what had once been the western half of the Roman empire as well as to the Persian and then the Islamic courts. With the crusades and the influx of Latins and Turks into east Mediterranean politics the Byzantine foreign office and Byzantine gold had full scope for the diplomacy which had been exercised to such good effect in the early middle ages. Byzantine diplomacy, like the civil administration and military organization, showed considerable flexibility and proved capable of being adapted to the changing needs of more than ten centuries.

III. THE CHURCH

1. Position of the Emperor.—When Constantine the Great recognized Christianity and indeed accepted it as his own religion he inaugurated a new era in the history of the Roman empire. At first tolerated, then by the end of the 4th century the only permitted religion (though the proscribed paganism lingered on), the Christian church henceforth took its place in public as well as private life. Its rapid integration with the polity and the importance accorded it were symbolized by the special position of the Christian emperor. He was regarded as the vicegerent of God on earth, and as such he had the special duty of protecting the church and of furthering its aims. He had the right of summoning general church councils and of presiding over them; his was the deciding voice in the appointment of the patriarch; he could inaugurate changes in the organization of sees or in episcopal status; and, particularly in the earlier middle ages, he tried to impose his will in doctrinal matters. It is especially this last which has given rise to the charge of caesaropapism. But in fact this is hardly justified. Even Justinian I himself clearly laid down that "the two gifts of God," the *sacerdotium* and the *imperium*, were two quite distinct spheres. The emperor, permitted as he was to enter the sanctuary and to communicate as priests and deacons did, never performed the priestly functions. When he tried, often for political ends, to impose his views in matters of faith against the will of the church, he was never permanently successful. Normally the emperor was the protector of the church and the guardian of orthodoxy, and the relation between church and state was one of close interdependence.

2. Ecclesiastical Divisions.—In the 4th century there were some Christian communities outside the Roman empire, but the greater part of Christendom lay within imperial bounds and ecclesiastical organization and ecclesiastical conferences were modeled on imperial administration and procedure. Dioceses were under bishops, provinces under metropolitans. Over them were the regional archmetropolitans, or patriarchs as they were called by the 6th century. These were originally the bishops of the three cities specially venerated for their Christian associations, Rome, Alexandria and Antioch, although also great metropolitan centres in the secular sense. During the 4th century Constantinople, as New Rome and the imperial capital of the eastern half, rose to prominence, and although not without bitter opposition, was accorded second place after Rome (381). This was confirmed in the so-called 28th canon of the ecumenical Council of Chalcedon (451). In the 5th century, the bishop of Jerusalem's claim to the title of patriarch was also recognized. After the Arab conquest of Egypt, Palestine and Syria, the patriarchs of Alexandria, Jerusalem and Antioch naturally played a less important role in Christian affairs and the lead was taken by Rome and Constantinople.

Political circumstances also led to different developments in the eastern and western halves of the Roman empire, and this was reflected in ecclesiastical relations between the two patriarchates. Leo III's transference of south Italy and Sicily, the western Balkans and Greece from Roman jurisdiction to the patriarchate of Constantinople, and rivalry in the missionary field, particularly among the Slavs, as well as differences of discipline, ritual and doctrinal emphasis, all helped to foster a situation which from the 11th century onward was acerbated by Latin political and economic ambitions.

The year 1054, when the patriarch Michael Cerularius and his followers were excommunicated by the papal legate Cardinal Humbert, is often taken as marking the beginning of the existing schism between Rome and Constantinople. It was in fact not an excommunication of the Orthodox church as such, and the door was left open for reconciliation. But the Greeks were bitterly antagonized by such events as the Latin capture of Constantinople in 1204. Henceforth people and church stood together, and imperial pleas for reunion, such as were attempted at the Council of Lyons (1274) or the Council of Ferrara-Florence (1439), were scorned by the Byzantines. As their political power dwindled, so their national feeling grew, and one of the most fervent manifestations of this was their refusal to accept any reunion with Rome.

3. Doctrinal Issues.—A general council was by long custom the acknowledged method of dealing with ecclesiastical problems of doctrine and discipline. The first was called by Constantine the Great at Nicaea (325), and this set the pattern and demonstrated the strength of the links between church and state. The emperor summoned the general council and either he or his representative took the chair. Procedure was modeled on that of the senate, and the emperor could intervene in debates if he wished. As the senior patriarch, the pope (or his legates) had the right of voting first. The decisions or canons of the council were confirmed by the emperor. It was in the general councils of the 4th to the 7th centuries that trinitarian and christological doctrine was defined (*see* COUNCIL). In the 8th and 9th centuries the doctrinal problem was primarily the iconoclast heresy settled at the second Council of Nicaea (787) and at a council held in Constantinople in 843.

After the rift with Rome in the 11th century, the Byzantine church still had its theological problems which were usually dealt with by the patriarch of Constantinople's standing synod, reinforced by metropolitans and autocephalous archbishops, including the eastern patriarchs. There were occasional cases of heretical error arising among educated scholars and churchmen, but the only instance of widespread heresy was Bogomilism, a form of the dualism which troubled Latin as well as eastern Christendom. The Bogomils (*q.v.*), who grew to strength in the Slav Balkans, spread into the Byzantine empire in the 11th and 12th centuries, and the heresy was never completely eradicated, especially in Bosnia. Byzantine theological discussions of the later middle ages (apart from the question of reunion) tended to centre in hesychasm, which had a long ancestry in Christian Greek spirituality (*see* HESYCHASM). This problem was debated in councils in the mid-14th century, and though it was in essence a matter for the church it had widespread political repercussions because of the secular affiliations of its supporters and opponents in an age of civil war. It also brought out the differing theological emphasis of the Greek and Latin churches. Generally speaking, the Byzantine people were bitterly antagonistic to the Latin church and to Latin thought, as their attitude to reunion shows, but there were notable exceptions. Some Greek scholars and churchmen availed themselves of the opportunity to read western writers, such as Thomas Aquinas, some of whose works were translated into Greek, and though most preferred Turkish domination to reunion a small minority traveled westward and entered the Roman church. Under Ottoman domination after 1453, the Byzantine church long remained the one bulwark of the Christian population.

4. Patriarch.—The head of the Byzantine church was the patriarch of Constantinople, who through force of circumstances was the dominating figure of eastern orthodoxy. He also exercised authority over the churches of the Slavs in the Balkans and in Russia. As head of the Byzantine church he had the right of crowning the emperor; as chief ecclesiastic he was widely influential. He could excommunicate the emperor, as happened when Leo VI was excommunicated because of his fourth marriage, or refuse coronation, as when John I Tzimisces was forced to agree to patriarchal conditions before he was crowned. During a minority the patriarch might act as one of the regents, as Nicholas Mysticus did in the early years of Constantine VII's reign. But normally his role in purely political matters was a subordinate one, though emperors obviously preferred a patriarch who would be likely to support their policy and took steps to ensure this. The patriarch was chosen by the emperor from three names submitted to him by the synod, and he could if he wished put forward a different name; if a patriarch once appointed proved intractable or unacceptable there were ways of contriving his resignation.

The patriarch was responsible for maintaining orthodoxy and discipline, and in both respects he normally had an ally in the emperor, who shared in conciliar activity and could supply the backing sometimes necessary to implement the canons. The emperors, particularly before the 10th century, issued their own edicts on points of doctrine, as for instance the *Ecthesis* of Heraclius on monotheletism (*see* MONOTHELITES), but such imperial intervention in matters of faith did not permanently alter orthodoxy as interpreted by the tradition of the church. Ecclesiastical administration was also the subject of innumerable imperial rulings, particularly insofar as concerned property, for the church was one of the most important landowners in the empire.

5. Other Clergy.—Subordinate to the patriarch was the hierarchy of metropolitans and bishops presiding over provinces and dioceses. Autocephalous bishops were not subject to metropolitans and had no bishops under them. Metropolitans were at first chosen by the patriarch from three names put forward by the provincial bishops, then from the 10th century on by the standing synod of Constantinople. Bishops were chosen by the metropolitans from three names put forward by the provincial synod. The metropolitan presided over the provincial synod, which legislated on matters concerning the whole province and acted as a court of appeal against episcopal sentences. Bishops-elect, if married, had to separate from their wives and normally assumed the monastic habit; they were in fact usually chosen from the monastic ranks. They were responsible in their dioceses for pastoral work and administration of church property as well as for the clergy and monks. In legal matters certain cases were reserved to their courts, and they could act whenever a cleric was involved. Bishops were assisted by their diocesan clergy and had their own *curias*. Cathedral churches were served by special dignitaries; Hagia Sophia in Constantinople originally had five, then nine, great patriarchal officials. The clergy, except for bishops, could retain their wives if they had married before being ordained subdeacon. Second marriage was disapproved of and precluded the possibility of ordination.

Pastoral work originally centred in the cathedral church in the town, but as Christianity spread other churches were founded in towns and in the countryside. Some (*catholicai ecclesiai*) were parish churches directly under the bishop who nominated their clergy; others (*eukterioi oikoi*) were chapels on private estates or even built by villagers. The founders of such chapels appointed the priest but had to get the bishop's consent for this as well as for the performance of certain sacraments. There were also the chapels in the many monasteries which did in fact also minister to the faithful laity, though this was not their primary function.

6. Finance.—The revenues of the church were derived largely from the gifts of the faithful which from the time of Justinian I were regarded as the property of the particular institution or church. They were administered by the priests responsible for the services under the foundation deed or by a steward (*oiconomus*) appointed by the bishop. Landed property often was granted out on lease in return for a yearly payment. It was regarded as inalienable, although imperial practice, particularly in the later middle ages, made inroads into ecclesiastical property. A *canonicon* or ecclesiastical tax from the laity and priests of both parish "catholic" churches and private chapels was assigned to the bishop and from the 11th century was made compulsory. Monasteries also paid this *canonicon*. Bishops normally would be responsible for the stipends of their cathedral clergy. The parish churches were provided for by the bishops and in the later middle ages from property reserved for this purpose. Founders of private chapels made their own arrangements for the maintenance of their own clergy. Many priests also worked their land and lived as *paroikoi* on estates. Priests also received the voluntary offerings of their parishioners, given for instance when some sacrament was performed.

7. Monasticism.—Side by side with the secular clergy were the monks, cenobitic and eremitic, and theirs was one of the greatest single influences in Byzantium, for it was in the contemplative life that Byzantines considered the perfect Christian life to be most nearly realized (*see* MONASTICISM).

8. Laity.—Within this ecclesiastical framework Byzantine men and women, lay and monastic, were instructed in the Scriptures and the traditions of the church, whether by the sermon of bishop or abbot (of which splendid examples have survived) or by the simple teaching of the parish priest. Above all they drew their strength from the sacraments, in which everyone shared alike and which were performed in a liturgical setting as impressive in the simplicity of the small country chapel as in the majestic ceremonial of Hagia Sophia in Constantinople.

See also ORTHODOX EASTERN CHURCH.

IV. BYZANTINE SOCIETY

Byzantium was both a cosmopolitan and an aristocratic society. Its many different races found some kind of unity within the framework of a Christian empire in the main deriving its administrative and cultural traditions from the Greco-Roman world, though not uninfluenced by oriental civilizations. The geographical situation of its capital, Constantinople, enabled it to command routes by land and sea between Asia Minor, the Balkans and western Europe, or leading to Russia, central Asia and beyond. It was the metropolis of Mediterranean economy certainly up to the end of the 12th century, and its gold coin, the nomisma, was the medium of international exchange until it was supplanted by the Italian cities, notably Venice and Genoa in the period after 1204. Constantinople drew considerable revenue from customs dues and from its own export trade, particularly of its highly prized materials and its works of art, such as ivories. Both industry and trade were under strict state control. In the countryside there were always large estates owned by important families (as the Ducas or the Phocas) and worked by serfs and slaves and other agricultural labourers, as well as tenant farmers. There were also villages recognized as taxable units, with a free peasantry working their own small farms, but this was a precarious life, subject to the depredations of the tax collector and the ravages of nature, and often had to be abandoned for the position of tenant on a large estate with obligations to a landlord in return for his protection. Conditions changed over the long history of Byzantium, but the landed magnate was always a powerful factor in provincial economic life as in the government of the state.

In the capital the civil service formed an essential element of the polity, though the interests of its higher members often clashed with those of the nobility. In this trained bureaucracy a young man without birth or family backing could rise to the influential upper ranks as an administrator or a court official. Byzantine society, certainly the middle and upper reaches, was well educated and aware of its continuity with its Greek past. The wealthier families had tutors for their children and there were some schools in the provinces. Teachers were available in the big cities, and Constantinople, to which the ambitious naturally gravitated, had its own university, founded as early as 425, providing higher instruction in a secular curriculum in which law and philosophy took pride of place. The church also had its schools, but the state had no need to depend on these for the provision of educated civil servants. Intellectual activity was equally assiduously promoted in imperial circles, and in the rare exceptions when this was not so (as in the case of Basil II) the fact was noted with disapproval. This interest grew rather than diminished as Byzantine political fortunes waned; the exiled Nicaean emperors were at pains to build up their libraries in Asia Minor, and, amid the stresses of civil wars and foreign dangers in the 14th century, protagonists such as John VI and Nicephoras Gregoras supported their respective points of view in lively and lengthy literary works.

Byzantium left an extensive and varied literature. Most of it is in a language somewhat artificially modeled on Attic Greek; much, especially letters and speeches, is in a highly rhetorical style. In some literary fields the Byzantines excelled. Their contemporary histories and memoirs, their writings on Christian spirituality, their lives, whether of saints or of secular figures, are often outstanding. (*See* HISTORY: *Historiography*.) Secular poetry was usually written in classical metre; the Byzantines did not excel in this field, though there are exceptions, such as the short poems in the *Greek Anthology*. Some of the finest Byzantine poetry was either liturgical or concerned with Christian spirituality and this was not in classical metre. (*See* GREEK LITERATURE: *Byzantine* [*4th Century A.D.–1453*].) Inseparably allied to liturgical poetry was church music, where Byzantine achievements, only deciphered in the 20th century, can hold their own with comparable medieval western masterpieces (*see* BYZANTINE MUSIC).

Throughout the middle ages Byzantium influenced and conferred benefits upon its neighbours in varying degrees, and in certain respects that influence and indebtedness still continue. For much of the middle ages Greek was not understood in Latin Europe, but Latin translations of a number of Greek works were made, whether of ancient Greek or of Hellenistic authors, or of later Christian writers such as the desert fathers or Pseudo-Dionysius. From the 12th century onward this work of translation was greatly accelerated, spreading via Hungary, Italy and Sicily, Spain and the Arabs; more westerners themselves gradually learned to read the Greek originals which by the early modern period were being eagerly studied in western Europe. An obvious debt was owed in respect of the masterpieces of ancient Greece, where texts could hardly have been continually copied and read without the interest of an educated Byzantine public. Another source of influence was art and architecture, both through the smaller objects such as ivory reliquaries, fine textiles and illustrated manuscripts which traveled as gifts to princely courts and as merchandise, and through the craftsmen trained in Byzantine ateliers who went to work in south Italy or Sicily or the Balkans (*see* BYZANTINE ART AND ARCHITECTURE).

The Byzantine state itself with its imperial and administrative traditions impressed contemporaries, not only the travelers from all parts who were continually passing through the capital, but particularly those Slavs who in the course of the middle ages learned how to build up their kingdoms in the Balkans and further afield in Russia. They profited by contact with the living imperial regime, from translations of its legal codes (also widely influential in Latin European countries), from marriage alliances which brought Greeks into their family and court circles, and above all from the church. Greek missionaries and then Greek ecclesiastics spread the Byzantine conception of a Christian polity with its close relationship between church and state.

The Byzantine empire in the middle ages performed a further duty. It acted as a bulwark against the Muslim upsurge which threatened Greco-Roman civilization. When Constantinople finally fell to the Ottomans, the western European kingdoms were strong enough to resist the advance of Islam in a way which might not have been possible earlier. And although the Balkan kingdoms and the Greek lands of the empire were for several centuries under Ottoman control, both Slav and Hellenic national consciousness was strong enough to survive together with the Orthodox Church. *See* also references under "Byzantine Empire" in the Index.

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BYZANTINE LITERATURE: *see* GREEK LITERATURE.

BYZANTINE MUSIC. The term is used to describe the liturgical chant of the Byzantine Church down to the 16th century; it has survived in some monasteries to the present day. It has been preserved in a great number of manuscripts, mainly from the 10th to the 19th centuries, though a few have come down from the 9th and even the 8th centuries. The most interesting are those written before the end of the 14th century. Before the deciphering of the notation and the transcription of the main body of Byzantine liturgical chant in the second quarter of the 20th century, Byzantine music was believed to derive from ancient Greek music. This misapprehension was furthered by the fact that Byzantine theorists applied the speculations of Greek and Hellenistic mathematicians to their own chant, though according to Nicolas Mesarites, *c.* 1200, in his description of the church of the Holy Apostles at Constantinople the teaching of singing was in practice independent of Greek theory.

In fact Byzantine chant, like western chant, derives in the main from that of the Syro-Palestinian liturgy, which had inherited the practice of the Jewish synagogue, and is in no way connected with classical Greek music. The earliest example in style of Byzantine music is the famous Oxyrhynchus hymn to the Trinity (late 3rd century) that used to be considered as the last document of Greek music. It is written on a strip of papyrus in the letter notation ascribed to Alypius.

Structure of the Melody.—The 20th-century deciphering of the notation and transcription of the chants led to the discovery of the principle of Byzantine musical composition. It is now seen that each melody consists of a number of melodic formulas. They are the archetypes from which the musician worked. His creative activity consisted in adapting the formulas to the text and in composing connecting passages. The formulas were divided into eight groups, each of which represented a certain mode (*Echos*). This principle of melodic construction was taken over from the Syrian Church. There it was the custom to sing in cycles of eight weeks a repertory of hymns in all eight modes, each week being assigned to a single mode. This custom derived from Gnostic calendaric speculations and can be traced back to Babylonian cosmology: it caused late Neoplatonic theorists to identify the Byzantine modes with the ancient Greek *echoi* and to attribute to each of the scales a certain quality of mood. These theorists overlooked the fact that in Greek scales the division into tones and semitones runs downward, whereas in Byzantine scales, as in medieval modes, it runs upward. The *Echos* theory of the Greek philosophers cannot, therefore, be applied to the Byzantine modes. At the beginning of a melody the mode was indicated by the Greek numerals, one to four, and their plagal correspondents.

Development of Notation.—Like western musical notation Byzantine notation is a system of neumes based in the main on the prosodic signs of the Greek grammarians. Its first phase is the "ekphonetic notation," designed to indicate the correct cantillation (chanting) of the lessons without giving any pitch; it occurs fully developed, in 8th-century manuscripts and has remained unchanged. The earliest musical manuscripts date from the 9th century. In these the notation is primarily intended to guide the singers in performing correctly chants they have memorized. The signs indicated the rise and fall of the melody but not the exact intervals. They fixed the rhythmic nuances, and showed which sign ought to be accentuated, which prolonged and which shortened. When, in the 11th century, many of the old hymns were replaced by new ones it became necessary to give clearer indications. Some signs were added and others interpreted in a different way in orde to mark the intervals. The third stage, beginning about 1200 was the adaptation of the approximate interval values into exac ones. Finally, at the beginning of the 14th century, supplementary signs were added in red ink to indicate the correct execution of groups of notes. Thus the system of Byzantine neumes was from the earliest times more precise than that of the Gregorian chant in indicating the rhythmic nuances of the melodies and, in its later stages, as precise as western staff notation in giving the size of the intervals.

The system, however, was a complex one. When, in the 17th and 18th centuries, the art of Byzantine chanting gradually decayed, the signs were no longer understood, and the neo-Hellenic notation introduced by Chrysanthus of Madytus in his *Theoretikon mega* (1832) is an artificially simplified version for the modern printed hymnbooks.

Literal transcriptions can be made only from manuscripts written after 1200, because in these the exact pitch is clearly indicated. Yet it is obvious from the similarity between the later, more elaborate and the earlier, simpler notation that the shape of the syllabic melodies remained practically unaltered from the 10th to the 15th centuries, whereas from the 13th century on the melismatic chants increased their coloraturas so abundantly that the words became incomprehensible and the original shape of the melodies could hardly be recognized. Some 18th-century *stichera* (*sticheron,* a short hymn following a verse from the Psalms), however, preserved the 13th-century shape of the melodies.

Types of Hymn.—The earliest form of Byzantine hymn was the troparion, a short stanza inserted after each of the last six or three, verses of a psalm. Composition of troparia independent of a psalm originated in the time of the emperor Leo I (457–474) Anthimus and Timocles are mentioned as the first hymn writers soon to be followed by a great number of poet-musicians who were the authors of innumerable troparia. In the 6th century Sophronius, patriarch of Jerusalem (634–638), wrote two cycles one for Christmas, the other for Good Friday, each consisting o 12 troparia.

In the same century a composite form appeared, the kontakion a poetical homily, which in its content, poetical form and dramatic character derived from the three main forms of Syria poetry, *mêmrâ, madrâshâ* and *sôgithâ*. The greatest master of the kontakion was Romanos, a Syrian by birth who was inspired by the spirit of Syriac poetry but who wrote in Greek. Romanos went to Constantinople during the reign of Anastasius I (491–518) and composed several hundred kontakia. Romanos is possibly the poet-composer of the most famous hymn of the Greek Church, the Akathistos hymn for the feast of the Annunciation. The patriarch Germanus, celebrating the victory over the Arabs, who besieged Constantinople in 718, wrote a new proemium (introductory stanza) to the Akathistos, which from then on was also regarded as a hymn of victory. The kontakia are collected in the kontakarion. None of the surviving kontakaria is earlier than the late 13th century, and the melodies they contain are of a richly melismatic type. It is doubtful if they are the original melodies; for the words of the hymns, mostly by Romanos, are so important and of such sublime quality that they were certainly originally chanted in a simple way, as were the lessons. It is possible that there is a liturgical reason for the increase in ornamentation. When, after the Trullan council (691–692), preaching became an obligatory part of the service, the kontakion, the sung homily, became superfluous and fell out of use. This is why the later kontakaria contain only the proemium and first stanza, not the whole kontakion, but with more extended melodies. The Akathistos, however, has an exceptional position; all its 25 stanzas are still sung in the office of the feast of the Annunciation.

Toward the end of the 7th century a new form, the kanon, came into being. Though poetically inferior to the kontakion, it was in its form and content such a perfect expression of Byzantine piety that kanon-singing holds an important place in the liturgy down to the present day. The first kanon writers, Andrew of Crete, John of Damascus and Cosmas of Jerusalem, came from the monasteries at Jerusalem; a second group, however, writing in the 8th and 9th centuries, belonged to the Studios monastery in Constantinople during the worst days of iconoclasm. There was also the nun Kasia (b. *c.* 810), a gifted poetess, famous for her monostrophic poems. In the 11th century, St. Nilus founded the monastery of Grottaferrata near Rome, and south Italian and Sicilian kanon-writing flourished for another century.

In the heyday of the Byzantine empire the office was so rich in hymns that a great orientalist speaks of the "ivy of poetry" that overgrew the liturgy.

Now that so great a part of Byzantine chant has been transcribed it has become clear that it is in no way inferior to western chant, and that it is no less impressive than Byzantine visual art.

Secular Byzantine Music.—Music also played a great part in the ceremonial life of the emperor. Wherever he went he was greeted by the "acclamations" of the two factions, the Blues and he Greens. Acclamations were chanted when he appeared at the hippodrome and when he and the patriarch went to church. Portable organs were carried in processions; they were played during meals and in the hippodrome; but they were never taken into the church. In 1880 S. Lambros discovered a collection of folk songs in an Iviron manuscript on Mount Athos, written by Athanasios Kapetanos between 1650–70. The melodies, written in late Byzantine (Koukouzelian) notation, the only document rom these days, published in facsimile and transcription by B. Bouvier (1960), are of the same type as neo-Greek folk songs.

See also MUSIC IN ANCIENT CIVILIZATIONS.

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(E. J. Wz.)

BYZANTIUM (mod. ISTANBUL, in European Turkey), an ancient Greek city on the shore of the Bosporus, occupying the most easterly of the seven hills of the modern city, was founded by Megarians about 657 B.C. It owed its continuing importance to its command of the grain trade from the Black sea and of one of the shortest passages from Europe to Asia. When the Persians advanced into Europe in 514 Byzantium came under Persian control, but remained restive and was liberated by the Greeks under the Spartan king Pausanias in 478. When Pausanias was officially discredited he occupied Byzantium, but was soon expelled by the Athenians (477). Byzantium then became a tribute-paying member of the Delian league. It joined Samos in revolt in 440, but was reduced without serious fighting. It revolted again in 412 after the Athenian defeat at Syracuse but was recovered by Alcibiades in 408. Lysander captured the town in 405 and installed a Spartan governor, but in 389 Thrasybulus expelled the pro-Spartan party and restored democracy and the Athenian alliance.

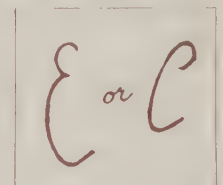
Byzantium joined the Athenian confederacy of 377, but revolted in 357 when Mausolus, ruler of Caria, stirred up the islands against Athens. When, however, Philip II of Macedonia advanced against it in 340 an appeal was made to Athens. The Athenians under Chares effected little against the Macedonians, but in the following year gained a decisive victory under Phocion and compelled Philip to raise the siege. The divine intervention of Hecate on this occasion was commemorated by the symbol of crescent and star stamped on Byzantine coins of this period (the device later adopted by the Turks).

During the reign of Alexander the Great, Byzantium was compelled to acknowledge Macedonian supremacy; after the decay of Macedonian power it regained its independence, but suffered from the incursions of Gallic tribes. The treasury was drained to buy off the Gauls about 270 B.C. and with the further imposition by the Gauls of an annual tribute of 80 talents, the Byzantines were compelled to exact a toll on all the ships which passed through the Bosporus—a measure which the Rhodians avenged by a war in 219 in which the Byzantines were defeated, and forced to restore the freedom of the straits.

When Pontus and Bithynia together became a Roman province in Pompey's (Pompeius') settlement of 62 B.C., Byzantium ranked as a free city; under the early empire it was regarded as part of Bithynia but remained free until, having sought arbitration on some of its domestic disputes, it was subjected to the imperial jurisdiction and gradually stripped of its privileges. The emperor Claudius remitted the heavy tribute which had been imposed on it; but the last remnant of its independence was taken away by Vespasian. The city was besieged and taken (A.D. 196) by Septimius Severus in his campaign against Pescennius Niger; he destroyed it, demolished the famous wall and put the principal inhabitants to the sword. Severus afterward rebuilt a large portion of the town and gave it the name of Augustus Antonina. It had scarcely begun to recover its former position when, through the capricious resentment of Gallienus, it was once more sacked. From this disaster the survivors recovered so far as to be able to check an invasion of the Goths in the reign of Claudius II, and the fortifications were strengthened during the civil wars which followed the abdication of Diocletian. Diocletian had resolved to transfer his capital to Nicomedia; but Constantine, aware of the advantages that the situation of Byzantium presented, resolved to build a new city there on the site of the old and transfer the seat of government to it (A.D. 330). Renamed Constantinople (*see* ISTANBUL), it was the capital of the East Roman or Byzantine empire (*q.v.*).

See also references under "Byzantium" in the Index.

C THE third letter of the alphabet, corresponds to Semitic 𐤂 *gimel* (which probably derived from an early sign for "camel"), and Greek Γ *gamma*. Greek forms were Γ, Γ, Λ, <. From the last derived the round form C, which occurs at Corinth and in the Chalcidic alphabet. Both < and C are found in the early Latin alphabet, as well as in Etruscan. The rounded form survived and became general, and the shape of the letter has since altered little. In certain medieval forms of writing the minuscule letter tended to become pointed; *e.g.*, C. Roman cursive forms are shown in the illustration to the right.



The sound represented by the letter in Semitic and in Greek was the voiced velar stop, represented in English by the "hard" *g*. In the Latin alphabet it came to represent the unvoiced velar stop (indicated in English by *k* as well as *c*), and was for some time, it appears, used for both the voiced and unvoiced sounds. This change is in all probability due to the Etruscan alphabet from which the Latin alphabet was derived, for a phonemic distinction between voiced and voiceless stops apparently did not exist in the Etruscan language. An early Latin inscription exists in which the word *RECEI* (probably an early dative form of *rex* "king") occurs, the letter *C* being still employed to represent the voiced sound. Finally a new symbol *G* was used for the voiced sound, and *C* displaced *K* as the representative of the unvoiced stop.

In modern English the letter represents two separate sounds: (1) the unvoiced velar stop as in the Latin alphabet; and (2) the unvoiced sibilant, identical with the sound represented by *s* in certain positions. The letter represents the sibilant when followed by any of the front vowels, *e, i* and *y* (*e.g.*, in "receive," "cider," "cycle"); in all other cases (except before *h*) the velar (*e.g.*, "call," "come," "clear," "crumb," "epic"). This is due to the palatalization of the velar in early medieval times before the front vowel, the stages of sound change being *k*>*ki*>*tš*>*ts*>*s*. The letter *c* was applied by French orthographists in the 12th century to represent the sound *ts* in English, and this sound developed into the simpler sibilant *s*. Gradually the use of the letter *c* to represent the velar before front vowels (for example, in the Middle English *cyng*) gave way to that of *k*, ambiguity being thus as far as possible avoided. The *c* takes the place of *s* in words such as "mice," "advice," in which *s* would represent a voiced sibilant (identical with the sound of *z*), and in words such as "practice" merely as a means of grammatical distinction. (*See* also ALPHABET.)

Before *k* the letter is often redundant (*e.g.*, in "thick," "clock," etc.). The combination *ch* represents an unvoiced palatal affricate (*tš*), as in "church," except that in words of Greek origin it generally has the sound of *k; e.g.*, in "chorus."

In chemistry, C is the symbol for carbon.

In music, C is the name of the third note of the musical alphabet, this note being at the same time one which has always occupied a peculiarly distinctive position, in that it is the keynote of what used to be called, from the fact that it contains no accidentals, the natural scale. Thus on the pianoforte it consists entirely of white notes and hence has come to be regarded as the simplest and most fundamental of all keys. C is further one of the three notes (F and G being the others) which have served for centuries, in conjunction with the appropriate signs, to indicate the clefs. *See* MUSICAL NOTATION. (J. W. P.)

CAAGUAZÚ, a department of east central Paraguay stretches southward from the Cordillera de Amambay as a dissected watershed area between the Paraguay and Paraná rivers and as an extension of the Brazilian plateau. Area 8,345 sq.mi Pop. (1960 est.) 95,276. Northern Caaguazú is a thinly peopled forest yielding wood and maté; the southwestern area is a savanna district growing tobacco, oranges and sugar, raising cattle and processing these products and petitgrain essence. Coronel Oviedo the capital (pop. 8,298), is the centre of this agricultural area. It is linked with Asunción by an arterial road. (G. J. B.)

CAAZAPÁ, a department of southern Paraguay, lies where the last forested hills of the Brazilian plateau reach the lowlands of the Tebicuary, a tributary of the Paraguay. Area 3,66 sq.mi. Pop. (1960 est.) 91,749. A population density of 25 per square mile is supported by an agricultural and pastoral economy in which oranges, sugar, petitgrain and leather are the principal products. Maté is gathered and timber extracted from the forests; Paraguay's principal railway, between Asunción and Encarnación serves the lowlands and a branch line runs from Borja to Aba on the forest edge. The capital, Caazapá, was established in 160 and is reached by a road from Villarrica. (G. J. B.)

CAB: *see* CARRIAGE.

CABAL, a private organization or party engaged in secret intrigues, and applied also to the intrigues themselves (through the French *cabale*, from the Cabala [*q.v.*], a mystical interpretation of the Hebrew scriptures). In England the word was jealously used throughout the 17th century, with the alternative junto or cabinet (*q.v.*), to describe any secret and extralegal council of the king, more particularly the foreign committee of the privy council. The invidious meaning attached to the term was stereotyped by the coincidence that the initial letters of the names of Charles II's ministers, Clifford, Arlington, Buckingham, Ashley and Lauderdale, spelled cabal.

CABALA (KABBALAH, QABBALA; literally "tradition") denotes the developed forms of Jewish mysticism and theosophy from c A.D. 1200 and, in a less technical sense, the entire range of the esoteric doctrine of Judaism from the beginning of the Christian era. The term Cabala meant originally the non-Pentateuchal part of scripture and the oral traditions of Judaism. As a designation of Jewish mysticism it dates from about 1200. From Nahmanides (1194–1270) onward the Cabalists (*mequbbalim*) refer to themselves also as "those knowing grace," the Hebrew word for "grace" (*hen*) being read as an acrostic for "secret science" (*hokhma nistara*). Older terms are "mysteries of the Torah" (*sitre tora raze tora*), "masters of the mystery" (*baʿale ha-sod*), "men of faith" (*anshe emuna*), "those who understand" (*ha-maskilim; cf* Dan. xii, 10), etc.

Cabala is essentially an oral tradition in the sense that initiation into its doctrines and practice requires a personal guide, if only to avoid the dangers inherent in the mystical experience. It is also understood as a "tradition" in the sense that it claims to represent the esoteric part of the oral Torah revealed by God to Moses or the original revelation to Adam. Jewish mysticism therefore regards itself as circumscribed, at least in theory, by the authority of tradition. Characteristic in this respect is the role played by revelations by the prophet Elijah, the archetypal figure of the guardian of tradition, in the charismatic experience of Jewish mystics.

Cabala comprises two aspects, viz., theoretical Cabala (*qabbala ʿiyyunit*) and practical Cabala (*qabbala maʿasit* or *shimushit*). The latter amounts, to all intents and purposes, to white magic, operating with the holy names of God in contrast to black magic, which uses demonic powers (witchcraft). Black magic is strictly prohibited in Cabala, but employment even of the holy names is damnable if intended for selfish ends. Warnings against the use of the divine names for the sake of magical power are repeatedly uttered. As early as the 2nd century A.D. the Mishnah condemns it (Abot i, 13): "He that makes use of the crown shall perish" (crown being a metaphor for the most holy name of God). This passage is quoted by many Cabalists. It is permitted, however, to employ the holy names for the purpose of contemplation and spiritual ascent. Abraham Abulafia's doctrine of the combination (*zeruf*) of letters stresses the pursuit of the inward path as distinct from magical power. But it is difficult to draw the line, and magical tendencies often prevail in cabalistic practice. Hayyim Vital emphatically points out the dangers involved in the use of magic formulas (*hashbaʿot*), even for the sake of spiritual meditation. In certain Cabalists the borderline between white and black magic is somewhat blurred, especially in necromancy, exorcism and the writing and use of amulets. Cabala also is linked with many occult sciences, such as astrology, alchemy, physiognomy and chiromancy.

Cabala represents the irruption into normative Judaism of deep-seated but repressed mythical ways of thinking. Dissatisfied with the plain meaning of the traditional interpretation of Judaism, and repelled, in the 13th century, by the excessive rationalism of the philosophers, the Cabalists created a new dimension of religious depth in the very heart of Judaism. From the 16th century onward Cabala almost displaced Jewish philosophy until the 18th-century period of Enlightenment. In the popularized form it achieved in Hasidism (18th century) it held sway over large masses of Jews in eastern Europe.

Merkabah Mysticism.—The oldest form of Jewish mysticism arose as a kind of rabbinic gnosis within the circles of the teachers of the Mishnah in the 1st and 2nd centuries of the Christian era. In opposition to the radical dualism of heretical Jewish Gnosticism, however, it was careful to stress the unity of God. Its main concern was the mystical contemplation of the *Merkabah* (throne of God) described in Ezek. i. The statement (*Tosefta Megilla,* iv) "Many have preached about the *Merkabah* without ever having had a vision of it" indicates that the true mystics experienced ecstatic visions of the celestial hierarchies and the throne. The ascent of the visionary is described, in Gnostic fashion, as a perilous journey through the spheres of hostile planet angels with the help of magic seals. From about A.D. 500 the visionaries of the *Merkabah* are termed "descenders" to the throne (*yorde merkava*), indicating most probably the posture (putting the head between the knees) that, along with fasting and hymnody, induced the trance. The verse (S. of Sol. vi, 11) "I went down to the nut orchard" was held allegorically to refer to the contemplation of the *Merkabah.* (The medieval mystic Eleazar of Worms was to elaborate the image of the nut as a symbol of the "depth" of the *Merkabah.*) A famous passage from the earliest phase of *Merkabah* mysticism uses the term "garden" (*pardes*) as a synonym for the contemplation of the *Merkabah* when speaking of the "Four who entered the garden," Rabbi Akiba ben Joseph being the only one who emerged "in peace"—*i.e.*, unharmed—from this experience. The *Merkabah* signifies in rabbinic mysticism what the pleroma or divine fullness means in Gnosticism. The texts describing the soul's descent are contained in the Hekhalot books (*hekhalot* = "palaces"; *i.e.*, the various celestial chambers), dating from the 3rd century. The Hebrew Book of Enoch belongs to the 5th to 6th centuries. The movement arose in Palestine but spread to Babylonia, whence its documents found their way into Italy and Germany.

The original Gnosticism is still discernible in the figure of Metatron, which plays a considerable part in the Hebrew Book of Enoch and subsequent Cabala. As the highest angel he occupied a seat next to the throne of God. The Babylonian Talmud contains three references to Metatron. Heretical Jewish gnosis refers to him as the "lesser Yaho" (his original name having been Yahoel or Yoel), a term that reappears in the Coptic work *Pistis Sophia* (3rd century). Another highly Gnostic and barely Judaized doctrine is that of the "Measure of the Body" (*shiʿur qoma*), interpreting the body of the beloved in S. of Sol. v as the body of the Creator. The gigantic measurements and the splendour of the description—perhaps related to the mythical figure of the Iranian *Urmensch* (primordial man)—have parallels in Greek and Coptic texts of the 2nd and 3rd centuries. They aroused violent opposition in nonmystical circles but were regarded as symbols of profound mysteries by the *Merkabah* mystics.

From the period between the 3rd and 6th centuries dates the earliest speculative text of Jewish mysticism, the *Sefer Yezira* ("Book of Creation"), describing the process of creation in terms of the ten primordial numbers (*sefirot*) and the 22 letters of the Hebrew alphabet, forming together the "32 secret paths of wisdom." The numbers are connected with the "living creatures" (angels) of Ezek. i and may go back to the "hyperessential numbers" of the Neoplatonist Proclus. The letters are applied to the three parallel worlds of man (*nefesh*), the planetary spheres (*ʿolam*) and the course of the year (*shana*). The book was attributed to the patriarch Abraham, and numerous commentaries were written on it. It gave a powerful impulse to theurgic Cabala.

Merkabah mysticism culminates in the bizarre *Sefer Bahir* ("Book of Clarity") edited in Provence in the 12th century and foreshadowing the doctrine of the *Sefirot* (divine potencies) in 13th-century Cabala. It interprets in midrashic fashion scriptural verses, rabbinic homilies and topics of *Merkabah* and *Yezirah* mysticism, and shows a marked magical tendency. Mystical interpretation of the divine commandments plays a considerable part in it. Typically Gnostic terms such as *ha-male* (pleroma) and *nezahim* (aeons) are introduced. One of its principal sources is the book *Raza Rabba* ("The Great Mystery"), which was imported from the east to Provence via Germany.

The Hasidim of Medieval Germany.—In the *Hasidim* (Devout, Pietists) of 12th- and 13th-century German Jewry in the Rhineland are met for the first time clearly defined individual Jewish mystics. Samuel the Hasid, his son Judah the Hasid (a great legendary figure) and Eleazar of Worms, all of them members of the Kalonymide family that had migrated from Italy to Germany, were steeped in the tradition of *Merkabah* mysticism and occult sciences. They were also under the spell of Neoplatonic thought as mediated by Abraham ibn Ezra and Abraham bar Hiyya. Above all, they derived inspiration from the conception of God found in the Hebrew paraphrase of Saadia's *Book of Beliefs and Convictions* (*see* SAADIA BEN JOSEPH), the influence of which is reflected in the superb hymns composed in this circle. The mystical presence of God is sought in humility and in the love of God rather than in ecstatic visions of the *Merkabah* type. The glory of God that appears in the *Merkabah* visions as occupying the throne is differentiated from a still higher inner glory or holy spirit, while God himself remains unrevealed. Yet there is a strong note of pantheism in the manner in which the immanence of God is expressed. The German *Hasidim* reflect the spiritual climate of their age and environment, which was saturated with popular mysticism and the cultivation of a personal spiritual life, illustrated, for example, by St. Francis of Assisi and the Order of Cluny. The excessive penitentiary practices advocated by the group also may be due to Christian influence. The main documents of the German *Hasidim* are the *Sefer Hasidim* (in two versions), a collection of stories, homilies and doctrines; and Eleazar of Worms's numerous tracts.

Rise of Cabala in Provence and Spain.—Of decisive importance for the development of Cabala were the Jewish mystics in Provence (second half of the 12th century) and Spain, particularly Gerona (*c.* 1200–60). The leaders of pre-Cabalistic Jewish mysticism in Provence, where the *Sefer Bahir* was edited, were Abraham ben Isaac of Narbonne, one of the great rabbinic authorities of the time; his son-in-law Abraham ben David, famous for his glosses on Maimonides' Code of Laws (*Mishne Tora*); his grandson Isaac the Blind; and Jacob ha-Nazir of Lunel, who wrote a commentary on the prayers. Claiming revelations of the prophet Elijâh, they initiated new Cabalistic doctrines. According to Shemtob ben Gaon (beginning of the 14th century), Abraham ben Isaac's *Compendium of Cabala,* though offering only hints to the initiated, already contained essential elements of the *Sefirot* doctrine beyond the stage found in the *Sefer Bahir.* The *Sefirot* are the "soul" and "inner life" of the hidden God, the transcendent Cause of Causes. The old *Merkabah* doctrine is said to refer only to the Creator aspect of God, not to his inner life. Of a more philosophical type are the small pseudepigraphical tracts that emanated from another circle in Provence, named (by G. Scholem) the *Iyyun* circle after the *Sefer ha-Iyyun* ("Book of Contemplation"). Here Neoplatonic thought intrudes forcefully into a hitherto mainly Gnostic type of mysticism. The concept of emanation (*azilut*) is applied to the ten *Sefirot,* which are identified with the "intelligible lights" (the ten "separate intellects") of Islamic and Jewish Neoplatonism.

Neoplatonic speculation gains even greater importance in the circle of Gerona (Judah ben Yaqar, Ezra ben Solomon, Azriel, Jacob ben Sheshet and the celebrated Bible commentator and rabbinic scholar Moses ben Nahman or Nahmanides). According to Azriel, the difference between the Cabalists and Neoplatonists may be reduced to one of terminology. In his *Commentary on the Ten Sefirot* he sought to derive the principles of Cabala from Neoplatonic concepts. Ezra's *Commentary on Canticles* contains mystical interpretations of the "reasons of the divine commandments" (*ta'ame ha-mizwot*). Nahmanides' exegetical work is shot through with mystical references. In his immediate circle may be sought the origin of the highly influential *Sefer Temuna* ("Book of the Image"), which describes the 22 letters of the Hebrew alphabet as the image of God and evolves the theory that in each successive world period (*shemitta*) another of the seven lower *Sefirot* predominates. This mystical theory of history had a marked influence on later phases of Cabala and was invoked by the heretical theology of Sabbatianism (*see* SABBATAI ZEBI). Another important figure was Abraham Abulafia, the representative of prophetic (*i.e.,* ecstatic) Cabala, who elaborated a system of contemplative techniques. Though he was repudiated by the religious authorities of his time, and his numerous tracts were repressed by the Cabalists, his influence was nevertheless pronounced. Joseph Gikatila wrote his *Ginat Egoz* ("Nut Garden") under Abulafia's influence. Of a more Gnostic frame of mind are the two brothers Jacob and Isaac ben Jacob ha-Kohen, Todros Abulafia and Moses ben Simon of Burgos. These Cabalists introduced the doctrine of a separate realm of demonic emanations as a parallel to the holy *Sefirot.*

The Zohar.—All these variegated elements merged in the main work of Cabala, the *Sefer ha-Zohar* ("Book of Splendour"), which made its appearance in the 1280s. The Zoharic corpus of writings contains:

1. The *Book Zohar* proper; printed first in Mantua (1558–60) in three volumes, it discourses in homiletic fashion on the Pentateuch. Interspersed in the main text are a number of smaller and often disjointed tracts such as the *Sifra di-zeni'uta* ("Book of Concealment"); *Idra Rabba* ("The Greater Assembly") and *Idra Zutta* ("The Lesser Assembly"); the story of *Saba* ("the Old Man") dealing with the mysteries of the soul; the story of *Yanuqa* ("the Child") on the mysteries of the Torah; *Sitre Tora* ("Secrets of the Law"); sections of the *Midrash ha-Ne'elam* ("Mystical Midrash"); *Raya Mehemna* ("The Faithful Shepherd") offering cabalistic interpretations of the divine commandments.
2. The book *Tiqqune Zohar* (*editio princeps* also in Mantua, 1558) in 70 chapters, each beginning with a fresh discourse on the first word of the Torah.
3. The *Zohar Hadash* ("New Zohar") containing sections of (1) and (2) that were missing from the manuscripts of the first edition and were supplemented from manuscripts found in Safed.

All parts of the *Zohar* are attributed to Simeon ben Yohai (*q.v.*), the celebrated 2nd-century teacher of the Mishnah and a legendary figure of Jewish mysticism. Doubts as to the authenticity of this claim arose immediately on the appearance of the *Zohar.* Isaac ben Samuel of Acre visited Spain in 1305 in order to meet Moses de León of Guadalajara, who from 1280 onward had circulated copies of the *Zohar.* He was assured that De León possessed in his home the ancient original of this book, but De León died before he could fulfill his promise to show the original to Isaac. His widow subsequently denied the existence of an original text. The question has remained a mystery and given rise to a great deal of discussion among both Jewish and Christian scholars. In the 19th century A. Jellinek concluded from the close analogies between the *Zohar* and known writings of Moses de León that the author of the *Zohar* was none other than De León himself. His view was accepted by H. Graetz and subsequently was reconfirmed, after much initial hesitation, by G. Scholem. According to Scholem, Moses de León wrote first the *Midrash ha-Ne'elam* between 1275 and 1280 and completed the bulk of the *Zohar* between 1280 and 1286. The *Raya Mehemna* and the *Tiqqune Zohar,* on the other hand, were composed by some other Cabalists 10 or 20 years later in imitation of the *Zohar* proper. Between 1286 and 1293 De León published a series of minor works designed to propagate the doctrines of the *Zohar,* the last being the *Maskiot Kesef* ("Settings of Silver"). Scholem's theory is based mainly on linguistic evidence. Moreover, the *Zohar* reflects the conditions of Jewish life in Spain around 1280, and it employs theological and psychological doctrines current at that time. Its borrowings from the Geronese school and from Gikatila's *Ginat Egoz* are striking.

The *Zohar* is preoccupied with the theosophical description of the inner life of Divinity as expressed in the ten *Sefirot;* the destiny of the human individual; and the meaning of the divine commandments. The world of the *Merkabah* ranks lower than the ten *Sefirot,* and all interest now shifts to the higher plane. Beyond it human thought is unable to penetrate, and even within its compass the uppermost point of transition from the *Ensof* ("Infinite") to God's self-revelation defies all understanding.

The ten *Sefirot* are (1) *Keter Elyon* or "Supreme Crown," also called God's primordial Will, and *Ayin* ("Nothing"); (2) *Hokhma* or "Wisdom," identical with the "Beginning" (*reshit*) of creation and with Eden or the source of all blessings; (3) *Bina* or "intelligence," the "supernal Mother" and womb of the totality of all individuation. There follow the seven lower *Sefirot,* mystically represented by the seven days of creation; they contain (4) *Hesed* or "love"; (5) *Gevura* or "power," also called *Din* or "stern judgment"; (6) *Rahamin* or "compassion," also called *Tiferet* or "beauty"; (7) *Nezah* or "endurance"; (8) *Hod* or "majesty"; (9) *Yesod* or "foundation"; and (10) *Malkhut* or "kingdom," identical with the *Shekhina* (lit. "presence"—*i.e.,* of God) as a female purely receptive potency, and with the *Keneset Yisrael,* the *ecclesia* of Israel conceived as the celestial archetype of the terrestrial people of Israel.

These *Sefirot* form the "world of union" (*alma di-yihuda*) as distinct from the lower world of created beings, which is a "world of separation" (*alma de-peruda*). The *Sefirot* constitute the mystical Tree or Upper Man and are meant to describe a real process of divine life overflowing into the entire creation. The pantheism inherent in this view presented a major problem to later Cabalists Innovations of far-reaching significance are the introduction of male and female principles into the Sefirotic world, recalling the old Gnostic doctrine of pairs; and the concept of a holy union (*ziwwuga qadisha*) or *hieros gamos* between the *Sefirot,* particularly between the first and the last. The harmony of the divine life is described in terms of the union between "the Holy one, blessed be he" and his *Shekhina.* The present unredeemed state of the world is explained as due to a rupture of that supernal union, and eschatological hope envisages the restoration of this union when God again will be "one" (Zech. xiv, 9). Evil arose by the breaking away of the "left side" of the Sefirotic world from its union with the rest, thus establishing the demonic "other side" (*sitra ahra*) the domain of Satan and impurity. Redemption means the restoration of all things to their pristine harmony, and can be aided by man's attachment (*devequt*) to God. From *devequt* flow pure and holy actions, and the "upper roots" of holiness in the worlds above are thereby strengthened. In terms of man's individual destiny, the pious fulfillment of the divine commandments prepares for him the celestial garment (*haluqa de-rabanan*) with which to clothe his soul in the upper paradise after he has departed from the world.

Post-Zoharic 14th-Century Cabala.—Joseph Gikatila's *Shaʿare Ora* ("Gates of Light") develops the *Zohar's* doctrine of the *Sefirot* by systematically linking the names of God and the divine commandments with the individual *Sefirot*. Gikatila also elaborates the meaning of the commandments in voluminous tracts. Of particular importance are the two pseudepigraphical works *Pelia* (on the first six chapters of Genesis) and *Qana* (on the commandments), which engage in vehement criticism of nonmystical rabbinic Judaism, following a trend already noticeable in the *Raya Mehemna*. Other Cabalists, such as Joseph ibn Waqar of Toledo, Nisim ibn Malka of Fez and Samuel ibn Matut of Guadalajara, seek to reconcile philosophy and Cabala.

16th-Century Cabalists of Safed.—The expulsion of the Jews from Spain (1492) led to a deepening of mystical yearning. In the circle of Jewish mystics in the little town of Safed in Upper Galilee occurred a great revival of Cabala that fully articulated these tendencies. Moses Cordovero, his teacher and brother-in-aw Solomon Alkabez, Joseph Qaro, Eliezer Azikri and, above all, Isaac Luria and his pupil Hayyim Vital were the chief members of his group. Azikri's *Sefer Haredim* ("Book of the Godfearing") mirrors the mystical piety of the holy brotherhood Sukkat Shalom (Tabernacle of Peace) founded by the group. Joseph Qaro's mystical diary recording the revelations vouchsafed to him by his *maggid* or angel testifies to a charismatic experience that was not unique.

Cordovero, the profound theorist of Cabala, was soon eclipsed by Isaac ben Solomon Luria (*q.v.*), creator of the "new Cabala." His chief doctrines are (1) on *zimzum* (God's "retraction"); (2) on *shevirat ha-kelim* (the "breaking of the vessels"); and (3) on *iqqun* ("restoration" of God's unity). The doctrine of *zimzum* teaches that God's first act of creation consisted in his retraction r withdrawal into himself in order to make room for the world. But a residue (*reshimu*) of the divine light remained in the primordial space created by his withdrawal, and from it and its mixture with the quality of stern judgment inherent in the act of withdrawal he world came into being. The process of creation was set in motion by the emanation of light from the *Ensof* forming first the primordial man (*Adam qadmon*) from which, in turn, the lights of the *Sefirot* burst forth in one total emanation. These lights had o be channelized in order to create a universe of differentiated beings and therefore were directed into special "bowls" (*i.e.*, the individual *Sefirot*). But under the impact the seven lower vessels broke, and from their shattered fragments the domain of evil arose. Now the lights of the *Sefirot* were organized in new configurations of "countenances" (*parzufim*), each revealing God under a different aspect. Of special interest to Luria is the "countenance" of he six lower *Sefirot* and its relation to the tenth *Sefirah* called *Shekhina* or Rachel. The fate of the *Shekhina* was of deep concern o him, and his peregrinations (*gerushim*) with his disciples in the icinity of Safed on the eve of the Sabbath were meant as paricipations in the "exile of the *Shekhina*." *Tiqqun* signifies the estoration of the union of the *Sefirot* and the complete self-ealization of God, a process in which man is destined to play a sigificant part.

The spread of Lurianic Cabala and its adoption by large numbers f Jews constitutes one of the major factors in 17th- and 18th-entury Jewish history. It prepared the ground for the Sabbatian movement and the subsequent rise of 18th-century Hasidism *q.v.*).

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CABALETTA, originally an operatic aria based on a simple nimated rhythm, and later the concluding section of an operatic aria, usually at the end of an act. The term is derived from the diminutive of the Italian *cobola*, "a couplet." An early example is "Le belle immagini" in Gluck's *Paride ed Elena* (1770). In 19th-century Italian opera it signifies either a short aria in quick tempo with repeats, of which there are examples in the operas of Rossini, or a brilliant conclusion to an aria such as Violetta's "Sempre libera degg'io" in Verdi's *La Traviata*. Anne's cabaletta in Igor Stravinsky's *The Rake's Progress* (1951) has the form of a short aria of a quick, uniform rhythm.

CABALLERO, FERNÁN, pseudonym of Cecilia Francisca Josefa de Arrom (1796–1877), Spanish writer, whose father, Nikolas Böhl von Faber (a German merchant married to an Andalusian and settled in Madrid), had stimulated interest in Spain's medieval and classical literature with his *Floresta de rimas antiguas castellanas* (1821–28) and *Teatro español anterior a Lope de Vega* (1832). She is famous for her defense of the traditional virtues of Spain—Catholic, monarchist, moral and rural—against the upsurge of 19th-century liberalism.

Born in Morges, Switz., Dec. 25, 1796, she went to Spain when she was 17 years of age. In 1816 she married Antonio Planells y Bardaxi, a soldier of fortune who was killed in action the following year. In 1822 the young widow married Francisco Ruiz del Arco, marqués de Arco Hermoso, an officer in one of the Spanish household regiments. Upon his death in 1835 the marquesa found herself in straitened circumstances, and in less than two years she married Antonio Arrón de Ayala, a man considerably her junior. Arrón was appointed consul in Australia, engaged in business enterprises and profited; but unfortunate speculations drove him to suicide in 1859.

One of the earliest Spanish folklorists, she collected into many volumes, full of entertaining anecdotes, the language, superstitions and customs of the country people of Sevillian Andalusia. Of these, the most notable are *Cuadros de costumbres*, *Relaciones* and *La familia de Alvareda* (which originally was written in German). She claimed that in her novels also she was only a recorder of fact, but this cannot be accepted. In *Clemencia* (1852), one of her best novels, the rivalry for a lady's hand of a Frenchman and an Englishman is largely autobiographical.

Her best-known novel, *La Gaviota* (Eng. trans., *The Seagull*, 1867), was written originally in French and translated into Spanish by José Joaquín de Mora; it was first published serially in *El Heraldo* (Madrid) in 1849. It was a success from the beginning. No other Spanish book of the 19th century obtained such instant and universal recognition. It was translated into most European languages and a prominent critic of the day hopefully proclaimed the writer to be a rival of Scott. It is acclaimed, incorrectly, as the first realistic novel of Spanish customs. It describes the career of a selfish child of nature with a golden voice, whose life is ruined by success in the big city. Like her other novels, it is marred by its obtrusive morality and slow pace, but these are lightened by lively, sympathetic presentation of country people and their conversation.

Fernán Caballero died in Seville, April 7, 1877. She had been three times married, yet remained childless. She may well be remembered primarily as a remarkable woman, whose complex personality and intimate griefs are revealed in a voluminous correspondence, still largely unpublished. (R. F. B.; X.)

CABAÑAS, third smallest department in El Salvador (area 420 sq.mi.), bordered on three sides by the deep Lempa Valley, was established in 1873. Pop. (1969 est.) 125,204. Although mostly rugged terrain, Cabañas ranks second in the country in production of rice, third in beans, and is significant in the production of corn, vegetables, livestock, and cheese. Manufactures include distilled liquors and clay products, especially pottery from excellent clay deposits.

Ilobasco (pop. [1961] 4,716) is noted for its miniature Salvadoran dolls. Sensuntepeque (pop. [1969 est.] 6,606), 49 mi. by highway from San Salvador, is the departmental capital and leading pottery-manufacturing centre of the country. (C. F. J.)

CABANILLES, JUAN BAUTISTA JOSÉ (1644–1712), the last notable representative of the 16th- and 17th-century Spanish school of organ composers, was baptized at Algemesí, Valencia, Sept. 6, 1644. He spent his adult life as organist of Valencia cathedral. He was appointed on May 15, 1665, following the death of his predecessor and teacher, Jerónimo de la Torre, and, as his position required, was ordained a priest in 1668. He appears to have traveled little, although his reputation spread as far as France, where he is known to have played. He died at Valencia, April 20, 1712. His surviving works include a huge number of pieces for organ and other keyboard instruments: *tientos, tocatas, versos, pasacalles, gallardas*. While these contain many interesting features, for example the brilliant figuration of the *tocatas* and the dissonances of the *tientos de falsas,* Cabanilles was content to extend Renaissance techniques without wholeheartedly accepting the new baroque style. (Jo. St.)

CABARRUS, FRANÇOIS (Francisco), Conde de (1752–1810), French financier, who gained prominence as a financial adviser of the Spanish king Charles III, was born at Bayonne in 1752. He originally settled in Madrid as a manufacturer of soap. The 18-century enlightenment had penetrated as far as Madrid, and the king, Charles III, was favourable to reform. A circle of men animated by the new spirit had grown up that was trying to infuse fresh vigour into an enfeebled state. Among these Cabarrus became conspicuous, especially in finance; he devoted his considerable talents to the organization of a bank, to the formation of a company to trade with the Philippine Islands, and to a reformation of the currency and taxation. These measures were halted by the death of Charles III (1788), which was followed by the reactionary government of Charles IV.

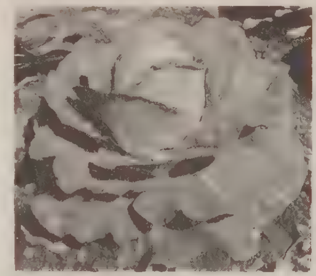
The men who had taken an active part in reform were suspect and prosecuted by the new government. Cabarrus himself was accused of embezzlement and was imprisoned in 1790. After a confinement of two years, however, he was released, restored to favour, and created a count. He was nominated Spanish ambassador to Paris, but the Directory raised objection to his appointment on the grounds of his French birth.

Cabarrus took no part in the intrigues by which Charles IV was compelled to abdicate and his son was deprived of the succession in favour of Joseph Bonaparte. His French birth and his intimate knowledge of Spanish affairs, however, recommended him to Joseph, and he became minister of finance under the new government, holding that post until his death at Seville on April 27, 1810. His daughter, Thérèse, was the famous Madame Tallien (*see* Tallien, Jean Lambert).

Cabarrus' works include *Memoria al Rey . . . para la extinción de la Deuda Nacional* (1783), and *Cartas . . . al Señor D. Gaspar de Jovellanos y . . . al Príncipe de la Paz* (1808; new ed., 1933).

CABBAGE, a biennial vegetable and fodder plant whose various forms are said to have been developed by long cultivation from the wild or sea cabbage (*Brassica oleracea*) found near the seacoast of various parts of England and continental Europe. The cultivated varieties, however, have departed widely from the original type, and they present marked and striking dissimilarities among themselves. The wild cabbage is a comparatively insignificant plant, growing one to two feet high, in appearance similar to charlock (*Brassica kaber*) but having smooth leaves. The wild plant has fleshy, shining, waved and lobed leaves (the uppermost being undivided but toothed), large yellow flowers, elongated seed pod and seeds with conduplicate cotyledons. Although the cultivated forms differ in habit so widely, the flower, seed pods and seeds present no appreciable difference. The common horticultural forms of *Brassica oleracea* may be classified according to the plant parts used for food and the structure or arrangement of those parts: (1) leaves: loose or open foliage (kale and collards) and leaves folded into compact heads (large terminal heads, *e.g.,* common cabbage and savoy cabbage; and small axillary heads, *e.g.,* Brussels sprouts); (2) flowers and thickened flower stalks: flowers little or not modified (sprouting broccoli) and flowers much thickened and modified (cauliflower and heading broccoli); (3) stem much expanded to a bulbous structure (kohlrabi). All these forms intercross as readily as do varieties of a single form. Many distinct horticultural varieties of these several forms are commercially important.

All these forms of "cabbage" have succulent leaves that are free of hairs and covered with a waxy coating; in most of them the waxy coat gives the leaf surface a gray-green or blue-green colour. These plants grow best in mild to cool climates, tolerate frost, and some of them tolerate hard freezing at certain periods of growth. Hot weather impairs the growth and the eating quality of all of them. Only those forms grown for their flower parts are annuals; the others are biennials. After an initial period of growth the biennials must undergo a period of rest imposed by temperature below 45° F. before flower parts can develop. Premature flowering brought about in part, by untimely temperature often is a cause of economic loss to growers. The edible portions of these plants are low in calori value. They serve as sources of bulk, vitamins and minerals in the diet.



J. HORACE MCFARLAND CO.

FIG. 1.—HEAD CABBAGE (BRASSICA OLERACEA FORM CAPITATA)

Kale (*Brassica oleracea* form *acephala*) produces a strong-growing rosette of long-petioled, elongated leaves with wavy t frilled margins. In a long growing season the main stem reaches a height of two feet or more. In the United States the plant is usually harvested by cutting off the entire rosette before the stem has elongated, but in Great Britain and in Europe the individua lower leaves are usually removed progressively as the main stem elongates. Kale is grown mainly for autumn and winter harves because cold improves its eating quality and its hardiness permits harvest of fresh greens after most fresh vegetables have become unavailable. Thousand-headed or Jersey kale is a different species a coarse, rapidly growing plant that may reach a height of eigh to ten feet and is grown only for stock feed.

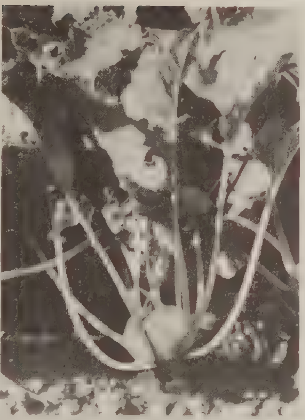
Collards (also *Brassica oleracea* form *acephala*) is another hardy, nonheading form of cabbage which is grown extensively as winter greens in the southern United States. The leaves are much broader than those of kale, are not frilled and resemble the rosett leaves of head cabbage. The lower leaves are commonly harveste progressively, the main stem reaching a height of two to four fee with a rosette of leaves at the top. The entire young rosette is sometimes harvested. Both collards and kale are primitive forms of cabbage similar to those used in ancient times in the Mediterranean region, where the species is believed to have originated.

Brussels sprouts (*Brassica oleracea* form *gemmifera*) produce tiny cabbage heads, about an inch in diameter, that form in th axils of the leaves along the much-elongated main stem. Thi plant is relatively new among food plants; it was first described i 1587 and apparently was developed in northern Europe about th 15th century or not long before. Because of its exacting climati requirements, Brussels sprouts is little grown except in cool districts near the sea. Firm "heads" will not develop if the daily mea temperature is much above 55° F.

Head cabbage (*Brassica oleracea* form *capitata*) is by far th most important of this species. In the U.S. yields average abou 9 tons per acre for fresh market and about 16 tons as grown fo kraut. Hard-headed cabbage, like Brussels sprouts, is a new cro plant that was developed in northern Europe during the middl ages. Soft-headed cabbages such as the savoy type are believed t be of southern European origin of an earlier time. Head cabbag is generally denoted by the simple term "cabbage," and is a major table vegetable in most countries of the temperate zones.

The heads of horticultural varieties of cabbage range in shap from pointed through globular to flat; from soft to hard in struc ture; through various shades of green, gray-green and magent or "red," and from one or two pounds up to ten pounds an more in weight. They also differ in suitability for specific uses The less hard varieties must be used more or less promptly afte harvest, for salads, in cookery or for the manufacture of sauerkraut; the very hard, late-maturing Danish type is suited to winte storage for later general use. Some varieties, such as Early Jerse Wakefield, will tolerate winter temperatures as low as 0° F. whe the plants are small, but most varieties will not.

The edible part of cauliflower (*Brassica oleracea* form *botrytis*) consists of a compact terminal mass of greatly thickened, modified and partially developed flower structures, together with their subtending fleshy stalks. As desired for food, this terminal cluster forms a firm, white, succulent "curd." The broad, much elongated leaves extend far above this curd. In most varieties of cauliflower the leaves of a plant must be tied together well above the curd, or broken over it, several days before harvest to prevent the discoloration of the curd by sunlight.



JOHN H. GERARD

FIG. 2.—KOHLRABI (BRASSICA OLERACEA FORM CAULORAPA)

Heading broccoli is, in effect, a slow-growing winter type of cauliflower and indistinguishable from it on the market. In the United States both are marketed as cauliflower. Cauliflower is very exacting in its climatic and cultural requirements.

Sprouting broccoli (also *Brassica oleracea* form *botrytis*) and cauliflower were both cultivated by ancient Mediterranean peoples. Despite the antiquity of sprouting broccoli and its popularity in Italy for centuries, it was not widely known in the United States until about 1925. The edible part of this plant is the unopened flower clusters and their subtending fleshy stems at the terminal of the main axis, from 2 to 4 ft. tall, and of the axillary branches. Large quantities are preserved by freezing in the United States as well as marketed fresh.

Kohlrabi (*Brassica oleracea* form *caulorapa*), first described n the 16th century, is another "cabbage" of recent European origin. Its most distinctive feature is the greatly enlarged stem just above the soil. It is best harvested for food when this enargement is 2 to 2½ in. in diameter. At this stage the enlargement s globular to slightly flattened, but if allowed to become old it beomes elongated. The flesh resembles that of turnip but is sweeter and milder. Kohlrabi is little grown for food except in kitchen gardens; in Europe it is grown for stock feed.

See also references under "Cabbage" in the Index.

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CABEIRI, an important group of deities, perhaps of Phrygan origin, worshiped over a large part of Asia Minor, on the slands nearby, particularly Lemnos and Samothrace, and in Macedonia and northern and central Greece, especially Boeotia. They were powers of fertility, perhaps originally indefinite in number; n classical times there appear to have been two male deities, Axiocersus and his son and attendant Cadmilus or Casmilus, and a ess important female pair Axierus and Axiocersa. These were variously identified by the Greeks with gods of their own pantheon Hephaestus, Dionysus, Demeter and Kore, the Dioscuri, etc.). The cult included worship of the power of fertility, symbolized by he male organ of generation; there were also, as usual in mysteries uch as these, rites of purification, which seem ultimately at least o have included insistence on moral purity; also initiation, preumably into the favour and intimacy of the gods. An obscure egend preserved by ecclesiastical writers says that there were three male Cabeiri, of whom two killed and beheaded the third.

They are often identified with the great gods of Samothrace though not on Samothrace itself). There, as early as the 5th entury B.C., their mysteries attracted great attention, and initiaon was looked upon as a general safeguard against all misfortune, articularly against shipwreck. But it was in the period after the eath of Alexander the Great in 323 B.C. that their cult reached its height, and initiation was sought not only by large numbers of ordinary pilgrims but also by persons of distinction. The island possessed the right of asylum or sanctuary. Excavation of the sanctuaries and the town proceeded systematically after 1938.

In 1888 interesting details as to the Boeotian cult of the Cabeiri were obtained by excavations of their temple in the neighbourhood of Thebes, conducted by the German Archaeological institute. Two male deities were worshiped: Cabeirus, who is shown on many vases reclining, drinking, surrounded by vines and grapes—*i.e.*, in the guise of Dionysus; and a boy called simply *pais*, "boy." The Romans, who claimed Trojan descent, identified the Cabeiri with the *penates publici* (*see* PENATES). (X.; H. W. PA.)

CABELL, JAMES BRANCH (1879–1958), U.S. novelist and essayist, had a great vogue in the 1920s, followed by an equally pronounced eclipse in popularity. Born in Richmond, Va., April 14, 1879, of an old and distinguished family, he began writing fiction shortly after the turn of the century. His great acclaim did not arrive, however, until after the suppression of *Jurgen* (1919) on moral grounds. For a decade or more he was extravagantly praised, but in the 1930s his mannered style and his philosophy of life and art lost favour with both critics and public.

Of his more than 50 books, the best known were the 18 volume *Biography of Manuel*, which, besides *Jurgen*, included *Cream of the Jest* (1917), *Beyond Life* (1919), *Figures of Earth* (1921), and *The High Place* (1923). Although he persistently avoided the literary convention of "realism" in these and his other books, his imaginary medieval province of Poictesme never concealed a septic view of human experience; and he remained, in H. L. Mencken's phrase, "the most acidulous of the anti-romantics." Cabell died May 5, 1958, at Richmond, Va.

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CABER TOSSING, a Scottish athletic event, consists in throwing a "caber," a straight, 13- to 18-ft.-long log from which the bark has been removed, so that it turns over in the air and falls on the ground with its small end pointing directly opposite the tosser. *See* HIGHLAND GAMES; SPORTING RECORD: *Highland Games.*

CABET, ÉTIENNE (1788–1856), French Socialist and founder of a settlement at Nauvoo, Ill., was born at Dijon, France, in 1788, the son of a cooper. Rebelling against the regimentation of his work as teacher at a local school, he turned to law and practised in Dijon until 1820. He then settled in Paris and became director of the *Vente Suprême*, the local association of the revolutionary organization known as the *Carbonari*.

After taking part in the revolution of 1830 in France, he was made *procureur général* in Corsica but was soon dismissed because of his attacks on the monarchy in his *Histoire de la Révolution de 1830*. Elected to the chamber of deputies as a member for Dijon in 1831, he founded, in 1833, a journal, *Le Populaire*. Cabet was exiled in 1834 for criticizing the government and spent five years in London, where he was influenced by Sir Thomas More's *Utopia* and by the ideas of Robert Owen. On the amnesty of 1839 he returned to France; in 1839–40 his *Histoire Populaire de la Révolution Française de 1789 à 1830* was published, and in 1840 a novel, *Voyage en Icarie*. Six years later he published *Le Vrai Christianisme suivant Jésus Christ*.

Voyage en Icarie contained Cabet's theories on progressive taxation, obligation to work, old-age pensions and the divisions of the products of industry. The Icarian movement gained popularity in France and Cabet sought to put his ideas into practice. He contracted to buy, through agents of the Peters Land company, a tract in Texas supposed to comprise 1,000,000 ac. In March 1848, 69 Icarians landed in New Orleans to pave the way for 1,500 who were to follow. But the purchase proved to be only 100,000 ac. of poor soil. At length the advance guard abandoned the Texas location and returned to New Orleans. Cabet, meanwhile, had left France with almost 500 followers, undaunted by the news of the Texas misfortunes. His little force met what was left of the firstcomers at New Orleans in 1849. Some lost heart and returned to France, and all refused to go to the Texas site. Cabet then purchased the old Mormon settlement at Nauvoo, Ill., and led 280 settlers there to start Icaria. The Icaria settlement was at best a compromise, for Cabet was never able to put into practice many of his ideas. The population never exceeded 1,800.

In 1856 dissensions arose and, with 180 followers, Cabet left to found a new settlement, but died the same year on Nov. 8 at St. Louis, Mo. (B. Mi.)

CABEZA DE VACA, ALVAR NÚÑEZ: *see* Núñez Cabeza de Vaca, Alvar.

CABEZÓN (Cabeçon), **ANTONIO DE** (*c.* 1508–1566), the first important Spanish keyboard composer and one of the earliest of the great keyboard virtuoso-composers, was born at Castrillo de Matajudíos, near Castrojeriz, Burgos, about 1508. He became blind in infancy. In 1526 Cabezón became organist to the empress Isabel, and in January 1548 was appointed organist to Philip II. From October 1548 to July 1551, Cabezón accompanied Philip's court to Italy, Germany, and the Low Countries. He went to England in 1554 for Philip's marriage to Queen Mary and remained there until January 1556. He died in Madrid on March 26, 1566.

The bulk of Cabezón's surviving music was published in two books, the *Libro de cifra nueva* (1557) of Luys Venegas de Henestrosa, and the *Obras de música . . . de Antonio de Cabeçon* (1578). The former also contains works by composers other than Cabezón; the latter was published posthumously by Cabezón's son Hernando, and includes a few pieces by Hernando and by Cabezón's younger brother, Juan. Both books are printed in *cifra nueva* ("new tablature") and specify the keyboard, harp, or *vihuela* (the Spanish form of the lute), although clearly primarily designed for organ or harpsichord. In *cifra nueva,* the notes of each octave are numbered 1 to 7, starting on F, with signs to indicate the particular octave; each part is printed on a single line of the "stave." Hernando says that the harp is so similar to the keyboard that it can play the same music without much difficulty. The *Libro de cifra nueva* shows two pictures of a *vihuela.* Hernando tells *vihuela* players that when rapid passages occur in two parts at once they should omit that of lesser importance. He then says that the book may also be used by *menestriles* (players of wind and stringed instruments), who will be able to see to what extent ornamentation may be added without doing violence to a composition.

Cabezón's compositions in the *Libro de cifra nueva* consist of about 40 pieces including *tientos* (fugal instrumental pieces), hymn verses, and a number of dances. The *Obras de música* includes *tientos,* hymn verses, sets of verses on each of the psalm tones and their *fabordones* (*i.e.,* fauxbourdons, four-part chordal harmonizations of the psalm tones), sets of Magnificat verses, sets of Kyrie verses, sets of variations and divisions, and nearly 50 sets of divisions on chansons and motets by leading continental composers. Cabezón's *differencias* (variations) include three sets on [*Guardame*] *las vacas,* clearly for harpsichord. A few vocal pieces have survived. An influential figure in the history of keyboard music, Cabezón's work represents a bridge between the forms of the 15th and 16th centuries, as well as between the somewhat stereotyped German keyboard style of the early 1500s and the smoother, more international style of keyboard writing that was emerging toward the middle of the 16th century.

The *Libro de cifra nueva* was edited by H. Anglès (1944; 2nd ed., 1964); *Obras de música,* also edited by Anglès, was published (3 vol.) in 1966. The latter edition omits nearly all the *canciones glosadas* and motets, three of which were edited by M. S. Kastner in *Antonio de Çabezón, Claviermusik* (1952). (G. F. Ol.)

CABINDA (Kabinda), a Portuguese possession (an exclave of Angola) on the west coast of Africa, lies north of the mouth of the Congo river. It is bounded by the Atlantic on the west, the Republic of Congo (formerly French Middle Congo) north and northeast, and Democratic Republic of the Congo (the former Belgian Congo), south and southeast. Its coastline is 56 mi. and its greatest width 70 mi. Pop. (1960) 58,547, *de jure,* of whom 1,992 were white and 634 mixed. Area 2,807 sq.mi. For administrative purposes Cabinda is a district of Angola, from which it is separated by the Congo river and a strip of the Congo territory, and is divided into two *concelhos,* Cabinda and Cacongo, and one circumscription, Maiombe. The inhabitants are Bantu Negroes, called Cabindas. They are intelligent, energetic and enterprising, and known as daring sailors and active traders. The Maiombe region is rich in forests, though transportation difficulties have hindered exploitation, and its beauty is an attraction to tourists.

Cabinda's busy trade has consisted mainly of timber, palm oi and kernels, cocoa and coffee. The area is favourable to the production of rubber, fruit and ivory. Alluvial gold is extracted and deposits of mineral and other phosphates have interested U.S. companies. In 1957 contracts were made for the prospecting and exploitation of petroleum. The district's chief town, Cabinda, is seaport situated on the right bank of the small river Bele. Population of the town in 1960 was 13,499, including 1,106 whites. A second town and harbour is Lândana to the north. (A. A. G. P.)

CABINET, a governmental term denoting a body of adviser to a sovereign or chief executive. It has been an important elemen in nearly all countries where legislative powers have been vested in a parliament or congress, but it has taken markedly differen forms in various countries, the two most striking examples bein Great Britain and the United States.

GREAT BRITAIN

As a British constitutional term, the word "cabinet" originall signified a small room. Cabinet counsel came to mean secret counsel or advice, and cabinet council the body of persons that gav such counsel.

Historical Development.—The cabinet in England derive from the privy council. In Tudor times, in order to facilitate th subdivision of labour, many standing and temporary *ad hoc* committees of the council were appointed, and the practice was continued under the Stuarts. One of these committees, usuall called the foreign committee, gradually became of outstanding importance. On it sat the king's most intimate advisers and it debated the most serious affairs of state, domestic as well as foreign Decisions were frequently reached in this committee before th subject of the decision had even been broached before the priv council, the functions of which were thus to a large extent usurped

After the Restoration of 1660, under the auspices of the earl o Clarendon, much use was made of committees, particularly of a informal, secret committee for foreign affairs (which in fact deal with any matters requiring secrecy). On Clarendon's fall th precedent was followed by a standing committee of the privy council, called the committee for foreign affairs. This committee, because of the coincidence of the initial letters of the names of som of the members (Clifford, Ashley, Buckingham, Arlington and Lauderdale), has passed into history as the cabal.

By the reign of Anne the routine of "committee" and "cabinet had become the accepted, but still unpopular, machinery of executive government: the committee, meeting as often as necessar throughout the week in the office of the senior secretary of stat at the Cockpit in Whitehall, deliberated upon all business of government and prepared it for the sovereign, with whom final decisions would be taken, generally at weekly meetings, in her cabine with the lords of the committee. By this time only formal busines was transacted at meetings of the privy council. But George who spoke no English, from 1717 onward ceased to attend, an less and less frequently in the succeeding years did the lords o the committee come to the palace to wait upon a king who neve appeared. The designation "the committee" was dropped. It wa as "the cabinet," since that had been the title of the decisive body that the executive was henceforth known.

Meanwhile, in proportion as the foreign committee and its descendants developed into the recognized executive of the nation so did it tend to be composed more and more exclusively of th principal political officials. The numbers swelled from 6 or 7 under Charles II to 10 or 12 under Anne and reached 20 or more under the Georges. Not all of these were effective officials; the included borough magnates and the king's personal favourite

Such unwieldiness led naturally to the development of an inner cabinet, at first informal but after 1739 recognized and regulated. It consisted of the first lord of the treasury, the lord chancellor, the lord president and the two secretaries of state. It met at Sir Robert Walpole's house, as he became the king's "first minister," the first lord of the treasury and the effective master of the house of commons. This dual system, of inner (efficient) and outer (nominal) cabinets persisted until the inner cabinet, by gradual accretion of important office holders, displaced its outer shell. This stage was reached by 1783, when the younger Pitt formed his administration.

Throughout the 18th century the cabinet remained in an indeterminate position. It had a genuinely independent executive power but could neither flout the will of the commons nor forfeit the favour of the king. Thus Walpole resigned in 1742 when the commons pronounced against him after the election of the previous year. But his resignation did not involve, as it would now, a complete change in the administration. The success of George III in reasserting the crown's right to direct policy and to control ministries effectively checked for a period any tendency toward ministerial independence. The strongest prime minister of the 18th century, the younger Pitt, enjoyed his position primarily as a result of royal favour.

Thus although there were isolated instances of the crown accepting, against its inclination, the advice of ministers (*e.g.*, George IV's assent to Catholic emancipation in 1829) it was only the passage of the 1832 Reform bill that made possible the emergence of cabinet government today. Henceforth no cabinet could maintain itself unless it had the support of a majority in the house of commons, or could obtain a majority by dissolving parliament and appealing to the electorate. Obviously for both these purposes it must be united, and the most natural and solid basis for unity was party. Hence party government and cabinet government developed simultaneously.

Principles of Cabinet Government.—The cabinet may be described as a committee of privy councilors, with seats in parliament. The members are united by political principle and they profess unanimity in public under the leadership of the acknowledged head of the party commanding a majority in the house of commons. It is by this head, with the sovereign's assent, that they have been appointed to the control of the principal government departments, to act through him as the sovereign's sole advisers, and to be severally and jointly responsible to the sovereign, the prime minister, parliament and the people, for their individual and collective actions, so long as they are supported by a majority of the house of commons. Membership of the privy council provides, through the privy councilors' oath, the necessary formal basis of loyalty and secrecy. The passage of the Official Secrets act in 1911 imposed legal penalties for the publication of cabinet documents. Obviously cabinet deliberation would be robbed of its frankness and cabinet action of much of its authority if freedom of speech inside the cabinet were not married to silence about its proceedings outside, and the rules of secrecy have in the main been admirably preserved. Of course, at a certain point cabinet proceedings pass into history, and the Public Records act, 1967, laid down that cabinet and other government records should become available after 30 years; moreover, such an eminent person as Sir Winston Churchill seems to have been granted generous latitude in the publication of cabinet memoranda in his memoirs. But in general the rule of secrecy means that students and the public are less well informed about the operations of the cabinet than about most parts of the machinery of government.

Cabinet members must have seats in parliament, both in order to defend their political actions, and to enable parliament to hold them to account. The Ministers of the Crown act, 1937, gives legal sanction to the obvious political necessity of distributing ministers in adequate proportions between the commons and the lords. It is essential that the prime minister should be in the commons and desirable that the finance ministers be there, too.

In ordinary times, members of a cabinet will obviously be members of the same party. Coalitions may occur, but experience suggests that in fact only war or other national emergency provides an adequate solvent for partisanship; the 1931 coalition soon lost unanimity of purpose and its short-lived experiment in "agreement to differ" over tariffs demonstrated the continuing validity of Lord Melbourne's principle of unanimity.

The doctrine of collective responsibility is the keystone of the cabinet arch. It implies an obligation on every member not to vote or speak against a cabinet decision and to support it in the division lobbies and in public. This in turn implies that important decisions shall normally be taken in full cabinet. Nevertheless, changes of policy may sometimes be announced without prior agreement. In such cases either the cabinet must disavow the spokesman (as Baldwin's cabinet disavowed Sir Samuel Hoare over the Hoare-Laval pact in 1935) and, as a corollary, the aberrant member must resign; or else the cabinet must close ranks behind the new policy and endorse it. In such circumstances the prime minister is in a particularly strong position. As leader of his party he enjoys especial authority in parliament and the country; as head of the cabinet he can require any hostile colleague's resignation. If the prime minister resigns, his cabinet falls with him and the right of advising the sovereign to dissolve parliament is his alone. (For details of the prime minister's powers *see* PRIME MINISTER.)

Relations With the Sovereign.—Because the full implications of the Reform act were not immediately grasped, Queen Victoria retained throughout her reign a degree of control over the cabinet that was logically incompatible with its position in the constitution. The sovereign's power is now restricted to the initial act of selecting an individual and inviting him to form a government. Whom he appoints, what policies his administration pursues, when he resigns or when he asks the sovereign to grant a dissolution—these are matters on which the prime minister, subject to the law of the land, is entitled to have his own way.

Composition of the Cabinet.—Cabinets have grown in size as the responsibilities of government have expanded. Sir Robert Peel in 1841 had only 13 members in his cabinet but by 1900 the number rose to 20 and it has seldom dropped below this figure in normal times since. The problem has increasingly become how to include all the important departments and yet not make the cabinet too unwieldy. Certain departments are so pivotal that they obviously must be included, such as the foreign office and the treasury. The importance of others may rise and fall with the changing emphases of politics. But room may also have to be found for some ministers who are not heads of departments but whose counsel or debating strength is of value; they can either hold sinecure offices, like the lord presidency, or serve without portfolio.

In war the needs of administration and execution take priority over those of politics. This has been reflected in the composition of wartime cabinets. Lloyd George in 1916 superseded H. H. Asquith's ordinary cabinet by one of five or six members only, none of whom, except the chancellor of the exchequer, had departmental duties. This inner circle of executives met daily, either by itself or, more frequently, in the company of whatever departmental head was operationally concerned with the business under discussion. Opportunity was also taken of visits to Britain by dominion prime ministers to invite them to attend cabinet sessions, and in 1917 Gen. J. C. Smuts was made a regular member. At the outset of World War II in 1939 Neville Chamberlain reduced his peacetime cabinet of 23 to one of 9, but, unlike Lloyd George, he included 5 members with departmental responsibilities, the 3 service ministers, the foreign secretary and the chancellor of the exchequer. It was not until the formation of Winston Churchill's coalition government in 1940 that cabinet numbers shrank to five, but it gradually expanded again and for most of the war stood at eight or nine. As the numbers increased to more than 20 the initial policy of basing the cabinet on nondepartmental ministers was abandoned.

Cabinet Committees and Secretariat.—The modern cabinet does much of its work through committees on which heads of departments not of cabinet rank frequently serve. The first formal committee to be instituted was the committee of imperial defense established in 1904. The prime minister was chairman and the committee contained, in addition to the ministers directly concerned with military matters, the three chiefs of staff. As the work of the committee expanded subcommittees developed to deal with detailed questions of manpower, supply, etc. In 1946, at the same time that a minister of defense was created, the committee's name was changed to the defense committee. After the first lord of the admiralty and the secretaries of state for air and war were made ministers of defense and their departments reorganized under the secretary of state for defense in 1964, the committee was renamed the Defense and Overseas Policy committee.

The home affairs committee was first set up in June 1918 to consider all questions of internal policy, but has become more of a legislation committee, concerned with the drafting of bills and the planning of parliament's work. It is for each government to decide on the committee structure most convenient for discharging cabinet business. The Labour government of 1945–51 developed an elaborate structure of almost 20 cabinet committees.

The cabinet was late in developing any secretariat of its own and for many years the only record of its proceedings was the confidential letter which the prime minister sent to the sovereign at the end of each meeting. The committee of imperial defense had had a modest secretariat ever since its inception and on the outbreak of World War I the obvious solution was adopted of taking over its staff, which became enlarged and was in 1916 placed under Sir Maurice Hankey as the first permanent secretary to the cabinet. Strict secrecy still governs all cabinet records but there is a great gain in the continuity and precision of cabinet action.

World War II led to the growth in 1940 of an economic section of the cabinet secretariat, which became a permanent part of the machinery of government in May 1944. Its duty is to measure and analyze economic trends and submit reports on them. There is also a central statistical office attached to the cabinet (also dating from 1940) whose job is to collect statistics from the departments.

The cabinet ordinarily meets in Sir Robert Walpole's house, No. 10 Downing street, which he bequeathed to the nation, and which prime ministers occupy to this day. For tables of the cabinets and ministers of English crown *see* MINISTRY, GOVERNMENT.

COMMONWEALTH OF NATIONS

The other countries of the commonwealth maintain cabinet systems closely related to those developed in the United Kingdom, though with local variations resulting from differences in political environment. The older countries, Canada, Australia, and New Zealand, base their cabinets on the U.K. model. India proceeded on much the same lines after independence. Ceylon is distinctive in having the conventions of the British cabinet system formally incorporated in its constitution. Pakistan, after an unsuccessful attempt to operate a system of parliamentary democracy, instituted what was virtually a system of military rule in Oct. 1958, while most of the newly independent African states maintain a high degree of personal or military autocracy behind a facade of cabinet government. The non-self-governing states of the commonwealth have in almost all cases an executive council under a governor and proceed in their evolution toward a full cabinet system along much the same path the British cabinet took in the evolution of its relations with the crown and parliament.

(H. G. N.)

CONTINENT OF EUROPE

On the continent of Europe, as in Great Britain, the cabinet—frequently termed council of ministers—became an intrinsic part of parliamentary systems of government. In many European countries, however, the historical development of cabinet bodies and their functions within the complex of parliamentary institutions differed appreciably from British experience.

Cabinets of a recognizably modern form first appeared in Europe during the 19th century with the gradual spread of constitutional government. Monarchs had previously made use of members of their court circles for the exercise of various administrative functions, but as their own private servants. The establishment of constitutional rule brought in its train a new status for the king's ministers. This was in large part due to the creation of elected representative parliaments whose approval was needed for budgetary matters and legislative acts. Ministers now came to share with the king responsibility for the processes of government—their signature, for instance, was required on legislative acts—and it became their task to defend policy proposals in parliament. The choice of such ministers continued, however, to rest with the king and many monarchs who only reluctantly agreed to the adoption of forms of constitutional rule clearly hoped that the change would not seriously interfere with their selection either of individuals or policies.

Germany.—In some cases the weakness of parliamentary bodies did in fact leave a large measure of personal power either to the monarch himself or to the person of his choice. This was the case in Prussia under the constitution of 1850, for instance, where ministers—though they had the right to appear in either chamber and speak as often as they pleased—did not in practice resign on an adverse vote. Nor did ministers in that state develop the cohesion characteristic of a modern cabinet: there was a minister president, but he had no authority over his colleagues and could not compel them to adopt his views. Similarly, in the German empire power continued to reside principally with the emperor who either, as in the case of William II, himself undertook the direction of public affairs, or, as with William I, delegated its exercise to a minister of his choice—Bismarck. In neither case did the cabinet assume a decisive role. In Germany the exercise of governmental power did not become dependent on a vote of confidence given by the assembly until the creation of the Weimar republic after World War I, and then the fragmentation of political parties within the *Reichstag* gave rise to a long series of weak minority cabinets. Actual government devolved more and more upon permanent civil servants and many ministerial posts came to be filled by nonpolitical experts, while political power shifted to the directly elected president to whom the constitution gave control over the army.

France.—In a number of other countries constitutional regimes gave place earlier to forms of government which gave much greater power to the cabinet, either through a process of formal constitutional change or by the gradual evolution of parliamentary practice. An example of the former was the French third republic (1870–1940) in which effective control of executive power was confined to the council of ministers who alone had responsibility for governmental acts. In the reaction against the second republic (1848–52) which, through its provision for the direct election of the president, had allowed Louis Napoleon to assume autocratic powers, the role of the president was greatly reduced. Elected by a joint meeting of the two houses of parliament, he was allowed to communicate with them subsequently only by message, though his ministers had the right of appearing in person and speaking. With the advent of the fifth republic (1958), however, presidential powers were again greatly strengthened, and actively exercised by Pres. Charles de Gaulle who regularly presided over cabinet meetings and determined policy himself in a number of important sectors, particularly foreign affairs. (*See* also FRANCE: *Administration and Social Conditions;* MINISTRY, GOVERNMENT: *Continental Europe.*)

Italy.—In Italy cabinet government evolved without forma constitutional change within the framework established by the Piedmontese *statuto* of 1848. Although this did not explicitly require ministers to have parliamentary support, the tradition established by Cavour of ministerial responsibility toward a parliamentary majority was continued by his successors, and it was rarely that the king subsequently attempted to nominate members of his own private circle for the position of prime minister, as he had done in 1848–49. Royal interference in certain aspects o policy, particularly foreign affairs, continued through the 19th century but did not assume proportions such as to call in question the right of the council of ministers, sustained by a parliamentary majority, to govern. The republican constitution of 1948, which reintroduced parliamentary forms of government after the Fascis interlude, for the first time gave explicit constitutional sanction to the role of the cabinet, but this was a confirmation of pre-Fascis practice rather than an innovation. (*See* also ITALY: *Administration and Social Conditions: Government.*)

The Netherlands.—In the Netherlands the change from a constitutional regime to one in which the majority in parliament exercised a determining influence on the nature and composition of the government was also gradual. The Fundamental law of 1814 left the king still the determining force in government and down to 1840 William I ruled as an autocrat, his ministers being treated as his personal servants. His abdication in that year was occasioned by constitutional reform which introduced a degree of ministerial responsibility, but his successor continued to be the main source of his ministers' strength. It was not until the further reforms of 1848 that the way to full ministerial responsibility to parliament was opened up, when William II was obliged to agree to the conditions laid down by the person he nominated to form a cabinet—Rutger Jan Schimmelpenninck—who first assured himself of a parliamentary majority and a homogeneous cabinet before he took office. The ensuing period up to 1868 witnessed a continuing conflict between king and parliament for control over successive ministries that ended in the triumph of the elected assembly. (*See* also BELGIUM: *Administration and Social Conditions;* NETHERLANDS, THE: *Constitution and Government.*)

Sweden.—Sweden was an example of another country where he process was also gradual. After the 1840–41 *riksdag* the Swedish kings recognized the need for governments to co-operate with parliament, but for a long time they refused to subject themselves to it when making ministerial appointments. The conflict over this issue was often bitter but again it was resolved in favour of parliament, the creation of the Liberal-Social Democrat ministry of 1917 generally being accepted as the final culmination of this process. (*See* also SWEDEN: *Constitution and Government.*)

Switzerland.—In their general form European cabinets resembled that in Britain, though that of the Swiss confederation remained a distinctive exception. Its federal executive is a body whose membership is fixed at seven, these being elected by the wo chambers of the legislature in joint session for a period of four years—the full parliamentary session. The presidency of the confederation rotates annually among these seven members. (*See* also SWITZERLAND: *Government.*)

The Common Problem of Stability.—Elsewhere cabinets are formed by a person designated by the head of state, usually after consultation with party leaders and other prominent poliicians. Except in Britain this process in Europe is frequently extremely laborious and lengthy. The Netherlands, because of the inely balanced political situation after World War II, saw some particularly prolonged attempts. In 1956 it took no less than 21 days to form a government and this followed on similar, if shorter, crises in 1952 (68 days) and 1951 (49 days). Several postwar Italian cabinets also had lengthy periods of gestation: hat of Fernando Tambroni was confirmed in office early in 1960 fter more than two months' intense maneuvering and even then it ailed to command a true majority in the lower chamber.

Such difficulties arose because of the absence of parties strong enough by themselves to command stable majorities in parliament —a reflection of the much greater political fragmentation found n most continental European countries as compared with Great Britain. In all but a few continental countries coalition cabinets re the rule and tend to be much less stable than single-party ministries.

Both France and Italy have a particularly unhappy and continung tradition in this respect. With the exception of the two French mpires France had only two long-lived cabinets after 1789—those f the comte de Villèle (1822–28) and François Guizot (1840–8). During the remaining ten years of the July monarchy 1830–40) there were 14 cabinets and the third republic between eptember 1870 and June 1940 gave rise to no less than 110. The ecord of the fourth republic (Jan. 1947–May 1958) followed the ame pattern—21 cabinets in office in addition to several others hich, once formed, failed to receive parliamentary approval. imilarly, in Italy there were 67 ministries in the 74 years beween 1848 and 1922 and 12 in the first 10 years of the republic 1948–58).

Although frequent changes of cabinet have not always reflected a basic political instability—the eight De Gasperi ministries between Dec. 1945 and Aug. 1953 being a case in point—it remains generally true that cabinets on the European continent have had much shorter lives than those in Great Britain and also much greater difficulty in the execution of their programs. Countries faced by such difficulties have had recourse to various constitutional devices to maintain some form of governmental continuity. Both the Netherlands and Italy from time to time resorted to cabinets whose task was limited to the carrying on of current business—"caretaker" ministries whose continuance in power depended on avoiding major political issues. Such was the case of the De Geer cabinet of 1926 in the Netherlands, which deliberately refrained from drawing up a political program; the 1960 Tambroni cabinet in Italy had a similar origin. In France and the postwar Federal Republic of Germany attempts were made to erect formal constitutional barriers against frequent cabinet crises provoked by adverse parliamentary votes. The most severe of these was the provision in the German republic's Basic law (art. 67) that the *Bundestag* can express its lack of confidence in the federal chancellor only by electing a successor by the majority of its members—the so-called "constructive vote of no confidence."

It is doubtful, however, whether the existence of this provision, by itself, explains the remarkable stability of cabinets in postwar Germany. There the personal political strength of Konrad Adenauer was the decisive factor, just as in other countries individuals of the stature of Alcide de Gasperi (or, earlier in the century, Giovanni Giolitti) succeeded in maintaining apparently impregnable parliamentary positions for long periods. In such circumstances cabinets sometimes became so transparently dependent on the power of a single person that accusations of dictatorship followed from frustrated members of the opposition.

Even such powerful individuals nevertheless remain subject to ultimate parliamentary support. This is not the case in presidential-type regimes that some countries resorted to after failing to maintain stable government with parliamentary regimes. The need for greater governmental stability was one of the powerful motives for the constitutional changes in France brought about by the fifth republic. The result in that case—which has been described as "a Hanoverian monarch masquerading as a Republican President" (P. M. Williams and M. Harrison, *De Gaulle's Republic,* Longmans, Green & Co., Inc., New York, N.Y., 1960.)—is a variation on a constant theme in European politics: the search for a form of executive power which can overcome the weaknesses so often displayed by cabinets dependent on parliamentary approval. (R. PR.)

UNITED STATES

In the United States, the president's cabinet is altogether different from the British cabinet. It is composed of the heads of the co-ordinate executive departments, but the members do not have seats in congress and their tenure does not depend on favourable votes on administration measures. The existence of the cabinet and its operation are matters of custom rather than law, for the cabinet as a collective body has no legal existence or power. The constitution contains no mention of and no provision for a cabinet. It does, however, assume, in incidental references, that congress will establish executive departments. One of these references says that the president "may require the opinion in writing of the principal officer in each of the executive departments, upon any subject relating to the duties of their respective offices." This language is all that remained of an attempt by some members of the Constitutional Convention to provide for a specific presidential advisory council. Some of the framers felt that the senate would function as an executive council. But the most important reason for the omission was the feeling among the delegates that the wisest course was to leave the president free to decide for himself where to go for advice.

George Washington inaugurated the practice of consulting regularly with his department heads as a group. In 1789 he wrote that the first three executive departments had been instituted because of "the impossibility that one man should be able to perform all the great business of the state." Quite naturally, he

United States Cabinet Officers

Secretaries of State

Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed	
Washington	John Jay*	...	Tyler	Daniel Webster		Arthur	James G. Blaine		Harding	Charles E. Hughes	1921
	Thomas Jefferson	1789		Hugh S. Legare	1843		F. T. Frelinghuysen	1881	Coolidge	Charles E. Hughes	
	Edmund Randolph	1794		Abel P. Upshur	1843	Cleveland	Thomas F. Bayard	1885		Frank B. Kellogg	1925
	Timothy Pickering	1795		John C. Calhoun	1844	B. Harrison	James G. Blaine	1889	Hoover	Henry L. Stimson	1929
J. Adams	Timothy Pickering		Polk	James Buchanan	1845		John W. Foster	1892	F. D. Roosevelt	Cordell Hull	1933
	John Marshall	1800	Taylor	John M. Clayton	1849	Cleveland	Walter Q. Gresham	1893		E. R. Stettinius, Jr.	1944
Jefferson	James Madison	1801	Fillmore	Daniel Webster	1850		Richard Olney	1895	Truman	E. R. Stettinius, Jr.	
Madison	Robert Smith	1809		Edward Everett	1852	McKinley	John Sherman	1897		James F. Byrnes	1945
	James Monroe	1811	Pierce	William L. Marcy	1853		William R. Day	1898		George C. Marshall	1947
Monroe	John Q. Adams	1817	Buchanan	Lewis Cass	1857		John Hay	1898		Dean G. Acheson	1949
J. Q. Adams	Henry Clay	1825		Jeremiah S. Black	1860	T. Roosevelt	John Hay		Eisenhower	John Foster Dulles	1953
Jackson	Martin Van Buren	1829	Lincoln	William H. Seward	1861		Elihu Root	1905		Christian A. Herter	1959
	Edward Livingston	1831	A. Johnson	William H. Seward			Robert Bacon	1909	Kennedy	Dean Rusk	1961
	Louis McLane	1833	Grant	Elihu B. Washburne	1869	Taft	Philander C. Knox	1909	L. B. Johnson	Dean Rusk	
	John Forsyth	1834		Hamilton Fish	1869	Wilson	William J. Bryan	1913	Nixon	William P. Rogers	1969
Van Buren	John Forsyth		Hayes	William M. Evarts	1877		Robert Lansing	1915			
W. H. Harrison	Daniel Webster	1841	Garfield	James G. Blaine	1881		Bainbridge Colby	1920			

Secretaries of the Treasury

Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed	
Washington	Alexander Hamilton	1789	Tyler	Thomas Ewing		Hayes	John Sherman	1877	Harding	Andrew W. Mellon	1921
	Oliver Wolcott, Jr.	1795		Walter Forward	1841	Garfield	William Windom	1881	Coolidge	Andrew W. Mellon	
J. Adams	Oliver Wolcott, Jr.			John C. Spencer	1843	Arthur	William Windom		Hoover	Andrew W. Mellon	
	Samuel Dexter	1801		George M. Bibb	1844		Charles J. Folger	1881		Ogden L. Mills	1932
Jefferson	Samuel Dexter		Polk	Robert J. Walker	1845		Walter Q. Gresham	1884	F. D. Roosevelt	W. H. Woodin	1933
	Albert Gallatin	1801	Taylor	W. M. Meredith	1849		Hugh McCulloch	1884		H. Morgenthau, Jr.	1934
Madison	Albert Gallatin		Fillmore	Thomas Corwin	1850	Cleveland	Daniel Manning	1885	Truman	H. Morgenthau, Jr.	
	George W. Campbell	1814	Pierce	James Guthrie	1853		Charles S. Fairchild	1887		F. M. Vinson	1945
	Alexander J. Dallas	1814	Buchanan	Howell Cobb	1857	B. Harrison	William Windom	1889		John W. Snyder	1946
	W. H. Crawford	1816		Phillip F. Thomas	1860		Charles Foster	1891	Eisenhower	G. M. Humphrey	1953
Monroe	W. H. Crawford			John A. Dix	1861	Cleveland	John G. Carlisle	1893		Robt. B. Anderson	1957
J. Q. Adams	Richard Rush	1825	Lincoln	Salmon P. Chase	1861	McKinley	Lyman J. Gage	1897	Kennedy	C. Douglas Dillon	1961
Jackson	Samuel D. Ingham	1829		W. P. Fessenden	1864	T. Roosevelt	Lyman J. Gage		L. B. Johnson	C. Douglas Dillon	
	Louis McLane	1831		Hugh McCulloch	1865		Leslie M. Shaw	1902		Henry H. Fowler	1965
	William J. Duane	1833	A. Johnson	Hugh McCulloch			George B. Cortelyou	1907	Nixon	David M. Kennedy	1969
	Roger B. Taney	1833	Grant	George S. Boutwell	1869	Taft	Franklin MacVeagh	1909		John B. Connally	1970
	Levi Woodbury	1834		Wm. A. Richardson	1873	Wilson	William G. McAdoo	1913			
Van Buren	Levi Woodbury			B. H. Bristow	1874		Carter Glass	1919			
W. H. Harrison	Thomas Ewing	1841		Lot M. Morrill	1876		David F. Houston	1920			

Secretaries of War

Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed	
Washington	Henry Knox	1789	Van Buren	Joel R. Poinsett	1837	Grant	William W. Belknap	1869	Taft	Henry L. Stimson	1911
	Timothy Pickering	1795	W. H. Harrison	John Bell	1841		Alphonso Taft	1876	Wilson	Lindley K. Garrison	191
	James McHenry	1796	Tyler	John C. Spencer	1841		James D. Cameron	1876		Newton D. Baker	191
J. Adams	James McHenry			James M. Porter	1843	Hayes	George W. McCrary	1877	Harding	John W. Weeks	192
	Samuel Dexter	1800		William Wilkins	1844		Alexander Ramsey	1879	Coolidge	John W. Weeks	
Jefferson	Henry Dearborn	1801	Polk	William L. Marcy	1845	Garfield	Robert T. Lincoln	1881		Dwight F. Davis	192
Madison	William Eustis	1809	Taylor	G. W. Crawford	1849	Arthur	Robert T. Lincoln		Hoover	James W. Good	192
	John Armstrong	1813	Fillmore	Charles M. Conrad	1850	Cleveland	William C. Endicott	1885		Patrick J. Hurley	192
	James Monroe	1814	Pierce	Jefferson Davis	1853	B. Harrison	Redfield Proctor	1889	F. D. Roosevelt	George H. Dern	193
	W. H. Crawford	1815	Buchanan	John B. Floyd	1857		Stephen B. Elkins	1891		Harry H. Woodring	193
Monroe	G. Graham (ad int.)	1817		Joseph Holt	1861	Cleveland	Daniel S. Lamont	1893		Henry L. Stimson	194
	John C. Calhoun	1817	Lincoln	Simon Cameron	1861	McKinley	Russell A. Alger	1897	Truman	Henry L. Stimson	
J. Q. Adams	James Barbour	1825		Edwin M. Stanton	1862		Elihu Root	1899		Robert P. Patterson	194
	Peter B. Porter	1828	A. Johnson	U. S. Grant (ad int.)	1867	T. Roosevelt	Elihu Root			Kenneth C. Royall†	194
Jackson	John H. Eaton	1829		John M. Schofield	1868		William H. Taft	1904			
	Lewis Cass	1831	Grant	John A. Rawlins	1869		Luke E. Wright	1908			
	Benjamin F. Butler	1837		William T. Sherman	1869	Taft	Jacob M. Dickinson	1909			

Secretaries of the Navy

Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed	
J. Adams	Benjamin Stoddert	1798	W. H. Harrison	George E. Badger	1841	Grant	Adolph E. Borie	1869	T. Roosevelt	Victor H. Metcalf	190
Jefferson	Benjamin Stoddert		Tyler	George E. Badger			George M. Robeson	1869		T. H. Newberry	190
	Robert Smith	1802		Abel P. Upshur	1841	Hayes	R. W. Thompson	1877	Taft	G. von L. Meyer	19
Madison	Paul Hamilton	1809		David Henshaw	1843		Nathan Goff, Jr.	1881	Wilson	Josephus Daniels	191
	William Jones	1813		Thomas W. Gilmer	1844	Garfield	William H. Hunt	1881	Harding	Edwin Denby	192
	B. W. Crowninshield	1815		John Y. Mason	1844	Arthur	William H. Hunt		Coolidge	Edwin Denby	
Monroe	B. W. Crowninshield		Polk	George Bancroft	1845		William E. Chandler	1882		Curtis D. Wilbur	192
	Smith Thompson	1819		John Y. Mason	1846	Cleveland	William C. Whitney	1885	Hoover	Charles F. Adams	192
	Samuel L. Southard	1823	Taylor	William B. Preston	1849	B. Harrison	Benjamin F. Tracy	1889	F. D. Roosevelt	Claude A. Swanson	193
J. Q. Adams	Samuel L. Southard		Fillmore	William A. Graham	1850	Cleveland	Hilary A. Herbert	1893		Charles Edison	194
Jackson	John Branch	1829		John P. Kennedy	1852	McKinley	John D. Long	1897		Frank Knox	194
	Levi Woodbury	1831	Pierce	James C. Dobbin	1853	T. Roosevelt	John D. Long			James V. Forrestal	194
	Mahlon Dickerson	1834	Buchanan	Isaac Toucey	1857		William H. Moody	1902	Truman	James V. Forrestal†	
Van Buren	Mahlon Dickerson		Lincoln	Gideon Welles	1861		Paul Morton	1904			
	James K. Paulding	1838	A. Johnson	Gideon Welles			C. J. Bonaparte	1905			

Attorneys General

Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed	
Washington	Edmund Randolph	1789	Tyler	John J. Crittenden		Grant	Alphonso Taft	1876	Coolidge	H. M. Daugherty	
	William Bradford	1794		Hugh S. Legaré	1841	Hayes	Charles Devens	1877		Harlan F. Stone	192
	Charles Lee	1795		John Nelson	1843	Garfield	Wayne MacVeagh	1881		John G. Sargent	192
J. Adams	Charles Lee		Polk	John Y. Mason	1845	Arthur	Wayne MacVeagh		Hoover	William D. Mitchell	192
Jefferson	Levi Lincoln	1801		Nathan Clifford	1846		Ben. H. Brewster	1881	F. D. Roosevelt	Homer S. Cummings	193
	John Breckinridge	1805		Isaac Toucey	1848	Cleveland	A. H. Garland	1885		Frank Murphy	193
	Caesar A. Rodney	1807	Taylor	Reverdy Johnson	1849	B. Harrison	William H. H. Miller	1889		Robert H. Jackson	194
Madison	Caesar A. Rodney		Fillmore	John J. Crittenden	1850	Cleveland	Richard Olney	1893		Francis Biddle	194
	William Pinkney	1811	Pierce	Caleb Cushing	1853		Judson Harmon	1895	Truman	Francis Biddle	
	Richard Rush	1814	Buchanan	Jeremiah S. Black	1857	McKinley	Joseph McKenna	1897		Thomas C. Clark	194
Monroe	Richard Rush			Edwin M. Stanton	1860		John W. Griggs	1898		J. Howard McGrath	194
	William Wirt	1817	Lincoln	Edward Bates	1861		Philander C. Knox	1901		J. P. McGranery	195
J. Q. Adams	William Wirt			James Speed	1864	T. Roosevelt	Philander C. Knox		Eisenhower	H. Brownell, Jr.	195
Jackson	John McP. Berrien	1829	A. Johnson	James Speed			William H. Moody	1904		William P. Rogers	195
	Roger B. Taney	1831		Henry Stanbery	1866		C. J. Bonaparte	1906	Kennedy	Robert Kennedy	196
	Benjamin F. Butler	1833		William M. Evarts	1868	Taft	G. W. Wickersham	1909	L. B. Johnson	Robert Kennedy	
Van Buren	Benjamin F. Butler		Grant	Ebenezer R. Hoar	1869	Wilson	J. C. McReynolds	1913		N. Katzenbach	196
	Felix Grundy	1838		Amos T. Akerman	1870		Thomas W. Gregory	1914		Ramsey Clark	196
	Henry D. Gilpin	1840		George H. Williams	1871		A. M. Palmer	1919	Nixon	John N. Mitchell	196
W. H. Harrison	John J. Crittenden	1841		Edwards Pierrepont	1875	Harding	H. M. Daugherty	1921			

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*John Jay was secretary for foreign affairs under the confederation, and continued to act, at the president's request, until Jefferson returned from Europe March 21, 1790.

†After Sept. 1947 the secretary of defense represented the national military establishment.

United States Cabinet Officers (Continued)

Postmasters General

Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed		Presidents	Year appointed	
Washington	Samuel Osgood	1789	Polk	Cave Johnson	1845	Garfield	Thomas L. James	1881	Wilson	Albert S. Burleson	1913
	Timothy Pickering	1791	Taylor	Jacob Collamer	1849	Arthur	Thomas L. James		Harding	Will H. Hays	1921
	Joseph Habersham	1795	Fillmore	Nathan K. Hall	1850		Timothy O. Howe	1881		Hubert Work	1922
J. Adams	Joseph Habersham			Samuel D. Hubbard	1852		Walter Q. Gresham	1883		Harry S. New	1923
Jefferson	Joseph Habersham		Pierce	James Campbell	1853		Frank Hatton	1884	Coolidge	Harry S. New	
	Gideon Granger	1801	Buchanan	Aaron V. Brown	1857	Cleveland	William F. Vilas	1885	Hoover	Walter F. Brown	1929
Madison	Gideon Granger			Joseph Holt	1859		Don M. Dickinson	1888	F. D. Roosevelt	James A. Farley	1933
	Return J. Meigs, Jr.	1814		Horatio King	1861	B. Harrison	John Wanamaker	1889		Frank C. Walker	1940
Monroe	Return J. Meigs, Jr.		Lincoln	Montgomery Blair	1861	Cleveland	Wilson S. Bissel	1893	Truman	Frank C. Walker	
	John McLean	1823		William Dennison	1864		William L. Wilson	1895		Robert E. Hannegan	1945
J. Q Adams	John McLean		A. Johnson	William Dennison		McKinley	James A. Gary	1897		Jesse M. Donaldson	1947
Jackson	William T. Barry	1829		Alex. W. Randall	1866		Charles E. Smith	1898	Eisenhower	A. E. Summerfield	1953
	Amos Kendall	1835	Grant	John A. J. Creswell	1869	T. Roosevelt	Charles E. Smith		Kennedy	J. Edward Day	1961
Van Buren	Amos Kendall			James W. Marshall	1874		Henry C. Payne	1902		J. A. Gronouski	1963
	John M. Niles	1840		Marshall Jewell	1874		Robert J. Wynne	1904	L. B. Johnson	J. A. Gronouski	
W. H. Harrison	Francis Granger	1841		James N. Tyner	1876		George B. Cortelyou	1905		L. F. O'Brien	1965
Tyler	Francis Granger		Hayes	David McK. Key	1877		G. von L. Meyer	1907		W. Marvin Watson	1968
	Charles A. Wickliffe	1841		Horace Maynard	1880	Taft	Frank H. Hitchcock	1909	Nixon	Winton M. Blount	1969

Secretaries of the Interior

Taylor	Thomas Ewing	1849	Grant	Zachariah Chandler	1875	T. Roosevelt	Ethan A. Hitchcock		Truman	Harold L. Ickes	
Fillmore	T. M. T. McKennan	1850	Hayes	Carl Schurz	1877		James R. Garfield	1907		Julius A. Krug	1946
	Alex. H. H. Stuart	1850	Garfield	Samuel J. Kirkwood	1881	Taft	Richard A. Ballinger	1909		Oscar L. Chapman	1949
Pierce	Robert McClelland	1853	Arthur	Samuel J. Kirkwood			Walter L. Fisher	1911	Eisenhower	Douglas McKay	1953
Buchanan	Jacob Thompson	1857		Henry M. Teller	1882	Wilson	Franklin K. Lane	1913		Fred A. Seaton	1956
Lincoln	Caleb B. Smith	1861	Cleveland	Lucius Q. C. Lamar	1885		John B. Payne	1920	Kennedy	Stewart L. Udall	1961
	John P. Usher	1863		William F. Vilas	1888	Harding	Albert B. Fall	1921	L. B. Johnson	Stewart L. Udall	
A. Johnson	John P. Usher		B. Harrison	John W. Noble	1889		Hubert Work	1923	Nixon	Walter J. Hickel	1969
	James Harlan	1865	Cleveland	Hoke Smith	1893	Coolidge	Hubert Work			Rogers C. B. Morton	1970
	Orville H. Browning	1866		David R. Francis	1896		Roy O. West	1928			
Grant	Jacob D. Cox	1869	McKinley	Cornelius N. Bliss	1897	Hoover	Ray Lyman Wilbur	1929			
	Columbus Delano	1870		Ethan A. Hitchcock	1898	F. D. Roosevelt	Harold L. Ickes	1933			

Secretaries of Agriculture

Cleveland	Norman J. Colman	1889	Wilson	David F. Houston	1913	F. D. Roosevelt	Henry A. Wallace	1933	Kennedy	Orville Freeman	1961
B. Harrison	Jeremiah M. Rusk	1889		Edw. T. Meredith	1920		Claude R. Wickard	1940	L. B. Johnson	Orville Freeman	
Cleveland	J. Sterling Morton	1893	Harding	Henry C. Wallace	1921	Truman	Claude R. Wickard		Nixon	Clifford M. Hardin	1969
McKinley	James Wilson	1897	Coolidge	Howard M. Gore	1924		Clinton P. Anderson	1945			
T. Roosevelt	James Wilson			W. M. Jardine	1925		Charles F. Brannan	1948			
Taft	James Wilson		Hoover	Arthur M. Hyde	1929	Eisenhower	Ezra Taft Benson	1953			

Secretaries of Commerce and Labor

T. Roosevelt	George B. Cortelyou	1903	T. Roosevelt	Victor H. Metcalf	1904	T. Roosevelt	Oscar S. Straus	1906	Taft	Charles Nagel	1909

Secretaries of Commerce

Wilson	William C. Redfield	1913	Hoover	Roy D. Chapin	1932	Truman	W. A. Harriman	1946	L. B. Johnson	Luther Hodges	
	Josh. W. Alexander	1919	F. D. Roosevelt	Daniel C. Roper	1933		Charles Sawyer	1948		John T. Connor	1964
Harding	Herbert C. Hoover	1921		Harry L. Hopkins	1938	Eisenhower	Sinclair Weeks	1953		Alexander Trowbridge	1967
Coolidge	Herbert C. Hoover			Jesse H. Jones	1940		Lewis L. Strauss‡	1958		Cyrus R. Smith	1968
	William F. Whiting	1928		Henry A. Wallace	1945		F. H. Mueller	1959	Nixon	Maurice H. Stans	1969
Hoover	Robert P. Lamont	1929	Truman	Henry A. Wallace		Kennedy	Luther Hodges	1961			

Secretaries of Labor

Wilson	William B. Wilson	1913	Hoover	William N. Doak	1930	Truman	Maurice J. Tobin	1948	Kennedy	W. W. Wirtz	1962
Harding	James J. Davis	1921	F. D. Roosevelt	Frances Perkins	1933	Eisenhower	Martin P. Durkin	1953	L. B. Johnson	W. W. Wirtz	
Coolidge	James J. Davis		Truman	Frances Perkins			James P. Mitchell	1953	Nixon	George P. Shultz	1969
Hoover	James J. Davis			L. B. Schwellenbach	1945	Kennedy	Arthur Goldberg	1961		James D. Hodgson	1970

Secretaries of Defense

ruman	James V. Forrestal	1947	Truman	Robert A. Lovett	1951	Eisenhower	T. S. Gates, Jr.	1959	L. B. Johnson	Clark M. Clifford	1968
	Louis A. Johnson	1949	Eisenhower	Charles E. Wilson	1953	Kennedy	R. S. McNamara	1961	Nixon	Melvin R. Laird	1969
	George C. Marshall	1950		Neil H. McElroy	1957	L. B. Johnson	R. S. McNamara				

Secretaries of Health, Education, and Welfare

isenhower	Oveta Culp Hobby	1953	Kennedy	Abraham Ribicoff	1961	L. B. Johnson	John W. Gardner	1965	Nixon	Elliot L. Richardson	1970
	Marion B. Folsom	1955		A. J. Celebrezze	1962		Wilbur J. Cohen	1968			
	Arthur S. Flemming	1958	L. B. Johnson	A. J. Celebrezze		Nixon	Robert H. Finch	1969			

Secretaries of Housing and Urban Development						*Secretaries of Transportation*					
. B. Johnson	Robert C. Weaver	1966	Nixon	George Romney	1969	L. B. Johnson	Allen Boyd	1967	Nixon	John A. Volpe	1969

Recess appointment, Oct. 1958 to June 1959. Senate failed to confirm appointment.

rned to subordinates in the executive branch for help, the more since the senate, anxious to preserve its legislative independence, as reluctant to act as an intimate advisory council. From the tset Washington sought advice, in informal conversation and riting, from the three secretaries and the attorney general. In 791–92 he began to consult occasionally with this group of four important and confidential matters. The term "cabinet" was st publicly used by James Madison in 1793.

Gradually, as administrative duties increased and different problems arose, new executive departments were created by congress. he departments of state, treasury and war were established in 1789. The offices of attorney general and postmaster general, also created in 1789, did not rank as regular departments until 1870 and 1872, but the attorney general was considered a member of the cabinet from the beginning and, upon the invitation of President Jackson, the postmaster general became a member in 1829. Other department heads became members as follows: the navy in 1798, the interior in 1849, agriculture in 1889, and commerce and labour in 1903; the latter department was divided in 1913 into two separate departments, commerce and labour, with separate heads; in 1967 it was recommended that the two be recombined. In 1947 the head of the reorganized national military establishment, the secretary of defense, became a cabinet member, while the secretaries of the departments under his direction—army, navy and air force—were not given cabinet rank. The cabinet was increased to ten members in 1953 when a department of health, education, and welfare was created and in 1965 the department of housing and urban development was created; and in 1966 there were twelve members with the creation of the department of transportation. The U.S. representative to the United Nations is considered a member of the cabinet. In 1971, when the post office department became an independent agency of the government, the rank of postmaster general was eliminated, reducing the number of cabinet members to eleven.

Washington's habit of calling regular and frequent cabinet meetings began a tradition that has been followed by every succeeding president. But it is important to remember that the cabinet exists solely to help the president carry out his functions as the nation's chief executive. He is virtually free to use it or not to use it as he wishes. The president may consult with cabinet members before making a particular decision but the responsibility for making that decision is nevertheless completely his. If he does not choose to consult with cabinet members there is little they can do about it. A story is told about a disagreement in Abraham Lincoln's cabinet that found the president's viewpoint opposed by all the members of the group. Lincoln called for a vote and announced the results—"One aye, seven nays: the ayes have it." The story may not be true, but it illustrates the relationship between the president, who makes decisions, and the cabinet, which advises.

Some presidents have relied on their cabinets a great deal and others have done so relatively little. The great variety in usage is accounted for by differences in the kinds of problems under consideration and, most importantly, by the differences in ability, temperament and working habits among individual presidents. Attendance at meetings has not, from the time Washington invited his attorney general, been restricted exclusively to those department heads who are of cabinet rank.

The business of cabinet meetings is initiated either by the president or the members. Usually the meeting opens with some comments by the president, either presenting a problem for discussion or passing along information to the group. Depending on the nature of his remarks, a round-table discussion or individual comments will follow. Typical items of business include: presidential speeches that relate to the policies of the administration, legislative proposals being prepared for presentation to congress, public opinion on matters of current concern and reports by individuals on departmental activities of general interest to the group.

When the president has finished with his business, cabinet members are given their chance to raise questions for consideration by the tradition of proceeding around the table. Usually the order of speaking has followed the order in which the departments were established—the secretary of state having the first opportunity and so on to the most recent addition to the group. The importance and success of cabinet sessions have varied greatly over the years. Some have been of help to the president; others have been more nearly a waste of time.

The cabinet, with a few early exceptions, does not take votes. The president may, on occasion, summarize a discussion and state what seems to him to be the general sense of the meeting. He may or may not announce his decision at the meeting. Cabinet transactions are, by public custom, kept secret. No formal or detailed records are kept. Information about them (except for occasional "leaks" to the press) comes mostly from the memoirs or reminiscences of former cabinet members. A notable exception occurred when a newspaperman was given, for use in his book, extensive notes taken in President Eisenhower's cabinet meetings. (Robert J. Donovan, *Eisenhower: the Inside Story*, 1956.)

President Eisenhower made several changes affecting his cabinet machinery in 1954. His previous experience in military organizations, where the emphasis was on regularized staff procedures, made him want to organize his political advisers in a similar system. He set up a cabinet secretariat (a secretary to the cabinet and one assistant) with responsibility for planning an agenda for cabinet meetings and circulating in advance information on the items to be discussed. It also supervised the implementation of decisions reached at the cabinet table. The purpose of these arrangements was twofold; first, to try to cut down on the disorganization that often characterizes cabinet discussions, and secondly, to try to increase the efficiency with which presidential decisions made in the cabinet meeting are carried out. The secretariat had some success in accomplishing these ends, mostly because the machinery suited the working habits of President Eisenhower. Presidents Kennedy and Johnson retained the cabinet secretary but both returned to the earlier, more flexible procedures.

Many different factors enter into the president's selection of hi cabinet. Ordinarily, all members are of the same political party as he. Some may be personal friends who are not well known to the public; others may be political leaders of national reputation Normally, the group contains representatives from different sec tions of the nation. The desires of pressure groups may influence the selection of certain members. Farm groups, for example will be interested in the appointment of the secretary of agriculture, business groups in the secretary of commerce, labour groups in the secretary of labour. Some men are chosen for their legislative experience; others are selected for their executive experienc in government, business, or some other field.

While nominations to the president's "official family" must b confirmed by the senate, confirmation is normally given prompt and without objection. Only seven nominees have been rejecte Cabinet appointment is for the duration of the administration however, the president may dismiss any member at pleasure, with out approval of the senate. Dismissals are rare, but individua resignations have been fairly common. Department heads ma also be removed by impeachment, but such action is extremel rare. In 1876 impeachment proceedings were brought agains Secretary of War William W. Belknap but he was not convicte

Under the Presidential Succession act of 1886 the cabinet wa given a special role in the event that both the president and vice president died, resigned, were removed or were unable to serv The members of the cabinet were next in line of succession, be ginning with the senior member, the secretary of state. Th Presidential Succession act of 1947 modified this procedure t place the speaker of the house of representatives and the presider pro tempore of the senate ahead of the cabinet members. In 196 the 25th Amendment provided for presidential appointment of vice-president before the 1947 order becomes effective.

The cabinet is only one of many sources of advice and assistanc that the president may use in fulfilling his executive responsibilitie Under President Eisenhower, for example, questions of foreign po icy were considered by the national security council, and cabin business was restricted to domestic affairs. Since cabinet membe are often more interested in their own particular departments tha in the president's broad over-all problems, he must sometimes tur for advice to individuals and groups outside the cabinet.

See also references under "Cabinet" in the Index.

(C. H. P.; R. F. Fe.)

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CABINET FURNITURE is the term used to describe all the varied pieces of furniture whose chief use is for storage. Even migratory peoples who had little need for seat furniture developed portable cabinet furniture, and even in cultures, such as the Japanese, in which few specialized furniture forms have developed, storage pieces are to be found.

Characteristically, a piece of cabinet furniture must have a ixed frame with a movable panel. The simplest storage pieces are boxes and similar containers. A box is formed of six sides, one of which is a lid that opens to allow access; the lid may slide or it may be fastened with hinges, hasps or catches. Boxes have been made from hide, wood, bark, metal, paper products and ceramics, sometimes covered with leather or fabric. Other containers related to the box (barrels, crates, ceramic vessels) have been used for storage; clay vessels were commonly used in most ancient cultures.

A great variety of storage furniture evolved from the box. A box that is lifted off the floor on legs, for example, becomes a chest or cabinet. Such improvements as drawers (essentially boxes within a box), interior compartments and fall fronts led to the development of specialized furniture forms such as the chest of drawers and the desk. Storage areas sometimes are incorporated into seat furniture, producing dual-purpose pieces.

Not all cabinet furniture is movable. From antiquity the practice of making storage space a part of interior architecture has persisted; such pieces often have been constructed in cabinetwork, fitted into the structure of the building.

The rest of this article is a historical survey of the forms of cabinet furniture; for the development of furniture styles *see* Furniture Design.

ANCIENT WORLD AND FAR EAST

Some pieces of Egyptian cabinet furniture have survived, and other types are known from wall paintings and bas-reliefs. The wooden box was the dominant form, often painted with repre-entations of rulers, deities and symbolic forms. The most impos-ng Egyptian boxes were the sarcophagi. Laminated wood often was used in making the tops and ends of these cases, thin riven ayers of wood being pegged together, the grain of one layer per-endicularly to the grain of adjoining layers. The resulting product was highly durable. Some sarcophagi were decorated inside nd out.

Actual pieces of cabinet furniture from the ancient near east ave not survived, but such furniture is known from extant art. As in Egypt, the box was the standard form, ranging in size up o the very large containers in which the treasures of kings were tored. The boxes (which probably were made of wood) often ere decorated with designs similar to architectural details.

Greek cabinet furniture is known both from surviving examples and from pictorial representations. The box was still the standard orm, made of wood and often painted. Coffins made in the Crimea the 4th century B.C. testify to the skill of Greek carpenters. he arched or gabled lids of these pieces were made from pegged minated wood, much in the manner of the Egyptian sarcophagi. ecoration included applied stucco or terra-cotta ornament in lief, brightly painted, and marquetry of rare woods. Pottery oxes with removable lids also were used for storage; some extant xamples are decorated with red-figured paintings, like those found n Greek table pottery.

Roman furniture is known from surviving pieces as well as from presentations in fresco and vase paintings. Boxes varied in size p to large wooden chests for storing money and clothing. Treasure chests, also made of wood, covered with bronze plates or bound ith iron, had hinged lids secured by heavy locks. Paintings of hests found at Pompeii show that the Romans were familiar with amed paneling; *i.e.*, panels filling in a rigid structural framework, stened with dowels or pegs. Previously the size of a chest had een limited by the size of its surface planks; with the framed-neling technique, however, larger surfaces, of lighter weight, uld be assembled. Chests often were supported on lion feet. all paintings at Pompeii show cupboards, apparently attached to e walls, with paneled doors and, probably, shelves inside.

Chinese furniture is portrayed in very early paintings, and so little change in style has occurred through the centuries that the forms are difficult to date. Many Chinese boxes are made of hide, stitched at the corners, but Chinese boxes of black lacquer from the 8th century are preserved in the Shōsō-in (the imperial museum at Nara, in Japan). Cabinets, chests and desks were made in red and black lacquer. Cabinet pieces also were constructed of a variety of hardwoods, sometimes inlaid, lacquered or carved. Chests and large cupboards, masterpieces of careful joinery, were decorated with brass and bronze pulls, hinges and mounts. An important piece of furniture was the scholar's desk, sometimes a writing table with drawers, on high legs, sometimes a table with compartments and drawers extending down to the floor. Boxes and chests for storing books and writing equipment were used as supplementary desk furniture. Cabinet furniture in Korea was similar to Chinese.

Fewer specialized furniture forms were developed in Japan, and those were easily movable. The box, made from basketry, lacquer or wood, was standard, though with many variations. The stationary desk, evolved from the low table, was an extension from a bay window, with a writing surface and compartments for holding writing equipment.

EUROPE AND AMERICA

Middle Ages.—As late as the mid-12th century chests that were set up in churches to collect money were often mere tree trunks, hollowed out by chopping, chiseling or burning; lids, if they existed, were made of rough, heavy boards. Five massive and unique chests from the 12th century, preserved in the Valère Castle church in Valais canton, Switz., are constructed of wide timbers secured with broad-headed nails and stand on four heavy legs; they are decorated with elaborate chip carving and open Romanesque arches. Chests of the period sometimes were covered with leather, bound with iron straps or scrollwork, inlaid, carved or decorated with painted plaster reliefs, though more often they were undecorated. Easily transportable and readily procurable, chests were the most widely used pieces of furniture of the middle ages, in contemporary illuminations often seen arranged around walls, and used for both seating and storage.

When framed paneling came into general use at the beginning of the 15th century, in the Burgundian Netherlands, cabinet furniture design began to evolve rapidly, culminating in this era in the upright cupboard, usually containing shelves and sometimes doors. The drawer was an innovation of the 15th century, originating probably in Burgundy or Flanders as a small portable chest installed inside a larger piece of cabinet furniture. The armoire, a movable cupboard fitted with doors, shelves and sometimes drawers and most often used for storage of clothing, also probably developed during this period. The desk, a box fitted with a hinged lid and placed upon legs, also began its evolution during the middle ages. Dual-purpose furniture began to develop, chairs and tables sometimes containing compartments or drawers for storage.

Renaissance.—The Renaissance style in furniture, beginning in Italy, showed a strong architectural influence: the function of a piece often was subordinate to its design. The box persisted in an important form known as the *cassone*, a marriage coffer used for storing the household linens that formed an essential part of the bride's dowry. These magnificent coffers, with bold and massive feet shaped like lions, other animals or claws, were raised on low platforms. They were richly adorned with carving, gilding, intarsia or gesso, and commonly were painted inside and out with scenes from the Bible or classical mythology. The family arms often were emblazoned on the front. The desk evolved further; in some instances a slant-top box was put atop a frame, other examples contained drawers below a flat surface. Large storage cupboards, sometimes in plain walnut, sometimes painted and gilded, were widely used; painted cupboards were commoner in the early Renaissance, carved ones later. Cupboards contained shelves above, sometimes concealed behind small doors; a large open shelf in the middle; and shelves below, also concealed by doors. Very large cupboards were made in two pieces.

The style of the Italian Renaissance, of course, soon came to affect the design of cabinet furniture in France and the Low Countries, though French furniture of the 16th century tended to be more delicate than the Italian. Chests remained an important form, their ornament often showing the influence of the designer Jacques Androuet du Cerceau. Cabinet pieces were inlaid with coloured woods, semiprecious stones, ivory, nacre and marble. Large cupboards were architectural in form. The armoire, which now came into wide use, was a tall, movable cupboard (the ancestor of the wardrobe) made in two sections, the top fitted with many small drawers, the bottom containing shelves, concealed behind one or two large doors, for storing clothing.

A cabinet piece common in Spain was the vargueno, a chest of drawers placed on a high wood and iron frame. Its drawers were concealed behind a fall front, strap-hinged with iron or bronze, which, when dropped, became a writing surface. The drawer fronts were often painted and the front sometimes was painted and inlaid with woods and ivory. The vargueno combined Moorish decorative elements with an essentially Renaissance structural form.

The furniture of England did not come under Italian Renaissance influence until about 1520, and even then the influence was seen mainly in superficial italianate decoration on essentially medieval forms. Workmen from the continent brought with them new ideas, however, and by the middle of the 16th century an individual English style was beginning to evolve. Enrichment of flat surfaces by painting, inlaying or carving was characteristic. The chest remained an important cabinet piece, a well-known type being the Nonesuch chest, the front of which was decorated with a representation of Nonesuch palace in parquetry. Because of their resemblance to German chests inlaid with architectural scenes, it is believed that these were made in Germany or by German workmen. They were largely responsible for the popularity of inlaid furniture in England.

Toward the end of the 16th century the court cupboard began its evolution. This was a large piece, usually in two sections, each with open shelves, for the display of plate and other important possessions. The earliest examples had heavy, turned baluster supports and often were intricately carved. A chest with drawers began its evolution toward the end of the century. Desks generally were merely portable boxes placed on tables or frames.

Baroque.—The 17th-century baroque ideal, as reflected in furniture, required that a piece be conceived as a single unit, all its design elements contributing to a harmonious total effect. The play of light and shadow over the surface was an important design consideration, and broken pediments, heavy moldings and twisted columns were borrowed from architecture. The influence of the orient was strong during this period. Lacquer furniture, screens and boxes began to be imported into Europe from India and the far east, and panels and pieces of oriental lacquer were incorporated into case pieces made in Europe. By the end of the 17th century lacquer pieces imitating eastern products were being made in Europe. Tropical woods also were imported and used in furniture making. Italian cabinets and cupboards of walnut and ebony had heavy, richly carved framework and panels inlaid with marble and semiprecious stones, the entire piece being supported by heavy, turned legs, numbering four to eight. In Flanders massive cupboards with four doors, two above and two below, were made from oak, elaborately carved and inlaid. The linen-press, developed at this time in Flanders or Holland and usually made of oak, was a contrivance for pressing napkins, sheets and other linen articles.

During the late 17th and early 18th century André Charles Boulle (*q.v.*) designed and built cabinet furniture veneered with tortoise shell or exotic woods and inlaid with brass or ivory, and though other craftsmen executed pieces in the same style, Boulle's name is generally associated with this furniture. Boulle's case pieces included the cabinet, cabinet-on-frame, desk, chest of drawers and coffer. The workmanship was of the highest quality, and pieces often were embellished with heavy gilt mounts that protected the corners.

In England significant changes and developments in furniture design did not occur until after the middle of the 17th century. The taste for oriental lacquers became widespread, and a process of imitating these works, called japanning (*q.v.*), was developed. In 1688 John Stalker and George Parker wrote *A Treatise on Japaning and Varnishing . . .* , which included patterns for designs as well as a description of the process. Cabinets-on-stands japanned or with oriental panels incorporated, generally had two doors concealing numerous small drawers or compartments. The cabinet rested on a carved and sometimes gilded or silvered stand

During the reign of William and Mary the taste of the Low Countries was brought to England by the court and the workmen they imported. The chest-on-frame, often called a highboy, a chest of drawers resting on a frame that held it above the floor, was an important form, commonly made of walnut wood. Drawer fronts were inlaid and surfaced with veneer made from walnut burl drawer pulls shaped like teardrops, and engraved quatrefoi escutcheons, further ornamented the drawer fronts. The base o the chest had four or six trumpet-shaped, turned legs connecte by flat stretchers. The dressing table, sometimes called a lowboy, a cabinet form closely resembling the lower section of the chest-on-frame, was made in one piece, and had drawers and trumpet-shaped legs and stretchers. Writing furniture was developed in a variety of forms. The chest with a desk enclosed, the latter fitted with pigeonholes and small drawers, was one of the most ingenious types.

At the beginning of the 18th century, during the reign of Queen Anne, another style influenced by the contemporary furniture o Holland came into fashion. Ornamentation was reduced to minimum, and curved lines began to replace the square lines of th William and Mary period. The cabriole leg, derived from th curve of an animal's leg, adapted from classical styles, and terminating in a pad, trifid or ball-and-claw foot, became the standar furniture support. Stretchers, commonly seen on earlier pieces o cabinet furniture, were discarded. The chest-on-frame and dressing table remained standard forms, differing from their predecessors chiefly in their simplicity and in the use of the cabriole le with no stretchers. The double chest of drawers, made in tw parts with drawers above and below, was an innovation. In som pieces the drawers extended to the floor; others were elevated o short cabriole legs. The desk contained an inner compartmen of pigeonholes and drawers, the front usually falling to form writing surface; drawers were set in below and the whole reste on cabriole legs.

American colonial furniture in the 17th century varied fro one region to another according to the nationality of the settlers though English furniture design was predominant. The chest o drawers, chest-on-frame, dressing table and desk made in Americ were conceived in the forms of pieces being made in England, bu since there was a lag in the transmission of styles, America wa always behind the current English taste. Some of the colonia pieces were of high style and as fine as anything made in London others, made by less skilled craftsmen, had a naïve provincia quality.

Rococo.—*France.*—The rococo style—one of the leaders i which was Juste Aurèle Meissonier (*q.v.*), designer, architect, goldsmith and sculptor—characterized by great delicacy, movemer and asymmetry, directly affected French furniture design onl from about 1735 to 1765. The central features of the style wer the use of the C-curve and the S-shape. With this were combined ribbons, trophies, floral and shell motifs. The cabriole le was refined to great delicacy and lightness. Chinese themes wer popular, and pagodas, waterfalls, birds and Chinese figures ar common decorative motifs.

Charles Cressent (*q.v.*), a pupil of Boulle, was the leading exponent of the *régence* style, excelling in the quality of ormol (brass made to imitate gold) mounts he applied profusely to furn ture. During the *régence* period also marquetries of coloure woods began to replace ebony and ebonized woods.

The commode, derived from the late 16th-century Italian ches was one of the most important furniture forms, developed i France between 1705 and 1710 and made in quantity by 172 The commode contained three large drawers (the technical joinery problems involved in making large drawers having now bee overcome) running the width of the piece, with a row of smaller drawers above. The *bombé* or swollen shape was introduced at this period, the curvilinear form being incorporated into the body of the piece as well as applied to externals such as legs or tops. The sides and front of a *bombé* commode undulated in sinuous curves, and the drawers were generally so well fitted that only a hairline betrayed their existence. This form was adopted and further enriched by rococo cabinetmakers. Chinese lacquer panels or marquetry inlays were incorporated into the front of the *bombé* commode, the top was marble, and the corners and legs were covered by ormolu or silver mounts, the most celebrated makers of which were Jacques and Philippe Caffiéri (*see* CAFFIÉRI).

The desk or *secrétaire*, another important form, was characterized by a drop front that, when dropped, served as a writing surface and, when closed, concealed small drawers arranged in rows; below was a door or doors concealing shelves or drawers. The tambour—a sort of flexible shutter made of thin strips of wood glued to cloth and running in a groove—which developed at this time was sometimes incorporated into the *secrétaire*. The movable bookcase, inlaid and mounted with ormolu, evolved during the Louis XV period.

The writing table, which began to appear at the end of the *régence* period, usually had three drawers, the whole piece being supported on four cabriole legs. The top was covered with leather or coarse woolen cloth called *bure*, from which the French word for desk, *bureau*, was derived. A *cartonnier* or set of shelves or drawers sometimes formed an integral part of the bureau, but more commonly it was a separate piece set on the bureau top. The cylinder-top bureau, the original roll-top desk, was a development of rococo cabinet furniture. Incorporated into the front of this type of bureau was a sliding door of tambour construction that could be pulled back to reveal a set of drawers and shelves. Slides could be pulled out and used as writing surfaces. The cabriole legs of the bureau were ornamented with gilt mounts.

Cupboards had glass-paneled doors opening upon an interior fitted with shelves. The corner cupboard, originally intended for utilitarian purposes, by the middle of the 18th century had become an elegant piece of drawing room furniture. These cupboards, of the same height as the commode, were essentially riangular in shape, supported on three or four short legs, with marble or wooden tops; they were inlaid or decorated with lacquer and had elaborate metal mounts.

England.—In England during the early 18th century the influence of the continent could be observed in the furniture designed by the architect William Kent (*q.v.*). The essential lines of his pieces were classical, in keeping with the architecture of the Palladian houses they were designed to grace; the ornament was ntricate, curvilinear and baroque. Kent designed chests of drawers, organ cases and desks as well as tables, chairs and room ineriors.

Although there was resistance to rococo in England, by 1740 it had begun to appear. The commode remained an important form, varying from a simple chest containing three drawers to a piece hat incorporated swell fronts with doors and drawers, the whole upported on elaborate cabriole legs. The chest-on-chest (highboy nd tallboy), generally made in two sections, had drawers above nd below. The clothes cupboard, a closely related form, had in its upper part doors, behind which were shelves or drawers, and in its lower part drawers. Both the chest-on-chest and clothes upboard generally rested on four bracket feet.

Library furniture was developed in great profusion. The desk had several forms, the chief being the bureau-bookcase and writing r library table. The bureau-bookcase had a case with two doors (either glass-paned or solid) and interior shelves above; the botom had a fall front (which formed a writing surface) concealing nterior compartments and, below this, drawers. The feet were f the bracket variety, or the whole rested on cabriole legs, ornamented in the French (rococo), Gothic or Chinese style. The writing or library table, related to the French bureau, had a flat op utilized as a writing surface, an empty space in the centre elow (which allowed a chair to be drawn up) with drawers on ither side; sometimes these were wide enough to be used by two persons, one on either side. The English bookcase was more strongly architectural than was the French model, having a pedimented top, a frieze above large doors that protected interior shelves, and doors or drawers below; sometimes a fall-front desk was incorporated into such a piece. The cabinet-on-stand often was constructed in the Chinese style, in imitation of a Chinese cabinet.

Mahogany was the favoured wood for English furniture of the period, having been first imported about 1720 and quickly replacing walnut. Much provincial furniture, however, was made from oak and yew, executed in a simplified version of the high style of the day.

Colonial.—France and England were the two most important countries in setting taste, and their influence was to be seen in almost all European countries. Colonial furniture showed the influence of the mother country. In America the English rococo was the dominant style, and Boston, Newport, New York, Philadelphia and Charleston produced mahogany furniture that ranked with the best made in London. The furniture of Boston, Philadelphia and Charleston was noted for its profuse decoration—indeed, the richness of the carving on Philadelphia case pieces has not been surpassed in American furniture—and strict adherence to London models; that of New York and Newport was plainer and more amply proportioned.

An important innovation in cabinet furniture was the block front, developed by the cabinetmakers of the Goddard and Townsend families (*see* GODDARD AND TOWNSEND) of Newport, R.I. The blocking was formed by the contrast of a raised area against a recessed area. The grain of the mahogany was accentuated and the play of light and shadow over the front produced a dazzling effect. The chest, chest-on-chest, desk and dressing table, when made with a block front, generally had little carving or other wood ornamentation.

Neoclassicism.—*Early.*—With the development of the neoclassic spirit in furniture design—in which the architect Robert Adam (*q.v.*) was one of the most important figures—the commode lost its serpentine shape and developed a semicircular front with veneered, inlaid or painted decoration. The bookcase retained much the same shape as its rococo predecessor, but classical decorative motifs were imposed. The wardrobe, desk, chest-on-chest and chest of drawers persisted in the new style.

One of the most important new developments was the sideboard, evolved from the side or serving table. Intended for use in the dining room, both for serving and for storing serving utensils, it contained drawers and compartments and had four or six tapered or turned legs. In some examples, at the rear of the wooden top there was a brass railing on which towels and napkins could be hung. Hepplewhite and Sheraton designed knife boxes, square or urn-shaped receptacles containing compartments for cutlery, to stand either on the sideboard or on pedestals beside it. A form associated with the sideboard and knife box was the cellaret ("little cellar"), a wooden box with zinc partitions holding ice; wine bottles were placed in it for chilling. The cellaret might be an integral part of the sideboard, concealed inside a drawer or compartment, or a separate box designed to be used near the sideboard. It usually contained a tap through which melt water could be withdrawn.

Many specialized case forms associated with personal grooming began to develop: dressing tables, wash stands and shaving stands containing ingeniously designed compartments that pulled out or folded back.

American furniture was much under English influence, and the books of Hepplewhite and Sheraton (*qq.v.*) were widely used by colonial craftsmen, who often constructed remarkably exact interpretations of the designs. Salem and Baltimore became important centres of furniture manufacture, the cabinet pieces made by Samuel McIntire of Salem being among the finest examples of American furniture of the period. Baltimore excelled in the production of painted furniture; on a background of red, black or white, colourful floral decoration was executed around panels on which were painted scenes from classical mythology. The New York cabinetmaker Duncan Phyfe produced the most highly individual neoclassical furniture, utilizing a unique combination of classical elements.

In France, neoclassicism was beginning to be noticed by the middle of the century, but it was not seen in furniture design until the 1760s. At first, classical ornament was sparingly applied to essentially rococo shapes; then the curved shapes began to straighten and eventually became rectilinear. The *bombé* form disappeared from commodes and legs became straight, tapered and fluted. Marquetry, now of classical inspiration, was popular, as were ebony and oriental lacquer panels. Boulle marquetry, which had dropped out of fashion during the Louis XV period, was revived. French cabinet furniture forms were essentially rococo and less original than the English. The commode, *secrétaire,* bookcase and corner cupboard were important pieces.

The influence of the Louis XVI style was felt all over Europe, and excellent furniture in this style was produced in Germany, Denmark, Sweden and Italy.

Empire.—In the Empire style, which began to evolve at the end of the 18th century, few new cabinet forms were developed. The commode, severely rectilinear, with drawers or doors concealing shelves or compartments, remained a basic form. Commode tops were of marble or wood, and gilt mounts were used along with painted and inlaid decoration. The bureau now developed as a form separate from the *secrétaire.* Both were desks, the former a low piece related to the writing table, the latter a tall cabinet piece with a fall front. Tall chests of drawers, bookcases and corner cupboards were all characterized by heavy application of classical ornament.

In the United States the Empire style was widely adopted, New York being the great centre of cabinetmaking. Duncan Phyfe (*q.v.*) developed from neoclassicism to the severe classicism of the Empire; his case pieces of this period, heavy and ornately carved, lost the individual quality of his earlier products. Craftsmen who came to New York from Paris produced cabinet furniture that closely followed French models of the day. One of these was Charles Honoré Lannuier, whose case pieces are characterized by use of French gilt mounts and metal inlays.

Regency.—An important name associated with severe classicism or the Regency style in England is that of Thomas Hope, who in 1807 published *Household Furniture and Interior Decoration.* His massive case furniture included bookcases, chests of drawers, commodes and desks. George Smith's *Cabinetmaker and Upholsterer's Guide* (1826) contained designs for sideboards, wardrobes, commodes, bookcases and *secrétaires,* richly carved with classical ornaments and often touched with gilt. The inclusion in this work of a low desk called a lady's *secrétaire,* distinct from the large bookcase *secrétaire,* heralds the era of greater specialization that was to develop in the 19th century.

Biedermeier.—Provincial Biedermeier-style furniture, produced in Germany and Austria from about 1815 until the middle of the 19th century, was characterized by use of geometric shapes and by freedom from excessive detail. Typical cabinet pieces, made from fruit woods, mahogany, oak and birch, were chests of drawers, bookcases, commodes, desks and small toilet pieces, exhibiting gracefully curved lines.

Romanticism and Revivalism.—Gothic revival furniture (which had begun to appear in the late 18th century) was characterized by the use of the pointed arch and of ornaments derived from architecture; hence the feeling of the case pieces was primarily architectural and they were heavy in general appearance even though the ornamentation or tracery might be delicate. Among the important designers of furniture in this style was A. W. N. Pugin (*q.v.*), better known as an architect. Gothic revival furniture was more popular in England than in France; in the United States it remained in fashion until the middle of the century. Andrew J. Downing included Gothic interiors and furniture in his influential *Architecture of Country Houses* (1850), showing monumental sideboards, bookcases, chests of drawers and desks that combined a multitude of details from many sources.

A revived interest in the orient began to manifest itself during the first decade of the century; India and China were sources of inspiration for cabinet pieces made from bamboo and lacquer or japanned panels, and Turkey and the near east inspired cabinet furniture made from dark woods and inlaid with mother-of-pearl and ivory. French revivals—Louis XIV, XV and XVI—were familiar, although not always accurate. The use of power machinery in the production of most of this furniture caused it to be coarse and to lose the qualities of individuality the originals possessed. Other revivals—Renaissance, Tudor, Norman, Italian, Elizabethan—produced new versions of the *cassone,* armoire, court cupboard and other pieces that were most unlike their models in the detail that was applied to them.

MODERN TRENDS

19th Century.—Innovations in cabinet furniture design began to appear around the middle of the 19th century. In New York city, John Henry Belter (generally in Louis XV style) made drawer fronts of laminated wood, which was stronger and allowed more intricate carving than did solid wood. A variety of storage pieces, from small boxes to commodes, was made from papier-mâché, sometimes inlaid with mother-of-pearl, painted or gilded. Mechanical furniture appeared, a single piece of which might serve several functions; in 1864 a portable camp chest that was a storage piece, chair, lounge and table was patented in the United States.

By the 1870s aestheticism, drawing its inspiration from the orient, especially Japan, became a dominant English trend, and the furniture it produced was light, delicate and based on straight lines. E. W. Godwin and Christopher Dresser were exponents of this style; Godwin's cabinets, bookcases and sideboards were light and simple in line. In the latter half of the century, the arts and crafts movement (*q.v.*) produced cabinet furniture that was free from the fussy detail of revival furniture. Some of the cabinets-on-stands designed by William Morris, although based on Gothic predecessors, showed a remarkable simplicity and restraint of line. The Globe-Wernicke sectional bookcases—which are considered the forerunners of modern "unit" furniture and which were developed toward the end of the 19th century and continued in use into the 20th—had glass doors that could be lifted and slid into the body of the case. *Art nouveau* (*q.v.*) was represented in furniture characterized by severe curvilinear surfaces and a use of asymmetric inlay and carving; leading designers of *art nouveau* cabinet pieces were Henry van de Velde, Victor Horta, Émile Gallé and Hector Guimard.

20th Century.—Throughout Europe and America simpler cabinet shapes began to appear. Handicraft traditions were allied to modern designs in many elegant and handsome variations, culminating in the Paris style of the 1925 Exhibition of Decorative Arts. At the turn of the century in the United States the arts and crafts movement was reflected in the Mission style, using predominantly oak wood, straight lines and heavy proportions. The early furniture designed by Frank Lloyd Wright, a leader in producing cabinet furniture, often built-in, that was harmonious with architecture, was related to that of the arts and crafts. In spite of arts and crafts, however, machine productions became a dominant factor in furniture design in the early part of the century, being advocated by such an influential institution as the Bauhaus (*q.v.*). Cabinet furniture made under this influence was undecorated, with highly polished wooden surfaces; Marcel Breuer, among others, designed furniture of this type to be used in his own architectural settings. By the 1940s Scandinavians were leaders in furniture design. Plywood was used in the construction of cabinet pieces by the Finnish designer Alvar Aalto; machine production introduced panel plastics into furniture construction in America, and molded plastics also were used in manufacture of drawer trays, a notable structural simplification.

The trend toward making storage areas part of interior architecture has been dominant throughout the century, at the expense of cabinet work. Large wardrobes and sideboards in particular have tended to disappear from the selections of available cabinets.

See also DESIGN.

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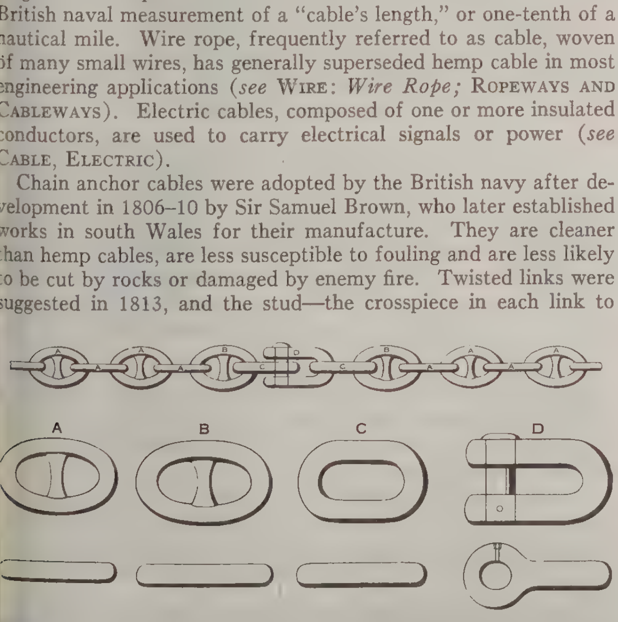
CABLE, GEORGE W(ASHINGTON) (1844–1925), U.S. author and reformer, noted for novels and stories dealing with life in New Orleans, was born in that city on Oct. 12, 1844. His first books, *Old Creole Days* (1879), a collection of stories first published in *Scribner's Monthly,* and a novel, *The Grandissimes* (1880), marked Creole New Orleans as his literary province and were widely praised. These works recaptured in a delicate gallicized prose and with a whimsical play of imagination the picturesque scene and the tone of life in the old French-Spanish city. Yet they employed a realism new to southern fiction. Though Cable was the son of slaveholders and fought in the Confederate cavalry, he came to see slavery as a moral wrong and held the same view of attempts to deny the freedmen full public rights. Thus his early fiction draws strength and urgency from the overtones of moral condemnation in his handling of caste and class and authorized oppression, whether before or after emancipation. He used essays and public lectures to urge the cause of Negro rights, in the face of violent abuse in the southern press, and he published two collections of his social essays, *The Silent South* (1885) and *The Negro Question* (1890). He abandoned the effort only after race discrimination in the south had become entrenched. In 1885 he settled in Northampton, Mass. Novels set mainly in the south came from his pen until he was past 70, but though better constructed they lacked the freshness and charm and also the force of moral conviction that characterized his early books. Cable died in St. Petersburg, Fla., on Jan. 31, 1925.

See Arlin Turner, *George W. Cable: a Biography* (1956), which contains an extensive bibliography. (A. Tr.)

CABLE, originally a rope, made of hemp or other material, of relatively large diameter; the term subsequently was applied to the heavy chain used with ships' anchors. Although this article deals primarily with chain cable, the old usage whereby the length of a hempen anchor cable was 101 fathoms survives in the British naval measurement of a "cable's length," or one-tenth of a nautical mile. Wire rope, frequently referred to as cable, woven of many small wires, has generally superseded hemp cable in most engineering applications (*see* WIRE: *Wire Rope;* ROPEWAYS AND CABLEWAYS). Electric cables, composed of one or more insulated conductors, are used to carry electrical signals or power (*see* CABLE, ELECTRIC).

Chain anchor cables were adopted by the British navy after development in 1806–10 by Sir Samuel Brown, who later established works in south Wales for their manufacture. They are cleaner than hemp cables, are less susceptible to fouling and are less likely to be cut by rocks or damaged by enemy fire. Twisted links were suggested in 1813, and the stud—the crosspiece in each link to prevent the chain from kinking—was introduced in 1816.



IG. 1.—TWO LENGTHS OF CHAIN CABLE COUPLED BY A "JOINING SHACKLE"
The end links (C) are made without studs in order to take the shackle. The djacent links (B) are made larger to take the big studless links. The shackle (D) is shown. The bolt of the shackle is secured by a steel pin and lead pellet

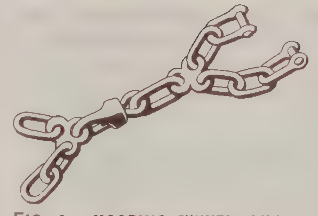
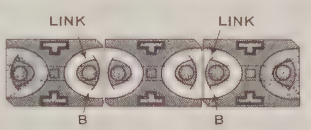


FIG. 2.—MOORING SWIVEL, PUT IN THE CABLES OF A WARSHIP WHEN SHE IS RIDING BY TWO ANCHORS, TO PREVENT THE CABLES FOULING EACH OTHER AS THE SHIP SWINGS

In manufacturing iron chain cables, the bars are cut to the required length of link, at an angle for forming the welds and, after heating, are bent by machinery and welded, each link being inserted in the previous one before welding.

Iron chain cable has largely been replaced by cast-steel, high-strength welded steel and a forged steel known as Die-Lock (links locked together in dies). All three types have a high elastic limit and can withstand great shock. Die-Lock and welded-steel cables, being stronger and lighter than iron, are standard in the U.S. navy and widely used in the merchant marine.



FROM AUSTIN M. KNIGHT, "MODERN SEAMANSHIP," 12TH ED., © 1945, D. VAN NOSTRAND COMPANY, INC.

FIG. 3.—MOLD FOR CAST-STEEL CHAIN

Distinguishing features of cast-steel chain are solid studs that are an integral part of the links and the absolute identity of each common link in the shot. Some types of high-strength welded-steel chain are constructed with alternate solid forged links that have integral studs, every other link having the stud welded in place. In Die-Lock chain the studs are also an integral part of the link, though they are split down the middle. A great advantage of cast-steel, Die-Lock and high-strength welded-steel chain is that the studs cannot fall out, thus eliminating the pounding of the links one on another and the danger of kinking.

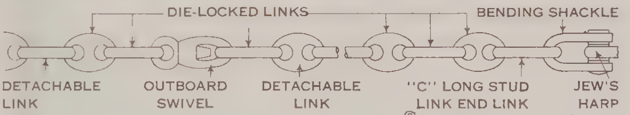


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FIG. 4.—OUTBOARD SWIVEL SHOT, DIE-LOCKED ANCHOR CHAIN

Chain cable is manufactured in lengths of 15 fathoms (90 ft.) known as shots, or in the British navy as "shackles of cable." Various types of connections are used to join the individual shots together and to connect the outboard end to the anchor and the inboard end to the chain locker of the ship. The U-shaped shackle and pin is not now as widely used as various types of detachable links. In general, these consist of interlocking or coupling plates held together by a stud and taper locking pin.

To indicate the amount of cable out, appropriate links are marked with white paint and with wire windings on the studs.

Ships ride to their cables by use of the brake band on the windlass or cable holder, using a chain stopper, guillotine or compressor. The cable is hove in by a power-driven windlass. (M. O'N.)

CABLE, ELECTRIC. Electric cables are usually used to transmit either power or information. An electric power cable transmits electrical energy from the point where the energy is generated to the point where it is used. The function of an electric communication cable is to transmit information, by electrical means, from one point to another. Descriptive terms, many of them self-explanatory, are frequently associated with the word cable, indicating its construction or use. Power cables may be described as bare (uninsulated), insulated, armoured, oil-filled, gas-filled, pipe type, or as dredge, service drop, vertical riser, etc. Communication cables are described as coaxial, telephone, telegraph, control, etc. The terms aerial, underground and submarine may refer to either power or communication cable. There is no clear distinction between an electric wire and an electric cable. Usually the former refers to a single, solid metallic conductor, with or without insulation, while the latter refers to a stranded conductor, or to an assembly of insulated conductors.

Power Cables.—Probably the simplest, as well as the most common, type of electric power cable is that which is suspended overhead between poles or steel towers. These cables consist of a number of wires, usually of copper or aluminum, twisted (stranded) together in concentric layers. Copper or aluminum is chosen for high electrical conductivity, while stranding gives the cable flexibility. Overhead cables are frequently subjected to severe mechanical stresses by high winds, or by the accumulation of sleet, or both. Because copper and aluminum do not possess high mechanical strength, alloys of copper or aluminum are sometimes used. Alloying increases the strength of the cable, at some detriment to its electrical conductivity. A more common solution of the problem is to include in the stranded assembly of a copper or aluminum cable a number of high-strength steel wires. The steel wires are protected from corrosion by a coating of zinc, copper or aluminum applied directly to the individual wires.

Many overhead cables, especially those operating at high voltages, have no insulating or other coverings. Cables operating at lower voltages frequently have coverings of asphalt-saturated cotton braid, Neoprene or polyethylene. These coverings offer some protection against electric shock to personnel accidentally contacting the line, and prevent short circuiting in case of temporary contact between the line and a grounded (earthed) object.

An equally important but less conspicuous type of electric power cable is installed in underground ducts, and is extensively used in cities where lack of space or considerations of safety preclude the use of overhead lines. The conducting element of such a cable is similar to that of the overhead cable, except that commercially pure copper or aluminum is invariably used (mechanical strength is not a problem underground), and the stranded conductor is frequently rolled to modify its shape and compactness, resulting in a cable of maximum electrical conductance and minimum size.

The conductors of any cable that is frequently or permanently in contact with grounded objects must be insulated throughout their length to withstand the full operating voltage. Cable insulations are usually thermosetting materials (natural rubber, silicone rubber, butyl, Buna S), thermoplastics (polyvinyl chloride, polyethylene), varnished cambric or oil-impregnated paper. Where high temperatures are encountered, insulations consisting wholly or partially of inorganic materials such as asbestos or fibre glass may be used. The thermosetting and thermoplastic insulations predominate for cables operating at 5,000 v. or less. Oil-impregnated paper insulation is usually used for cables of intermediate voltage, and is used almost exclusively for cables operating above 35,000 v. The required insulation thickness is dependent mainly on voltage, and may vary from about $\frac{1}{32}$ in. to 1 in.

The insulation of high-voltage oil-impregnated paper insulated cables must be maintained under pressure. Such cables are provided with longitudinal channels through which pressure is transmitted from pumps or other auxiliary equipment at the cable terminals. In an alternate design, the insulated conductors are installed in a steel pipe. The pipe is subsequently filled with oil which serves both as an insulating and a pressure-transmitting medium.

An insulated electric cable requires a covering over the insulation to protect it from mechanical abuse, moisture and other detrimental influences. A seamless lead or lead alloy tube (sheath) is extensively used as a protective covering for underground cables. For less exacting conditions, when greater flexibility is necessary, or for insulations less susceptible to moisture, protective coverings may be of nonmetallic materials, including impregnated fabric braids (in dry locations only), Neoprene, or one of the thermosetting and thermoplastic compounds already mentioned as insulations. Various combinations of metallic and nonmetallic materials are also used, the metallic part providing the primary moisture barrier and the other materials protecting the metallic part from damage, especially from corrosion. When exceptionally severe mechanical abuse is anticipated, additional coverings (armour) of saturated jute and steel tape, or of steel wire, may be applied as the final outer layer.

Some of the cables described above are suitable for overhead use, and such installations are common in suburban areas. The cables are rather heavy and have inadequate longitudinal strength; hence they are lashed to a high-strength cable (called a “messenger cable”) which provides the necessary support. Telephone cables are also frequently installed overhead in a similar manner.

These overhead and underground power cables comprise a major portion of the electrical circuit from the generator to the point of utilization of the electric power. However, the balance of the circuit (and sometimes the entire circuit) may require specialized cables. Illustrative of these usages, and the special conditions to be met are: cables for steel mills, boiler rooms and electric furnace operation (high temperature); cables on mobile equipment (vibration); shipboard cables; cables in chemical plants (corrosion); submarine and mining cables (mechanical abuse); and portable cables for many uses (excessive flexing). Cables for use near nuclear reactors and in guided missiles and artificial satellites must withstand various types and intensities of radiation and extremes in temperature and pressure.

Communication Cables.—Cables used to transmit information are quite different from power cables, both in function and in design. Power cables are designed for high voltages and high current loads, whereas both voltage and current in a communication cable are small. Power cables operate on direct current or low-frequency alternating current. Telephone cables operate at higher frequencies, and coaxial cables used for radar, television and many other communication services may have to carry frequencies up to 10,000 mc. per second. A power cable usually has not more than three conductors, each of which may be 1 in. or more in diameter; a telephone cable may have several thousand conductors, the diameter of each being less than $\frac{1}{20}$ in.

The insulation of telephone cable is almost invariably of dry cellulose (in the form of paper tape wrapped around the conducto or paper pulp applied to the conductor) or of polyethylene. The insulation thickness is a few hundredths of an inch or less.

The conductors of a control cable are usually fewer in number, larger in size and more heavily insulated than those of a telephone cable.

A coaxial cable is a two-conductor cable in which one of the conductors takes the form of a tube while the other (smaller but also circular in cross section) is supported, with a minimum o solid insulation, at the center of the tube. Several of these coaxial units, along with other types of communication conductors may be assembled within a common jacket or sheath. (For additional information on coaxial cable, *see* Radar.)

Protective coverings for communication cables are similar t those for power cables. They usually consist of an aluminum o lead alloy tube, or a combination of metallic strips and thermoplastic materials.

The construction of long submarine cables for either telephon or telegraph service is somewhat different from that indicate above. Such cables usually have a single solid or stranded central conductor insulated with gutta-percha or polyethylene, ove which may be applied a concentric outer conductor, followed b layers of asphalt or tar-impregnated jute roving and high-strength steel-wire armour. *See* also Cable Laying, Submarine; Electri Power: *Transmission;* Insulating Material (Electrical) Telephone; Telegraph. (L. E. Fo.)

CABLE LAYING, SUBMARINE. Submarine cable is transmission line of one or more conductors, suitably insulate and protected, for carrying electrical signals (telegraph, telephone etc.) or electrical power under water. Its installation is calle submarine cable laying.

Laying of the first successful transatlantic telegraph cable wa completed on July 27, 1866, from Heart's Content, Newfoundland to Valentia, Ire., by the famous steamship “Great Eastern.” Sinc that time submarine telegraph cables have been laid all over th world.

Submarine telephony was well established early in the 20th century but was limited to short, unrepeatered cables laid in shallow water. (The repeater is an amplifier inserted in the circuit t maintain the strength and fidelity of the signal.) The first sub merged repeater installation was made in 1943 on a coaxial submarine telephone cable between Anglesey, Wales, and the Isle of Man. The first transoceanic telephone cable system, consisting of two submarine links, was completed in the mid-1950s, one link from Clarenville, Newfoundland, to Oban, Scot., and the other from Terrenceville, Newfoundland, to Sydney Mines, Nova Scotia.

Submarine cables are made up of a core of one or more conductors, suitably insulated, which is covered and protected by layers of jute and armour. The core insulation must be able to withstand, without deformation or damage, the compressive and tensile strains to which it is subjected, and it must be electrically and physically stable after prolonged immersion.

Until the late 1920s a natural gum material called gutta-percha was used as insulation. Subsequently, improved substitutes, such as deproteinized rubber and polyethylene, were developed. The treatment and covering applied to the core of cables is varied to suit expected environmental conditions, but in any one cable run, the core is unchanged throughout its entire length. One or more layers of jute yarn is applied over the core to prevent damage by cutting action of the armour. The jute is given a chemical treatment known as cutching to guard against microbiological attack. Protection of the core insulation from marine borers may be provided by applying an overlapped thin metallic copper tape under the jute. Armour wires are applied over the bedding jute, followed by outer jute servings. All jute and armour applications are flooded with asphaltum tar compound.

The metallic elements of a cable are applied with a left-hand direction of lay to assure satisfactory handling characteristics. Directions of lay of the jute layers are similarly chosen. Fig. 1 shows the essential difference between the armour types employed and the approximate range of depths in which each is used. Mild-steel armour is used in the intermediate depths primarily to achieve weight and substance and thus withstand wear and damage. In deepwater cable, high-tensile steel armour is needed to withstand the strain of handling at great depths.

A cable-laying ship is specially outfitted for its unique function. It has an overhanging bow with three cable sheaves. On the stern is a paying-out cable sheave equipped with tanks which contain the supply of cable. During loading, the cable is carefully coiled by hand, layer by layer, in the tanks. The maximum capacity of the tanks is almost 2,000 mi. of deep-sea cable. Cable is generally laid at a ship speed of three to eight knots.

Shore ends of cable are necessarily laid by barges and tugs or by the cable ship's boats. Usually the route to be followed is marked by buoys. The cable joining the shore ends is laid by the ship in sections depending upon the different types and lengths of cable required. Prior to splicing and during all cable-ship laying operations, the cable is under continuous test to detect faults that may occur during laying. Cable splicing may be done either in the factory or aboard ship. A splice must be so made that the spliced cable is electrically and mechanically equivalent to a similar, unspliced cable of the same length.

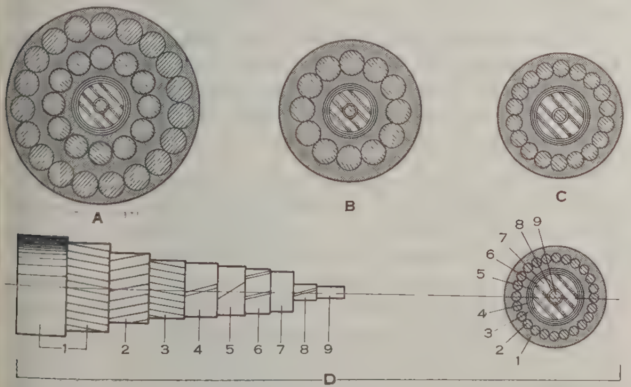

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FIG. 1.—TYPES OF CABLES: (A-C) END VIEWS OF CABLES WITH MILD-STEEL ARMOUR AND (D) SIDE AND END VIEWS OF CABLE WITH HIGH-TENSILE ARMOUR

(A) for short runs, 2.68 in. diameter; (B) for depths to 350 fathoms, 1.84 in. diameter; (C) for depths from 350 to 700 fathoms, 1.40 in. diameter; (D) for depths greater than 750 fathoms, 1.21 in. diameter: (1) two servings impregnated jute, (2) 24 armour wires, (3) one serving cutched jute, (4) Telconax tape (gapped), (5) Teredo copper tape (overlapped), (6) six copper return tapes, (7) polyethylene, (8) three copper surround tapes, (9) copper centre conductor

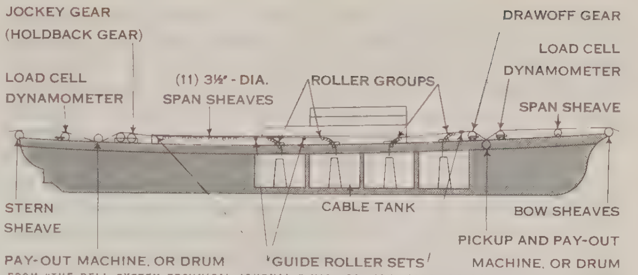

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FIG. 2.—SCHEMATIC DRAWING OF THE CABLE GEAR ON THE H.M.T.S. "MONARCH"

In the repair of cables, the approximate location of the fault is initially determined from the shore terminals by electrical measurements which can be converted into distances. The cable ship then proceeds to the approximate position of the fault, lowers a grapnel and hooks the cable by one of its prongs.

When grappling in great depths, strain on the cable frequently causes it to part. To avoid this, a special grapnel is used which, when it hooks the cable, will simultaneously cut it and hold the desired end. If a bight or loop of cable can be brought above the water, two ropes or chains are led over the bow sheaves and stoppered (fastened) to the cable, one on each side of the bight. The cable is then cut through with the stoppers holding each end of the cable. The cut ends are then bared and the cable is tested through to each terminal to determine in which direction the fault lies. Having determined the direction of the fault and its approximate distance, the repair crew seals and buoys the end of the good side of the cable. The ship then starts picking up cable in the direction of the fault, coiling the cable in one of the tanks. Cable is picked up at the rate of one to two miles per hour in deep water. When a sufficient amount of cable has been brought aboard to have passed the fault, the cable is again stoppered, cut and tested. If the fault has been removed and relaying over the bow is intended, the end of a sufficient length of good cable is led out of the cable tank around the forward cable drum and spliced on. When the splice is completed, the stopper is cast off and the good cable laid directly toward the position of the buoy on the other end. Arriving at the buoy, its mooring line and the cable end to which it is fastened are brought aboard over the bow sheaves with the picking-up gear. The ends are then spliced together and the bight of the cable slipped over the bow and dropped into the water.

See *Bell System Technical Journal,* vol. 36, pp. 1–326 (Jan. 1957), vol. 36, pp. 1047–1207 (Sept. 1957); H. D. Wilkinson, *Submarine Cable Laying and Repairing,* 2nd ed. (1908). (H. S. PN.)

CABOCHE, SIMON (SIMON LE COUSTELLIER) (fl. early 15th century), French agitator, by profession a skinner, led the Paris butchers in the riots that began in April 1413 and brought about the promulgation, in May, of the *Ordonnance cabochienne,* under the protection of John (*q.v.*) the Fearless, duke of Burgundy. This aimed at a radical reform whereby regularly constituted organs were to control all the administration and all official appointments. The butchers' excesses, however, caused the *bourgeoisie* to react, in August, in favour of John's rival Louis, duc d'Orléans, after whose entry into Paris the *Ordonnance* was torn up (Sept. 8). Caboche reappeared in Paris with the Burgundians in 1418, but never recovered his influence.

CABOT, GEORGE (1752–1823), U.S. politician and leader of the New England Federalists, was born in Salem, Mass., Jan. 16, 1752. After studying at Harvard from 1766 to 1768 he went to sea, gradually rose to become a shipowner and successful merchant, and retired from business in 1794. Throughout his life he was interested in politics, and as a contributor to the press and through his friendships exercised a powerful political influence, especially in New England. He was a member of the Massachusetts constitutional convention of 1779–80, of the state senate in 1782–83, of the convention which in 1788 ratified for Massachusetts the federal constitution and of the U.S. senate from 1791 to 1796. Cabot was president of the Hartford convention, a secret meeting called on Dec. 15, 1814, to express the opposition of the New England Federalists to the War of 1812. Its report of Jan. 5, 1815, attacking Pres. James Madison's administration and the war, aroused charges of lack of patriotism from which the party, already unpopular, never recovered (*see* FEDERALIST PARTY). Cabot died in Boston on April 18, 1823.

See Henry Cabot Lodge, *Life and Letters of George Cabot* (1877).

CABOT, JOHN (GIOVANNI CABOTO) (*c.* 1450–*c.* 1499), Italian (Venetian) navigator and explorer who, sponsored by Henry VII, king of England, voyaged in 1497 and 1498 to the northeast coasts of North America. The exact details of his life and of his voyages are still subjects of controversy among historians and cartographers.

John Cabot was born in Genoa about 1450, but moved to Venice and became a citizen of that city in 1476. He became well experienced in navigational techniques and in later years reported his impressions on visiting Mecca, Arabia, the great trading centre where oriental and western goods were exchanged. As a Venetian he must have known the intricacies of this trade, and he had presumably read of Asia in Marco Polo's writings. The idea that a sea route west across the ocean from Europe could secure oriental products at their source, and short-circuit the long, expensive routes and middlemen to the east, occurred to both Columbus and Cabot, and was probably current among speculative minds of that day.

Cabot moved to London with his family about 1484. His motives are not clearly known. It is possible that he had already envisaged a westward voyage, and came to seek English support. His plans probably differed from those of Columbus, for Cabot's course in 1497 and 1498 lay close to the 60° parallel which was, because of the earth's curvature, a much shorter route than Columbus' course across the 30° parallel. It was suggested that Cabot was aware of the advantages of the northern route and hence sought to promote his schemes in England, the most northerly commercial nation.

In 1496 Henry VII was on tour in western England, and on March 5 issued letters patent to Cabot and his sons authorizing them to voyage in search of unknown lands, to return their merchandise by the port of Bristol and to enjoy certain privileges and obligations. The news of Columbus' successes on behalf of Spain was a spur to English action, and secured some support for Cabot from Bristol merchants.

John Cabot set sail from Bristol on May 2, 1497, in the small ship "Matthew," with a crew of 18 men. He proceeded around Ireland and then north and west and made landfall on the morning of June 24. Cabot went ashore, took possession of the land for the English king and unfurled both the English and Venetian flags. He reported on returning to Bristol in August that the land was excellent, the climate temperate, that brazilwood and silk probably grew there, and the sea was covered with fish which could be caught not merely by nets, but with weighted baskets lowered into the water. England's dependence on Iceland's fish could be ended. In the midst of an enthusiastic welcome he voiced his plans to return to his landing place, and from there to sail westward hugging the coast until he came to Japan (Chipangu), the source, as he thought, of spices, and gems.

It was never definitely established where Cabot made his first landfall, whether in Labrador, in Newfoundland or on Cape Breton Island. He named various features Cape Discovery, Island of St. John, St. George's cape, the Trinity Islands and England's cape. These may be, respectively, the present Cape North, St. Paul Island, Cape Ray, St. Pierre and Miquelon, and Cape Race, all in the area of Cabot strait.

After his first voyage Cabot received £10 as a gift from the king and an annuity of £20. He dubbed himself "the admiral," and found London and Bristol merchants ready to back another voyage. New letters patent were issued to him on Feb. 3, 1498. It is possible that he visited Lisbon and Seville in search of experienced navigators and officers.

His second expedition probably consisted of five ships and about 200 men. Soon after setting out in May 1498, one ship was damaged by storm and sought anchorage in Ireland; the others sailed westward on the latitude of northern Scotland. Scholars have pieced together the probable course of this voyage from quite diverse scraps of evidence. The ships were carried northwestward until the east coast of Greenland was sighted in early June. Cabot steered northeastward along the coast when mutiny and formidable ice obstructions at 67° 30′ N. caused him to turn back southward along the coast. He passed the southern tip of Greenland and coasted on the eastern and western shores of Davis strait. There is evidence that he traded with natives on the Labrador coast. Continuing southward and eastward he did not discover the Gulf of St. Lawrence or the Bay of Fundy, but he did note the hook of Cape Cod. Finally, having failed to discover an oriental trade route and finding supplies running low, he turned back at the latitude of Chesapeake bay, and returned to England empty handed. The dreams of easy wealth were exploded; perhaps it was realized that a continent barred the way to Asia.

John Cabot drew his English annuity for 1499, and then disappeared from historical records. In spite of his fame and undoubted ability, he remains a shadowy figure. He may have been a more able navigator than Columbus, but his voyages did not lead immediately to empire building, and his exploits faded from memory.

Cabot's work of discovery was reinforced by the Portuguese explorer Gaspar Corte-Real. Cabot's son Sebastian was not independently heard of until May 1512.

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CABOT, SEBASTIAN (*c.* 1476–1557), son of the Italian navigator, John Cabot (*q.v.*). Although Contarini, Venetian ambassador at the court of Charles V, affirmed that Sebastian Cabot was born in Venice, more recent evidence supports the belief that he was born in Bristol, Eng., probably in 1476. In 1496 John Cabot and his three sons, Lewis, Sebastian and Santius, were issued letters patent by Henry VII to fit out ships under the English flag to conquer, occupy and possess for England any lands they might discover in any part of the world. Sebastian may have accompanied his father in a ship named "Matthew" on the voyage of May 1497 that resulted in the discovery of Labrador or Newfoundland, then believed to be the China coast. This was the first discovery of the new world by any navigators sailing in the British service.

In 1512 Sebastian was employed as a cartographer by Henry VIII and accompanied the English army sent to the continent to aid Ferdinand of Aragon against the French. Because of his knowledge of the northeast coast of North America, he was given a commission in the Spanish navy with the rank of captain, and named to command an expedition in 1516. The death of King Ferdinand that year canceled the project, but Cabot's services were retained by Charles V. In 1518 Cabot was given membership in the council of the New Indies (Consejo de las Nuevas Indias) and appointed pilot major and official examiner of pilots.

Upon his return to England in 1520 he was offered command of an expedition that had been organized to explore Newfoundland. He rejected this proposal and instead assumed command of a Spanish expedition composed of three vessels, which left Seville in 1525 for the purpose of developing commercial relations with the orient. He was diverted from this objective by reports of fabulous wealth in the Río de la Plata region of southern South America. After about three years of fruitless exploration he returned to Spain, where he was judged responsible for the failure of the expedition and was sentenced to four years' banishment. Nevertheless, he was pardoned by Charles V and restored to his old post of pilot major.

Edward VI then ascended the English throne and, recognizing the value of Cabot, offered him his old position in the English navy. He accepted the appointment in 1548 and was also granted a pension by the monarch. Cabot remained in England, and in the last years of his life, as governor of the Merchant Adventurers, he organized an expedition to search for a northeast passage to the far east. While this objective was not attained, and several naval disasters ensued, it contributed to the development of trade with Russia. Cabot died in London in 1557.

Bibliography.—Henry Harrisse, *John Cabot and Sebastian His Son* (1896); J. A. Williamson, *Voyages of the Cabots and the English Discovery of North America Under Henry VII and Henry VIII* (1929); G. E. Nunn, *The La Cosa Map and the Cabot Voyages* (1946). (J. L. Tr.)

CABRAL, PEDRO ÁLVARES (1467 or 1468–1520?), Portuguese navigator widely known as the discoverer of Brazil, was born in 1467 or 1468 in Belmonte. He was not, in point of fact, the first European to reach this part of South America. A member of the lesser nobility, he was appointed commander of an expedition to India that left Lisbon on March 9, 1500. (The first such expedition, led by Vasco da Gama [*q.v.*], had returned to Lisbon in 1499.) Cabral's fleet sailed so far to the southwest, either to avoid the calms of the Gulf of Guinea or to carry out possible instructions from the king (who may have wanted to make sure that the sea route to India via the Cape of Good Hope lay entirely within the Portuguese sphere as defined by the treaty of Tordesillas of 1494), that on April 22, 1500, it sighted Monte Pascoal on the Brazilian coast. After a stay of ten days in Brazil, largely at Cabrália bay in the present state of Bahia, during which time some reconnoitring was done and two Masses were celebrated, the fleet sailed on to India. After his return from the orient, Cabral led an uneventful life and died, probably in 1520. He was buried in Santarém, Port.

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CABRERA, RAMÓN (1806–1877), Spanish Carlist general, who, after Tomás de Zumalacárregui, was the most famous commander of the first Carlist War and later became one of the party's most controversial figures, was born at Tortosa on Dec. 27, 1806. Although he took minor orders, he did not make the church his career but instead became involved in the Carlist risings after Ferdinand VII's death (1833). Fanatical and daring, he soon dominated the leadership of the Carlist bands in Catalonia. He was nicknamed the "Tiger of the Maestrazgo" and inspired terror by his relentless cruelty, which rose to a climax after the liberals had shot his mother (1836). Cabrera, who gained several notable victories, including that of Morella (1838), for which he was created conde de Morella, refused to recognize the convention of Vergara which ended the war in the Basque provinces in 1839 and continued to hold out against forces under Baldomero Espartero in central Spain for nearly a year. In exile, first in France and then in England, he objected to Don Carlos' abdication (1845) in favour of his son, the conde de Montemolín, but from 1846 Cabrera again commanded Carlist bands in Catalonia. He retired from activity in 1849, disillusioned by the failure of these risings. Although the legend of his name led the Carlists to seek his advice and support after the September revolution in 1868, he had changed after marrying an English Protestant and settling down in England. He now advocated peaceful propagation of Carlist views and refused to accept offers to command Carlist forces when the civil war was renewed in 1872. He earned the execration of the party when, in March 1875, he advised them to desert the cause and to follow his example in recognizing Alfonso XII. He died in London on May 24, 1877. (C. A. H.)

CABRILLO, JUAN RODRÍGUEZ (João Rodrigues Cabrilho) (d. 1543), Portuguese navigator in the Spanish service, best known for his explorations of the west coast of the United States. Cabrillo arrived in Mexico in 1520, and participated in Cortes' siege of Mexico City in 1521 and in the conquest of Oaxaca, Tehuantepec and Guatemala. Leaving Navidad in northwest Mexico on June 27, 1542, he explored the Pacific coast of Lower California and continued northward to latitude 38° 31′, discovering San Diego bay, Santa Catalina Island, and San Pedro and Santa Monica bays. He died Jan. 3, 1543, in the vicinity of the Santa Barbara channel. His explorations were continued by his pilot, Bartolomé Ferrelo, who in 1543 reached the Oregon coast. (L. N. McA.)

CABRINI, SAINT FRANCES XAVIER (1850–1917), founder of the Missionary Sisters of the Sacred Heart and first United States citizen to be canonized, was born in Sant' Angelo, Lombardy, Italy, on July 15, 1850, the youngest of 13 children. From the time of her first communion and confirmation at the age of seven, Frances was fired with the desire to become a missionary, and her choice of Xavier as her name in religion was determined by this zeal.

Frustrated in her early attempts to become a religious, she agreed to take up residence in an orphanage sadly in need of reform. After three years the bishop encouraged her to take religious vows and appointed her superior of the orphanage. It was during the next three trying years that Frances Xavier became known as Mother Cabrini, the name to follow her through life. In 1880 she founded the Missionary Sisters of the Sacred Heart.

At the direction of Pope Leo XIII to "go west, not east," Mother Cabrini with a small group of sisters sailed for the United States in 1889. Their work in America was to be concentrated among the neglected Italian immigrants. This journey was the first in a series that was to take her through the Americas and into Europe. She became a naturalized citizen of the United States in 1909. Although plagued by ill-health most of the time, Mother Cabrini established 67 houses—one for each year of her life. She died Dec. 22, 1917, and was canonized July 7, 1946. Her feast is Nov. 13.

There is no satisfactory biography of St. Frances Xavier Cabrini. Two popular accounts are T. Maynard, *Too Small a World* (1945), and L. Borden, *Francesca Cabrini* (1945). (E. R. V.)

CABRIOLET: *see* Carriage.

CABROL, FERNAND (1855–1937), French Benedictine monk and noted writer on the history of Christian worship and related subjects, was born at Marseilles, Dec. 11, 1855. He made his monastic profession in 1877 and was ordained priest in 1882. In 1896 he was sent to Farnborough, Hampshire, Eng., as prior of the monastery which had been founded there in the previous year; seven years later he was elected abbot, an office which he held until his death on June 4, 1937.

Of Cabrol's numerous works one of the most important, because of its wide circulation, was his *Livre de la prière antique* (1900; Eng. trans., *Liturgical Prayer*, 1922). *Monumenta ecclesiae liturgica* was the title of an ambitious series inaugurated by Cabrol, of which only three volumes were published. In 1907 was completed the first volume of another project, launched in 1903, the *Dictionnaire d'archéologie chrétienne et de liturgie*, of which the last volume appeared in 1953. D. Henri Leclerq and, after his death, H. Marrou were co-editors. Lesser works of Cabrol include the following: *Les Origines liturgiques* (1906); *L'Angleterre chrétienne avant les Normands* (1909); *La Prière des premiers chrétiens* (1929; Eng. trans., 1930); *Les Livres de la liturgie latine* (1930; Eng. trans., 1932); *St. Benoît* (1933; Eng. trans., 1934); and *The Year's Liturgy* (published posthumously, 1938–40).

See L. Gougaud in *Revue d'histoire ecclésiastique*, 33:919–922 (1937); M. Havard, *Revue Grégorienne*, no. 22, pp. 201–13 (1937), no. 23, pp. 1–6 (1938); A. des Mazis, *Dictionnaire d'histoire et de géographie ecclésiastiques*, vol. xi, pp. 45 ff. (Am. S.)

CACCIA (Ital. meaning "hunt," "chase"), a musical setting of a text realistically describing a hunt or similar event. The musical form originated in France about 1300 under the name *chace* and later was adopted in Italy. The French *chace* was a three-part vocal canon; the Italian *caccia* was a canon for two voices accompanied by an independent instrumental tenor. Polyphonic compositions with similar texts occur in Italy and France up to the late 16th century, but these lack the canonic and other formal features of the 14th-century *caccia*.

The English word "catch" (*q.v.*), a type of round, may be derived from *caccia*.

CACCINI, GIULIO (sometimes called Giulio Romano) (*c.* 1550–1618), Italian singer and composer, whose songs greatly helped to establish and disseminate the new monodic music introduced in Italy about 1600. Little is known of his early years. He was born in Rome, about 1550, but Florence, where he lived mainly from at least 1579, was the scene of his triumphs. During the last 20 years of the 16th century, while playing and singing in court masques (for some of which he composed music), he perfected, largely in the orbit of the Camerata of Count Giovanni Bardi (*q.v.*), the new conception of song that he revealed to the world in *Le Nuove Musiche* (1602). This consists mainly of solo madrigals and arias, preceded by an important explanatory preface (Eng. trans. in O. Strunk, *Source Readings in Music History,* 1952). The madrigals show his new manner most clearly: an elegant and pliable vocal line, scrupulously following the inflections of the words and heightened by affective embellishments, stands out against a subdued chordal accompaniment in diatonic harmony improvised from the newly invented *basso continuo.* During the next 30 years many other Italian composers took up the fashion for monodies, and Caccini himself produced two more collections. He also produced an opera in 1600 (performed Florence, 1602) on the same libretto as Jacopo Peri's *Euridice,* to which it is markedly inferior. Caccini's was essentially a lyrical, undramatic talent. He died in Florence in Dec. 1618 and was buried there on Dec. 10.

See F. Ghisi, *Alle fonti della monodia* (1940). (N. Fo.)

CÁCERES, capital of the Spanish province of the same name, lies 22 km. (14 mi.) S. of the Tagus river and 300 km. (186 mi.) by road W.S.W. of Madrid. Pop. (1969 est.) 56,274.

Cáceres, built on an eminence on a low east-west ridge, consists of two towns, an old and a new. The old, upper town, with its medieval palaces, turrets and massive walls, half Roman and half Arab, is dominated by the lofty tower of the Gothic church of San Mateo. The once-famous monastery and college of the Jesuits is now a hospital. Steep steps lead down through four gates to the lower, modern town containing the law courts, town hall, schools and the palace of the bishops of Coria. Cáceres is situated on a branch railway. Cáceres produces cork and leather goods, pottery and cloth, and exports grain, oil, livestock, wool, sausages and phosphates from the neighbouring mines. The town is of Roman origin and probably occupies the site of Norba Caesarina.

Cáceres Province, in the region of Extremadura, is the second largest province of Spain (19,945 sq.km. [7,701 sq.mi.]). In the northeast it adjoins Portugal, and the Tagus river forms part of its boundaries. Pop. (1969 est.) 500,137. The mountainous areas are in the north and south, being formed by the Montes de Toledo and the Sistema Central. The remainder of the province is a plain with an average height of 1,300 ft. The climate is continental and extreme. The two mountain systems enclose an ample catchment area crossed from east to west by the Tagus, joined by its principal tributaries, the Alagón and Tiétar rivers, which flow from the Sierras de Gredos and de Gata. Among the dams recently constructed is that of Gabriel y Galán, on the Alagón, with a capacity of 924,000,000 cu.m. used for hydroelectric power and irrigation.

It is an agricultural and cattle-raising region. Soil and climate permit only the dry cultivation of cereals. Olive growing is important. Cultivation of cotton, tobacco and pepper has been increased and the new dams are transforming the economy of the province. Another source of wealth lies in the great flocks of sheep which come to the winter pastures of the Tagus from the hills of León. Pig keeping is also important. The province abounds with forests of evergreen oak and cork trees. Natural regions include La Vera, the richest, and Las Hurdes, one of the poorest and most backward in Spain where, however, conditions are being improved. The Plasencia valley is also fertile.

The region enjoyed great prominence during the Roman period. The roads leading to Mérida provided good communications with the rest of Spain and the bridge of Alcántara is one of the most notable Roman bridges. Alfonso IX conquered Cáceres from the Moors in 1229, and it became part of León. Its defense and colonization by the military orders of Santiago and Alcántara gave rise to large *latifundios* (land grants). This explains the concentration of population in large, widely separated towns.

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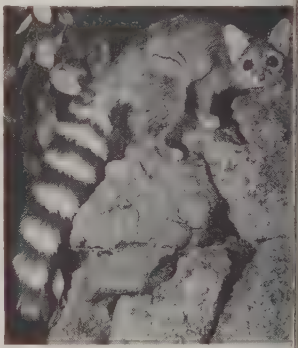
CACHAR, a district of Assam, India, occupying the upper basin of the Surma river and bounded on three sides by hills. After the partition of India in 1947 the remnant of Sylhet district (most of which went to East Pakistan) was added to it, but in 1951 the North Cachar Hills was incorporated in the new district of Mikir and North Cachar Hills. Area 2,688 sq.mi. Pop. (1961) 1,378,476.

The scenic hills generally rise steeply and are clothed with forests. The Surma is the chief river, and its principal tributaries from the north are the Jiri and Jatinga, and from the south the Sonai and Dhaleswari. Several extensive fens, notably that of Chatla, which become lakes in time of flood, are characteristic of the plain. This is alluvial and bears heavy crops of rice, next to which in importance is tea. The tea industry employs large numbers: about 90,000 self-supporting persons were engaged in th plantations in the 1960s and the annual output is about 42,000,00 lb. Manufacturing industries are otherwise slight.

The Eastern railway serves the district, including the head quarters town and trade centre of Silchar.

The district is the most thickly populated in Assam (415 pe square mile). It takes its name from the former rulers of the Kachari tribe, who settled there early in the 18th century. Late the Burmese threatened to expel the Kachari raja and annex hi territory; the British, however, intervened to prevent this and, o the death of the last raja without heir in 1830, obtained the terri tory under treaty. (S. Gl.)

CACOMISTLE (Cacomixl), or ring-tailed "cat," *Bas sariscus,* two species of carnivores related to the raccoons (*q.v.*) not cats. Their total length is about two feet, half of which is a black-and-white-ringed bushy tail. They have grayish-brown body fur, pointed snouts, long ears and white patches over the eyes. *B. astutus,* known as the ringtail, is found from the southwestern U.S. into Central America; *B. sumichrasti,* the true cacomistle, ranges in Central America to Peru. They are arboreal and nocturnal, and feed on fruits, mice, birds, lizards and grasshoppers. The voice is a bark. The litter consists normally of four. (L. H. M.)



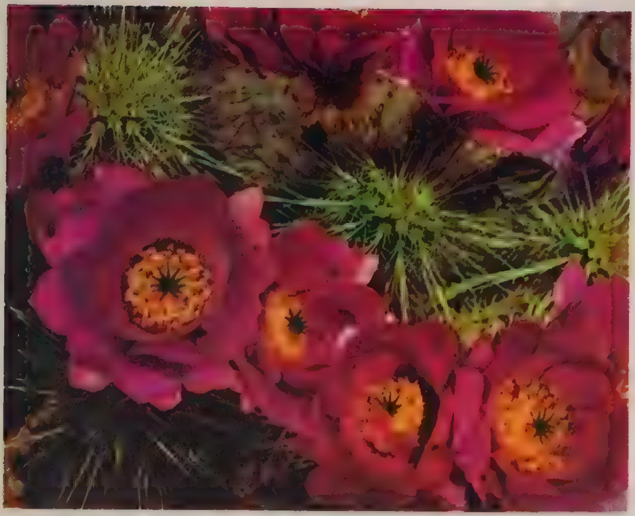
WILLIS PETERSON

RINGTAIL (BASSARISCUS ASTUTUS

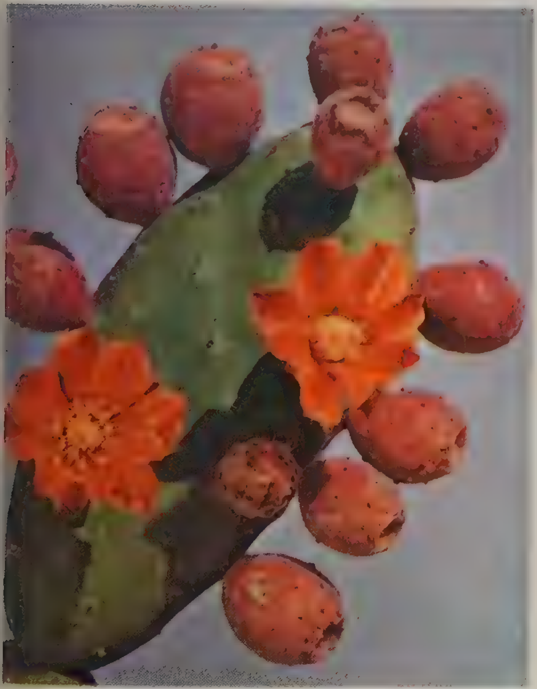
CACTUS, any of the curious, often spiny, succulent or fleshy stemmed plants of the family Cactaceae, order Cactales (Opunti ales), characteristic of and well adapted to dry regions. All bu a few are confined to the Western Hemisphere and are the domi nant vegetation of its deserts.

Appearance.—Most cacti appear to be all stem and no leaves The leaves, when present, are usually greatly reduced; they ma occur only temporarily at the growing end of the plant. Only i the genus *Pereskia,* restricted to the tropics, do the leaves fit th popular conception of those organs. Cacti vary greatly in size an general appearance from buttonlike peyote and low clumps o prickly pear to upright columns of barrel cacti and imposing choll and saguaro "trees." Some climbing tropical species, such a those of *Epiphyllum* and some species of *Rhipsalis,* have thi flattened stems. Regardless of its shape, degree of elongation, c branching, the cactus stem is succulent and the cortex and ofte the pith, or both, are greatly enlarged as storage tissue. The ap pearance of the plant varies also according to whether the ste surface is smooth or ornamented with protruding tubercles, ridge or grooves.

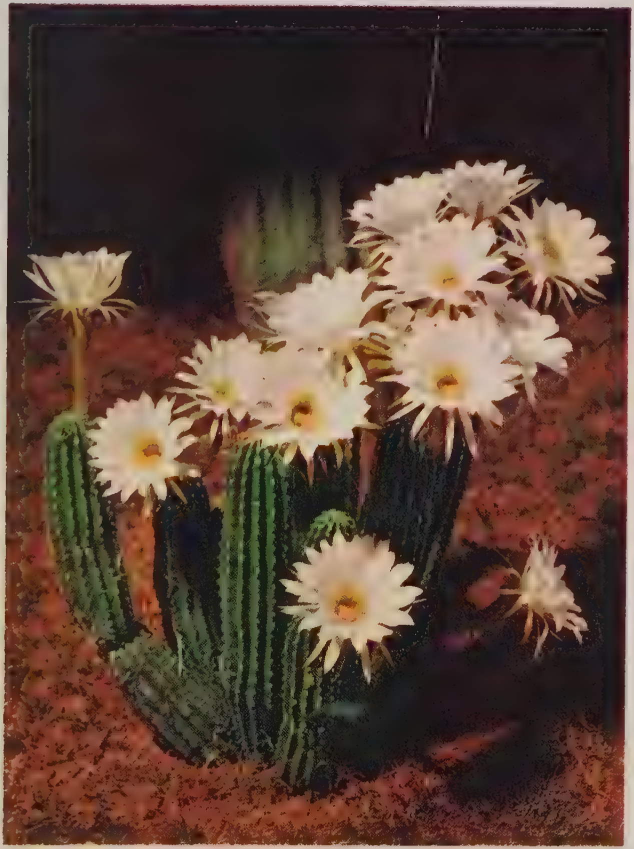
Many other plants, succulent and essentially leafless, are ofte



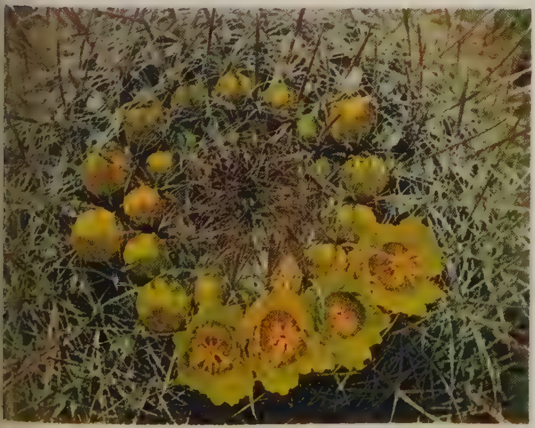
Strawberry hedgehog cactus (*Echinocereus engelmannii*)



prickly pear cactus (*Opuntia ficus-indica*) stem with blossoms and
it



A species of *Cereus* that blooms at night

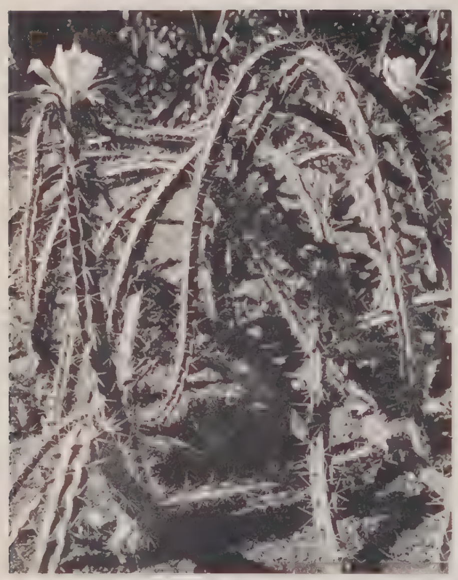


CACTI IN BLOOM

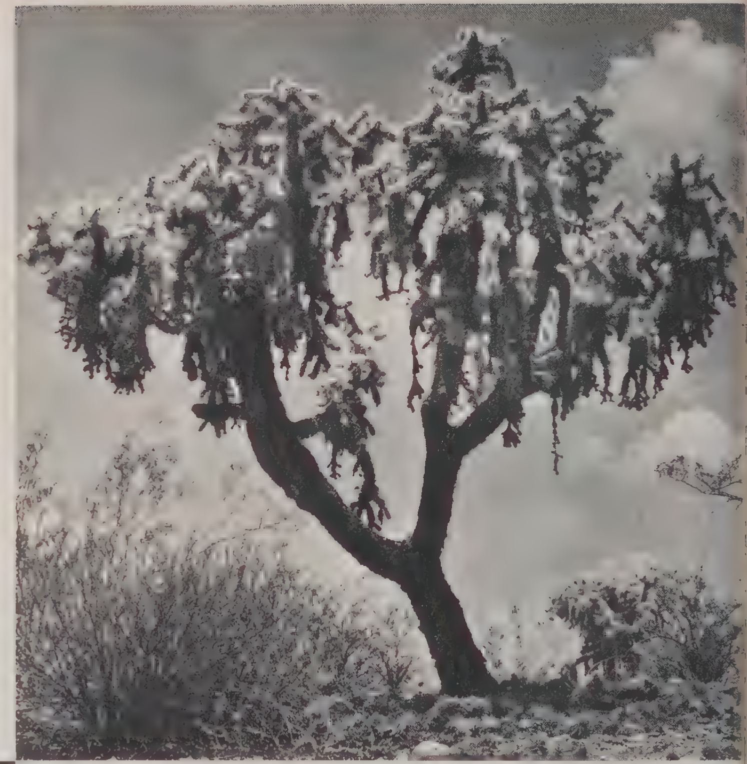
Pattern of blossoms on summit of a barrel cactus (*Echinocactus*)

PHOTOGRAPHS, (TOP) WILLIS PETERSON, (OTHERS) FPG

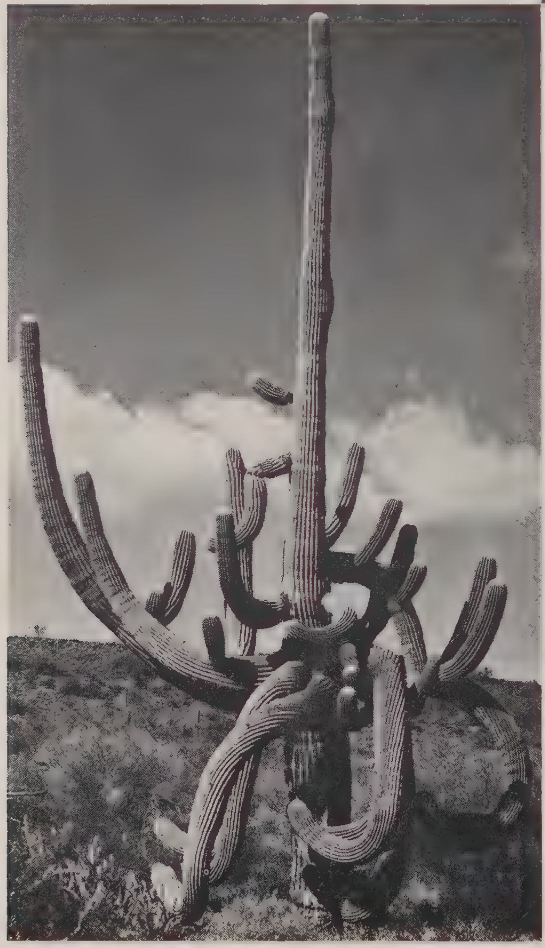
CACTUS



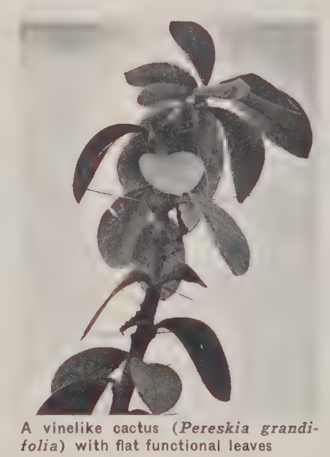
Night-blooming cactus (*Cereus* species) of clambering habit



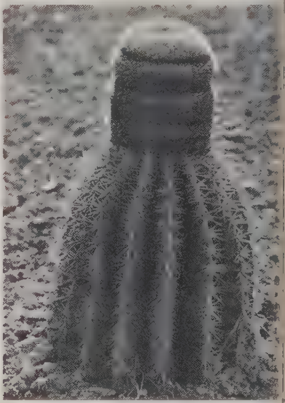
A treelike cholla (*Opuntia fulgida*) more than 10 ft. high



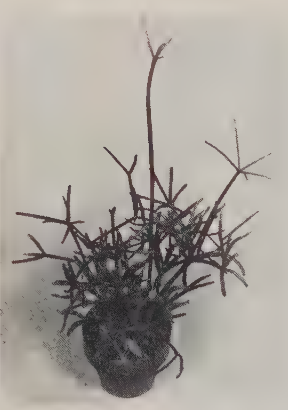
Giant saguaro (*Cereus giganteus*), specimens of which may rise 50 ft. or more above the desert



A vinelike cactus (*Pereskia grandifolia*) with flat functional leaves



Dense woolly new growth of this bar cactus hides a circlet of flowers



Rhipsalis, without spines, is the only cactus possibly native of the old world

REPRESENTATIVE CACTI

PHOTOGRAPHS. (TOP LEFT, TOP RIGHT, CENTRE) WILLIS PETERSON, (OTHERS)

confused with cacti. A large group of spurges (*Euphorbia* species) occurring in Africa includes many plants similar in appearance to cacti with long cylindroidal stems. These plants, common in cultivation, are distinguished readily by their milky juice, a feature rare in cacti and supposed to be absent in those cacti with elongate stems. Yuccas and the century plants (*Agave* species) often are confused with cacti, but they are distinguished readily by succulence of the leaves rather than the stems.

Distinction of cacti from all other succulent plants can be made by the presence of spines in areoles, special clearly defined areas, each developed from a lateral bud of the stem. Areoles are universal in the cactus family (at least in the juvenile phase), and they occur in no other plant family. In nearly all species there are tufts of stiff sharp spines. In some species the mature plant does not have spines, but it does have areoles, and these are filled with hair or sharp, barbed structures called glochids. The more obvious characters of the cactus family, in combination with areoles, are described below:

(1) The leaves, if discernible, are reduced in size (except in *Pereskia*, as indicated above). In the prickly pears and chollas (*Opuntia*) they are ephemeral, appearing only on young joints of the stem and falling away after a month or more of growth. They are relatively small and succulent, and they range from conical to elongate and cylindroid. In most genera the leaves are not visible to the unaided eye but are represented by a hump of tissue just below a spine-bearing areole.

(2) Frequently the flowers are large, attractive, and white or brightly coloured. All the genera have a floral tube that invests the ovary, and, except in *Pereskia*, is adherent to the surface. The portion of the tube covering the ovary usually develops small, inconspicuous scales, which increase gradually in size upward on the free portion of the floral tube above the ovary. These shade off into sepaloid flower parts and farther up into petaloid parts. Always there is a multitude of conspicuous stamens, and there are 3 to 20 or more stigmas arising from a single style. In some groups, especially *Opuntia*, there is only a short floral tube above the ovary, but in others, as with some species of *Cereus*, the tube may be very long. The fusion of the floral tube with the surface of the ovary occurs in all cacti except *Pereskia* and in many other flowering plants. A flower having this feature is described as epigynous, and its ovary is said to be inferior. The ovary and the investing floral tube may develop into a fleshy and often edible fruit. It is one-chambered, and the numerous seeds are produced on the walls.

(3) The flowers usually are associated with a spine-bearing areole, but in *Mammillaria* they may be produced in a special areole between the elongate tubercles of the stem surface or they may be in this position but have no visible connection with an areole. The flowers develop either inside the spine-bearing part of the areole or in a felted area either merging with it or remote from it and connected by an isthmus that bears felt and often glands.

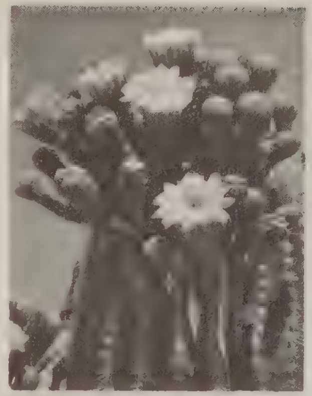
(4) The ovules usually are campylotropous, that is, curved between the hilum (point of attachment to the stalk) and the opening through which the pollen tube enters (micropyle).

Life Cycle.—Cactus seeds germinate readily and rapidly in some species and with difficulty or slowly in others. Large numbers of plants are grown from seeds for horticultural purposes. The characteristic feature of the seedlings is the pair of large seed leaves (cotyledons), which tend to be succulent, sometimes markedly so. Some species reach the flowering stage in two or three years, and they may develop both flowers and fruits even on the stems still retaining juvenile characters. (This curious feature led to naming of many supposed species based upon plants that seemed to be mature because of reproduction but which did not have the expected type of spines.)

Usually within a few years the succulent stem assumes the characteristic form and appendages for the species. In the prickly pears, in which the adult stem is composed of flattened joints arranged end to end, the portion developed in the first year of growth is cylindroidal for several months, the upper portion gradually becoming flattened and the subsequently developed joints being flat.

Most cacti reach a considerable relative size within five or ten years, but some grow much slower. Information concerning the age of older plants usually is lacking because the woody parts are very thin and counting of growth rings requires sectioning and careful study with a compound microscope. The saguaro or giant cactus of Arizona (*Cereus giganteus*) is estimated to attain ages in the hundreds of years.

Pollination is mostly by insects or birds, though sometimes by other animals such as bats. There is no precise mechanism governing the pathway of pollinators, and so pollination tends to be haphazard, at least in most of the larger flowers of the open as opposed to the tubular types. Most flowers open in the daytime and are visited by day-flying insects or birds, but many, and especially species like the saguaro and the various night-blooming *Cerei*, open at night. As with other night-pollinated plants the night-blooming cacti tend to be white-flowered.



WILLIS PETERSON

FIG. 1.—TOP OF BRANCH OF A SAGUARO (CEREUS GIGANTEUS), LARGEST CACTUS IN THE U.S.

Occurrence and Habitat.—Cacti are native to North and South America. The only representatives of the family possibly native to the Old World are members of the genus *Rhipsalis*, occurring in East Africa, Madagascar, and Ceylon. Whether these plants are native or introduced in these tropical areas is an open question; there have been many arguments concerning this point and a possible means of dispersal of this highly specialized group from the Western Hemisphere to the Eastern.

Various species of *Opuntia* and some other genera have been introduced into the Mediterranean region, and some have grown wild there since shortly after the discovery of America. Species of *Opuntia* are widely naturalized in India, the Malayan region, Hawaii, and Australia. In Australia and eastern Cape Province in South Africa, they have become pests difficult to eradicate.

The Cactaceae are native through most of the length of North and South America, from British Columbia and Alberta southward. The northernmost established occurrence is near Peace River in Canada, and various species of cacti range southward far into Chile and Argentina. The species growing at Peace River is the very small wide-ranging northern prickly pear, *Opuntia fragilis*.

The survival of cacti in dry regions usually is associated with their ability to store water in the thick, succulent stems and to obtain this water through widely spreading, shallow root systems. Even when the soil is dry the roots retain their capacity to absorb water the instant it becomes available. The stems of prickly pears concentrate water over the flat surfaces of the joints, and this drips or streams from the curved lower margins, thereby increasing the amount of water in the soil just under the plant. Some species of cacti have spines that point downward; water collected on the spines, even from light mists, is directed in droplets to the ground. The saguaro has downward-pointed spines during its earlier years of growth. These collect water and repel rodents that might eat the succulent stems to secure water. In older saguaros the stem above about the four- or five-foot level produces another type of spine, not downward-directed. For plants growing near the lower edge of a rock or a crack between rocks, the amount of water available from a relatively light rain may be greatly increased, as it would for a plant living under the edge of a roof. The greatest number of cactus species is found in Mexico and the bordering states from California to Texas, and in the drier parts of the Andes. However, there are large and undetermined numbers of species of cereoid genera in the tropics and of several genera on the dry sides of many Caribbean islands.

Some species of cacti are associated with tropical rain forests. Examples are to be seen in the Everglades in Florida, where species of *Opuntia* and *Cereus* occur at points where the water table may be only a few inches below the surface. Most species are sensitive to cold, but many grow in regions with cold winters, as, for example, in the United States, on the Great Plains and in the Great Basin and the Rocky Mountain system. These species, however, are on the fringe of the greatest concentration of cactus species—from southern California to New Mexico and

Texas. Cacti are native in all states but Alaska, Hawaii, Maine, New Hampshire, and Vermont.

Importance.—Cacti are economic plants in Mexico, parts of Central and South America, and the Caribbean region. Various species are cultivated for food; this includes vast complexes of prickly pears, especially of *Opuntia ficus-indica* and species of *Cereus*. Cooling drinks prepared from some of the fruits have been a popular native medicine for fevers. In Mexico leaves of chollas, resembling string beans, are used as food. In Latin America species of *Opuntia, Cereus,* and other genera are planted around houses where they may form an impenetrable fence.

The practicality of use of barrel cacti and other species as a source of water in the desert is open to debate. Water extracted by pounding the stems is palatable though insipid. Water can be distilled from the flesh by placing cut up stems in a pit beneath an inverted cone of transparent plastic; the heat-evaporated water condenses on the lower surface of the plastic and drips into a vessel.

The chief value of cacti is in cultivation for their ornamental features and general hardiness. They can be grafted easily, and many rare species are propagated by grafting upon more vigorous stocks. Many small cacti are suitable for home cultivation. They may be planted in ordinary potting soil with vermiculite, poultry charcoal, or crushed old mortar added to provide the most important need—a porous and quickly drained soil (few cacti can withstand retention of water around the roots). Cacti cultivated outdoors in dry climates should be watered about once or twice a week during the growing season. Without water, many cacti persist but do not grow. Some species, however, do require periodic drought. Many species grow well in warm weather in full sun, provided there is adequate soil moisture, but others require some shade. Cacti grown indoors or in greenhouses may require less frequent watering, especially in areas of high humidity.

Relationships.—The cactus family is in some respects similar to several families of the order Caryophyllales (Centrospermales). Cacti bear some similarities to certain members of the families Aizoaceae, which is known best in America for the ice plant, *Mesembryanthemum;* Portulacaceae, or purslane family; and Phytolaccaceae, or pokeweed family. These families are similar to the cacti in features of the pollen grains, in the development of the embryo sac (megagametophyte), and in the campylotropus ovules with the food in reserve in the perisperm. However, in the cacti the ovules may be amphitropous or even anatropous. Betacyanin pigments occur in the Caryophyllales as well as in the Cactaceae indicating a link between the groups; these pigments have been assumed to occur in no other groups of plants.

The Aizoaceae, despite similarities, lack a number of the characteristic features of the cacti. Leaves of the Aizoaceae usually are opposite; those of the Cactaceae are alternate. The leaves are conspicuously succulent, while in cacti the stems are succulent. The Aizoaceae do not have spines in areoles, as do cacti. The flowers are superficially similar, but in the Aizoaceae there are no leaves on the floral cup (tube) and leaves do not shade off into sepaloid and petaloid parts. In the Aizoaceae the fruit has partitions at maturity. There is more than one style instead of the single style in the Cactaceae.

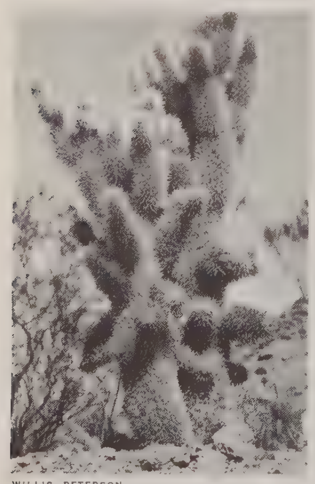

WILLIS PETERSON

FIG. 2.—CHOLLA (OPUNTIA BIGELOVII)

Similarities of the cacti and other groups, accompanied by numerous differences, indicate the derivation of these groups from a common ancestry. The major taxa and even the species of living flowering plants were mostly derived from ancestors that were wholly or partly displaced and that usually have become extinct leaving no recognizable remains behind. For thi reason speculation concerning the origin of an order like th Cactales from other living orders is futile.

The Cactaceae are not known definitely from fossils. A wel recorded presumed fossil cactus collected in Utah possibly represents a prickly pear, but this is open to question. It wa of Eocene age.

Classification and Survey.—Numbers of genera and specie of cacti are debatable. Probably only 20 or more genera an 800 to 1,200 or more species are worthy of recognition. Som of the better-known genera are as follows:

Melocactus.—Melon-thistle or Turk's cap cacti, of the We Indies, Mexico, Guatemala, and Colombia.

Ferocactus and Echinocactus.—Barrel cactus, native of th southwestern United States and Mexico.

Echinocereus.—Hedgehog cactus, of southern California to th southern Great Plains and Mexico.

Cereus.—Torch cactus, with numerous species, largely of Mexico, Central and South America, and the West Indies. Man supposed genera have been segregated. Probably some (but no most) are valid; the group is in need of thorough study.

Mammillaria and Coryphantha.—Fishhook and pincushio cacti, mostly of the United States and Mexico.

Epiphyllum.—Leaf cactus, of tropical and subtropical America

Opuntia.—Prickly pears and chollas, a large group occurrin in North America, the West Indies, and South America as fa south as Chile. The cochineal insect is nurtured on certain specie of *Opuntia*. Plantations, called nopalaries, are established f rearing this insect (*see* COCHINEAL).

Pereskia.—A genus differing most obviously from *Opuntia* i having less succulent stems and in the broad only slightly flesh leaves resembling those of other dicotyledons.

BIBLIOGRAPHY.—*General:* For a conservative treatment of the genera *see* F. Vaupel, *Cactaceae,* in A. Engler and K. Prantl, *Die natürliche Pflanzenfamilien,* ed. 2, 21:594–651 (1925); for a more radical bu general consideration of the entire family, *see* N. L. Britton and J. N Rose, *The Cactaceae,* 4 vol., (1919–24); a supplement to Britton an Rose's work, W. T. Marshall and T. M. Bock, *Cactaceae* (1941); Fran Buxbaum, *Morphology of Cacti,* 3 vol. (1950–55); Vera Higgins, *Stud of Cacti,* 2nd ed. (1946); for a discussion of about half the species native in the United States, *see* Lyman Benson, *Cacti of Arizona* (1950

Horticultural.—Curt Backeberg, *Die Cactaceae,* 6 vol. (1958–62 with good photographs of many species; J. Borg, *Cacti,* 2nd ed. (1956) W. Haage, *Das Praktische Kakteenbuch in Farben* (1961), rev. an trans. by E. E. Kemp as *Cacti and Succulents* (1963). (L. BN.)

CACUS AND CACA, brother and sister, were originally fir deities of the early Roman settlement on the Palatine hill, wher "Cacus' stairs" were later situated. Virgil describes Cacus as th son of the flame god Vulcan and as a monstrous fire-breathin brigand who terrorized the surrounding countryside. Cacus stol some of the giant Geryon's cattle from Hercules (*q.v.*), draggin them tailfirst to his lair on the Aventine hill. But a lowing co betrayed him and Hercules, bursting in, overpowered and kille him. There are various later versions of this story, which is trad tionally connected with the establishment of Hercules' oldest R man place of worship, the Ara Maxima, in the "cattle market whose name was believed to commemorate these events.

(D. E. W. W.)

CADALSO Y VÁZQUEZ, JOSÉ DE (1741–1782), Spa ish writer notable for his "Moroccan Letters," was born in Cád on Oct. 8, 1741, joined the army out of patriotism, although op posed to war on principle, and was killed on Feb. 27, 1782, at th siege of Gibraltar. He is studied mainly for his *Cartas marruec* (pub. in *Correo de Madrid,* 1789; as a book, 1793), in which Moorish traveler in Spain makes acute observations, still su prisingly relevant, about the country, its history and people. H satirical *Los Eruditos a la violeta* (1772), a digest of knowledg for the use of the pseudo-learned, was so successful that its titl at once became an epithet.

Other works reflect the conflicting theories and tastes of th time: his rhymed tragedy, *Don Sancho García, conde de Castil* (1771), rigidly applies neo-classical precepts, while his aut biographical prose-work, *Noches lúgubres* (pub. in *Correo d Madrid,* 1789–90; as a book, 1798), foreshadows the subjecti attitude and disillusionment of the romantics. His poetry, *Ocios de mi juventud* ("Diversions of my youth"; 1773), combines the national poetic tradition of the 16th with the new foreign sensibility of the mid-18th century.

See J. A. Tamayo, *Cartas marruecas* (1935); Edith F. Helman, *Noches lúgubres* (1951). (Eh. F. H.)

CA DA MOSTO (Cadamosto), **ALVISE** (1432–1488), Venetian explorer and trader, who wrote one of the earliest accounts of western Africa. In 1454 he obtained permission from Prince Henry the Navigator to make a voyage to the south on a profit-sharing basis. Setting sail on March 22, 1455, he visited the Madeira group and the Canary Islands, and coasting the west Sahara arrived at the Senegal, whose lower course had already been explored by the Portuguese 60 mi. up.

The Negro lands and tribes south of the Senegal, and especially the country and people of Budomel, a friendly chief reigning about 50 mi. beyond the river, are next dealt with in his narrative. Da Mosto thence proceeded toward the Gambia which he ascended some distance, but finding the natives extremely hostile he returned direct to Portugal. His account includes an interesting description of the commerce between Morocco and the western Sudan, and particularly the "silent trade" in gold. He claims to have drawn a chart of his voyage and to have observed the Southern Cross at the mouth of the Gambia. In 1456 he went out again. Doubling Cape Blanco he was driven out to sea by contrary winds and thus discovered the Cape Verde Islands. Having explored Boa Vista and São Tiago and found them uninhabited, he returned to the African mainland and pushed on to the Gambia, Rio Grande and Geba. Da Mosto returned to Venice in 1463, where he subsequently held important official appointments.

His narrative, first printed in the *Paesi nuovamente ritrovati* (1507), has frequently been reprinted. It is translated in "The Voyages of Cadamosto," *Hakluyt Soc.*, 2nd ser., vol. 80 (1937).

Bibliography.—R. H. Major, *The Life of Prince Henry of Portugal* (1868), where da Mosto's discovery of the Cape Verde Islands is rejected; C. R. Beazley, *Prince Henry the Navigator* (1895); A. da Mosto, "Il navigatore Alvise da Mosto," *Archivo Veneto*, 2 (1927). (G. R. Ce.)

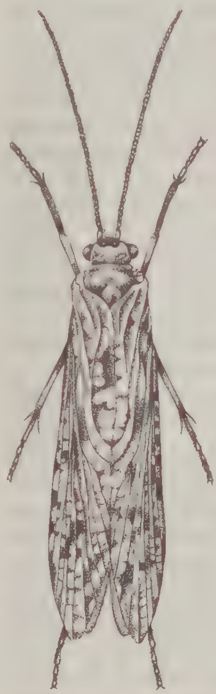
CADBURY, GEORGE (1839–1922), British businessman and social reformer, who, with his elder brother Richard, was a founder of the modern Cadbury cocoa and chocolate manufacturing business, is chiefly remembered for his innovations in promoting the welfare of working men and in particular for improving the conditions in which they were employed and housed. He was born at Birmingham on Sept. 19, 1839, of long Quaker ancestry. The brothers took over their father's decaying business in April 1861 and, gaining a reputation for quality, built up a huge concern with interests in Great Britain and overseas. In 1879 their factory was moved from the heart of industrial Birmingham to a rural site outside the city which they called Bournville. On Richard's death in 1899 the business became a private company with George Cadbury as chairman. Working conditions and social security measures were introduced which were much in advance of their times.

Cadbury taught in a Birmingham adult school for many years and his experience there convinced him that bad housing lay at the root of much social evil. In his private capacity he acquired land adjoining the factory and in 1895 he began to build working-class dwellings which were unusual for their amenities, in particular their ample gardens. He sold, leased or rented these houses without reserving them for his own employees, intending from the first to put his experiment on an economic basis and to build up a multiclass community. Bournville, as an example of controlled suburban development, set the pattern for subsequent state and private housing and town-planning schemes. In 1900 Cadbury renounced his financial interest in the estate and founded the Bournville Village trust which, by 1960, owned 1,000 ac. at Bournville, as well as agricultural land, and engaged in research and other activities in furtherance of its founder's aims.

George Cadbury also did a great deal for the evangelical side of the work of the Society of Friends (Quakers); he was especially interested in bringing about the unity of the Christian churches and was one of the founders of the National Free Church council. In order that Liberal views should be expressed in the press, he became chief proprietor of the London *Daily News* (afterward the *News Chronicle*) in 1901, and his family later acquired other newspapers, including the *Star* (1909), later incorporated in other newspapers. Cadbury died at Birmingham on Oct. 24, 1922.

Bibliography.—A. G. Gardiner, *George Cadbury* (1923); I. A. Williams, *The Firm of Cadbury* (1931); *Industrial Record* (1944); *The Bournville Village Trust: 1900–1955* (1956). (Wm. E. C.)

CADDIS FLY, the common name for an order of aquatic insects, the Trichoptera. Adult caddis flies, some of which superficially resemble moths, range from 1.5 to 40 mm. in length, and have a pair of long to very long antennae. Mouthparts are reduced except for long palps or feelers. In repose the two pairs of membranous wings are held rooflike over the body and have a moderate number of longitudinal veins but few crossveins. Males of a few species have scales on the head and wings; in all other caddis flies the body and appendages are hairy but not scaled.



FROM H. H. ROSS, "THE CADDIS FLIES, OR TRICHOPTERA, OF ILLINOIS" (STATE NATURAL HISTORY SURVEY OF ILLINOIS)

ADULT CADDIS FLY (RHYACOPHILA FENESTRA) (ABOUT FIVE TIMES NATURAL SIZE)

The young larvae, or caddis worms, with the exception of a few species found in ocean water or in damp moss, live in fresh water. They have distinct hard heads, three pairs of thoracic legs and a pair of hooks at the end of the abdomen. The mature larvae transform to pupae, which are very much like mummified adults.

The adults feed only on water and nectar. Generally the mated female crawls into the water and lays her eggs on or under a submerged object.

The larvae are omnivorous, feeding chiefly on microorganisms; in a few genera they are predators on other insects. Larvae of one group construct a fixed retreat and a net of some sort, eating the food strained from the water or caught on the net. Larvae of the family Rhyacophilidae are free-living, predaceous on other insects in the water. All others construct a portable case of mucous secretion, sand grains, bits of leaves or sticks, etc., with only the larval head and thoracic legs protruding from the case. Mature case-making larvae attach the case to a solid object, then pupate within it. Other larvae construct a cocoon for pupation.

When fully mature the pupa cuts its way out of the case or cocoon by using its strong, sawlike mandibles. It wriggles out of its house, then swims to the surface of the water and transforms to the adult stage. Many northern species have only a single generation per year; others may have more.

Caddis flies had already evolved about 200,000,000 years ago, as shown by fossil representatives in Triassic strata. About 5,000 living species have been described and classified in about 25 families; they are found on all the continents. Caddis flies are extremely abundant in practically all non-polluted fresh water and constitute an important segment of such aquatic communities. The primitive forms of all major groups live in cold streams (in which the order originally evolved), but over the aeons various lines have colonized warmer water and evolved into specialized genera and families, many of which now abound in tropical fresh-water habitats.

Bibliography.—G. Ulmer, "Trichoptera" in *Köcherfliegen von den Sunda-Inseln* (1951); C. Betten, *Caddis Flies, or Trichoptera of New York State* (1934); H. H. Ross, *Caddis Flies, or Trichoptera, of Illinois* (1944), *The Evolution and Classification of the Mountain Caddisflies* (1956). (H. H. R.)

CADDO, a North American Indian linguistic stock, applied also to specific tribes and to archaeological remains. Caddoan-speaking peoples occupying most of the eastern Great Plains area were the Arikara and Pawnee (*qq.v.*) of the Dakotas and Nebraska; the Wichita and Kitsai of Kansas, Oklahoma and Texas; and the Caddo proper consisting of three loose confederacies: Kadohadacho (Petit Caddo, Upper Nasoni and Nanatsoho), Hasinai (Nacogdoche, Anadarko, Lower Nasoni and others), and Natchitoches (Doustioni and Ouachita). Scattered farmsteads and hamlets of domed grass lodges and clay-walled huts with associated ceremonial centres of temple mounds were distributed along the Neches and Angelina rivers in Texas and the main course of the Red river from west central Louisiana into eastern Oklahoma and southwestern Arkansas. This is the area also of the Caddoan archaeological complex which has produced so many striking examples of American Indian workmanship. Throughout the whole area archaeological research shows the Caddoan tenancy to be ancient.

The Caddo proper may first have been seen by De Soto's party in 1542. The first adequate descriptions come from the survivors of La Salle's last voyage. The Caddo played an important role in early French and Spanish colonial ventures, and observers were impressed with the complexity of their culture. Advanced horticulture by the women was supplemented by the hunting of the men. There was a stable social stratification. A hereditary upper group marked by head deformation and other status symbols was concerned with directing political and religious activities. The religion involved regulation of daily life and prognostication through astronomical observations. There are scattered reports of ceremonial human sacrifice and cannibalism. These and other traits relate the peoples to the centres of high culture in Mexico and Yucatan. The total cultural fabric is reminiscent of the settled tribes of the lower Mississippi river and adjacent southeastern regions. There were influences from the plains but these were late and of minor importance. Early epidemics and continuing population decline reduced their numbers from many thousands to about 1,000 settled on a reservation in east central Oklahoma. *See* also PLAINS INDIANS; INDIAN, NORTH AMERICAN.

See John R. Swanton, *Source Material on the History and Ethnology of the Caddo Indians*, Bureau of American Ethnology *Bulletin 132* (1942). (P. Ho.)

CADE, JACK (d. 1450), was leader of the English rebellion which began in Kent at the end of May 1450, and was provoked by fear of reprisals for the capture and subsequent murder off Dover (May 2) of William de la Pole, duke of Suffolk. The rebellion was also a protest against the tyranny and corruption of Henry VI's ministers, particularly the lord treasurer James Fiennes, Lord Saye and Sele. The rebels, led by Cade, calling himself "John Mortimer, captain of Kent," marched from Ashford to Blackheath (June 10), but retreated a week later when the king advanced with his troops. Overtaken at Sevenoaks, they defeated part of the royal army (June 18), returned and entered London (July 3) after Henry VI had retired to Kenilworth castle. Lord Saye and his son-in-law, William Crowmer, sheriff of Kent, were executed, but the Londoners were soon alienated by Cade's lawlessness and his supporters were driven from the city into Southwark (July 5–6). The rebels dispersed when the government offered a pardon, but Cade continued resistance and was killed by Alexander Iden, the new sheriff of Kent, on July 12, 1450.

Cade's real identity remains a mystery. The proclamation ordering his arrest describes him as an Irishman, resident in Sussex until he fled to France after murdering a woman. There is a legend that he was John Aylemere, a physician. Possibly the rising did not have the same captain throughout; according to *Gregory's Chronicle*, although Cade led the rebels back to London after the battle of Sevenoaks, he was not the original leader. Cade did not, as Tudor chroniclers maintained, claim kinship with Richard, duke of York, although he called himself Mortimer, the family name of the earls of March, from whom the duke was descended.

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CADENCE in music is the name given to the approach to a phrase ending, sometimes now also called a close. Passing cadences have about the same value as commas or semicolons in prose; half closes as colons or full stops; full closes as paragraph endings. The word cadence means "fall" (Latin, *cadere*) and its use in this connection derives from the fall of a tone in the tenor part that defined a formal cadence in medieval music. In later music a cadence is defined mainly by the harmony, of which the momentum is more or less momentarily checked. Important cadences generally need to be acknowledged by a corresponding slackening of the tempo. *See* also CADENZA. (R. Do.)

CADENZA, the Italian word for cadence, is the name given to an unaccompanied bravura passage introduced at or near the close of a movement as a brilliant climax, particularly in solo concertos of a virtuoso character where the element of display is prominent. Until well into the 19th century these interpolated passages were often improvised by the performer, at suitable openings left for the purpose by the composer. They were displays not only of executive powers but also of more or less spontaneous imagination and invention. Modern performers use written-out cadenzas even for classical concertos, and modern concertos, if they include cadenzas, have them ready-made by the composer. *See* also IMPROVISATION. (R. Do.)

CADER IDRIS (CADAIR IDRIS), "the chair of Idris," one of the highest mountains in north Wales, ranking next to Snowdon in popular favour. It stands south of Dolgellau and the Mawddach estuary in Merioneth, in an area which contains a superb collection of glacial features and shows very clearly the interaction of structure and process in landscape building. The main core of the mountain is formed by a beveled ridge about 8 mi. long, culminating in a small monadnock known as Pen-y-Gadair (2,927 ft.) and sharply defined by steep rock walls, nearly 1,000 ft. in height to the north. The grassy slopes descending southward to the Dysynni valley are abrupt, while there is the sheer drop from the ridge to the dark tarn of Llyn-y-Cau, one of the most remarkable cirques (cwms) in Britain. Beyond the narrow wall, 1,000–1,200 ft. in height, is the opposing cwm, equally impressive, in which lies Llyn-y-Gadair. The views from the summit are impressive and varied on the north side; to the southwest the wide sweep of Cardigan bay is embraced. Mention of Cader Idris and its legends is frequent in Welsh literature, old and modern. (E. G. Bow.)

CADET, a younger son, or head of a junior branch of a family. As a military term, cadet commonly denotes a young man undergoing training to become an armed forces officer. The latter use arose in France, where it was applied to younger sons of the nobility who gained commissioned rank after being attached for a time without pay to active army units. The term "cadet," or "gentleman cadet," is applied in most nations to candidates for commission who are students in national military schools. In the United States, for example, cadet is the official title of students at the Military academy at West Point, N.Y., and at the Air Force academy in Colorado; students at the Naval academy at Annapolis, Md., however, are known as midshipmen, their official navy rank, though they were known as cadets in the 19th century. The word "caddie," a messenger boy or one who carries clubs at golf, is derived from "cadet" through the Scots form "cadee," as is the slang word "cad," a vulgar, ill-bred person. (T. N. D.)

CÁDIZ, a city of southern Spain, capital and principal seapor of the province of the same name, is situated on Cádiz bay, an inlet of the Atlantic ocean, 153 km. (95 mi.) S.S.W. of Seville by road. The population, commonly referred to as Gaditanos, wa estimated to be 113,749 in 1960.

Cádiz is built on the low, rocky extremity of a narrow sandy spit projecting about 5 mi. into the sea in a northwesterly direc tion from the Isla de León, which is separated from the mainland by a broad channel known as the Río Santi Petri. The isthmu and headlands on the mainland to the north nearly enclose th splendid bay, to which Cádiz owes its commercial importance The outer bay, affording extensive anchorage in from six to te fathoms of water, stretches from the promontory of Rota to th mouth of the Río de San Pedro, formerly a distributary of th Guadalete, which enters the bay opposite Cádiz. The inner bay guarded at its narrow entrance by the forts of Puntales an Cortadura on the isthmus and Trocadero on the opposite side, n longer provides good anchorage. On its south shore is the important naval arsenal of San Fernando. The entrance to the bays is somewhat obstructed by the low shelving rocks of Los Cochinos and Las Puercas and by shifting mudbanks deposited by the rivers, but the channel is well marked by illuminated buoys. Because of its almost insular position Cádiz enjoys a mild climate, with temperatures never falling below 32° F. in winter or rising above 85° in summer.

The city, 6 to 7 mi. in circumference, is hemmed in by the sea and surrounded by a wall, now mainly demolished, and has only one land exit. The houses, three-storied or more high, have flat roofs and watchtowers in the Moorish style. The Alameda is the finest of the marine promenades which fringe the city. The general air of cleanliness is due partly to the houses being whitewashed every year. In 1947 the city suffered great damage from the explosion of a naval arms store. The old cathedral was originally erected by Alfonso X of Castile (1252–84) and rebuilt after 1596. The new cathedral, begun in 1722 and completed in 1838, is a notable example of Andalusian baroque architecture. Its famous covered crypt, built on a bold, vaulted plan, contains the remains of the Gaditanian contemporary composer, Manuel de Falla. The cathedral possesses a magnificent collection of art treasures, including the silver coach for the Corpus Christi festival. Among important works of art, the church of the Hospital de Mujeres (women's hospital) has the "Ecstasy of St. Francis" by El Greco and the Santa Cueva chapel three outstanding paintings by Goya. The church of the Capuchin friars, now secularized, contains an unfinished picture of the "Marriage of St. Catherine," by Murillo, who died after falling off the scaffold on which he was painting it (April 3, 1682). In the centre of the city there is a signal tower, the Torre de Vigía (100 ft.), a well-known landmark. Cádiz possesses three theatres and a bull ring accommodating 14,000 spectators, and several charitable institutions, schools and museums. An old fort as well as a lighthouse stands on the rock of San Sebastián to the west of the city. By the 1960s an entirely new quarter had grown up along the isthmus.

The loss of the Spanish colonies in the Americas dealt a blow to the trade of Cádiz from which it never recovered. Its decline was later accelerated by the disasters of the Spanish-American War of 1898, by the decreasing demand for sherry and above all by its antiquated harbour works. After 1900 considerable improvements were made, until the harbour had more than two miles of quayside and recovery proceeded steadily. A free depot established in 1823, but lapsing after 1832, was successfully revived on modern lines. Industrial development is rather small, but important naval and mercantile shipbuilding yards and various factories exist on the mainland and there are tunny fisheries off the coast. The city is primarily a commercial port, exporting much wine, principally sherry from Jerez, salt, olives, figs, corks and salted fish, and importing coal, iron and machinery, timber, cereals, coffee and other foodstuffs. Several shipping lines call there and passenger traffic is important. The development of Cádiz, however, must always be limited by the restrictions of its site. The railway connects the town with Jerez and Seville. There is a military airfield at Jerez, 50 km. (31 mi.) N.E., and a Spanish-U.S. naval and air base at Rota.

History.—Cádiz, founded as Gadir, according to tradition, by Phoenician merchants from Tyre as early as 1100 B.C., was occupied by the Carthaginians about 501 B.C. At the close of the Second Punic War the city willingly surrendered to Rome and from this time as Gades its prosperity steadily increased. The wealth and importance of Gades became so great that under Augustus it was the residence of no fewer than 500 equites (*q.v.*), and was made a municipium with the name of Augusta Urbs Julia Gaditana, with citizenship ranking next to that of Rome. Throughout the Roman world its cuisine and its dancing girls were famous. In the 5th century it was destroyed by the Visigoths. A few fragments of masonry, submerged under the sea, are almost all that emains of the original city. Moorish rule over the port, which was renamed Jezirat-Kadis, lasted from 711 until 1262, when Cádiz was captured, rebuilt and repeopled by Alfonso X of Castile. Its renewed prosperity dated from the discovery of America in 1492. As the headquarters of the Spanish treasure fleets, it soon became the wealthiest port of western Europe. During the 16th century it repelled a series of raids by the Barbary corsairs; in 1587 all the shipping in its harbour was burned by an English squadron under Sir Francis Drake; in 1596 the fleet of the earl of Essex and Lord Charles Howard sacked the city and destroyed 40 merchant galleons and 13 men-of-war. But Cádiz quickly recovered, and its new fortifications enabled it to repel successfully attacks by British fleets under the duke of Buckingham in 1626, Admiral Blake in 1656 and Sir George Rooke and the duke of Ormonde in 1702. During the 18th century the wealth of Cádiz became greater than ever; indeed at this time it is said to have been wealthier than London. With the closing years of the century, however, it entered upon a period of misfortune. From Feb. 1797 to April 1798 it was blockaded by the British fleet, and in 1800 Nelson bombarded it. In 1808 the citizens captured a French squadron imprisoned by the British fleet in the inner bay. From Feb. 1810 to Aug. 1812 it was besieged by French forces, during which time it served as the capital of all Spain not under the control of Napoleon. There, too, the *Cortes* met and promulgated the famous liberal constitution of March 1812 which led to the 1820 revolution. Ferdinand VII was imprisoned there until released in 1823 by a French army. In the Spanish civil war of 1936–39 Cádiz fell to the Nationalists almost at once, and served as an important port of entry for reinforcements from Spanish Morocco.

CÁDIZ PROVINCE. In the historic region of Andalusia (*q.v.*) the province was formed in 1833 of districts taken from Seville. It is bounded on the north by Seville, east by Málaga, southeast by the Mediterranean sea, south by the Strait of Gibraltar and west by the Atlantic ocean. Pop. (1960 est.) 818,847; area 2,851 sq.mi.; exclusive, in each case, of Ceuta (*q.v.*), on the Moroccan coast, which, for administrative purposes belongs to Cádiz. The main features of the Atlantic coast line of Cádiz are the broad Guadalquivir estuary, which marks the frontier with Seville, the double bay of Cádiz, outlet for the Guadalete, chief river of the north districts, and Cape Trafalgar. Farther south, the Barbate river, draining the broad, marshy Laguna de la Janda, flows into the Strait of Gibraltar; and Punta Tarifa (Point Marroquí), on the strait, is the southernmost promontory of the European mainland. On the east coast the rock and fortress of Gibraltar overlook Algeciras bay; and the Guadiaro river, which drains the eastern highlands, enters the Mediterranean close to the frontier of Málaga. In the interior there is a striking contrast between the comparatively level western half of the province and the picturesque well-wooded mountain ranges of the east with splendid extensive views over the Strait of Gibraltar and the African coast. These mountains, which form the west end of the Boetic Cordillera, attain their greatest altitudes within the province in the Sierra del Pinar (5,426 ft.).

The climate is mild and equable, and with naturally fertile soil makes fruit, vine and olive growing one of the chief sources of wealth in the province, though severe droughts often cause great distress. Jerez de la Frontera (*q.v.*) is famous for the manufacture and export of sherry. Much cork is obtained from the mountain forests, and quantities of fish are caught off the coast and are salted for export. A considerable amount of salt is obtained by evaporation of sea water in pans near Cádiz bay. Railway communication is limited in the west to a line from Seville to Cádiz, with branch lines to Sanlúcar from Jerez and El Puerto de Santa María, and from Sanlúcar a few miles north to Bonanza; and in the east to a line from Seville to Algeciras. Apart from the provincial capital, the main centres of population (1960 census) are: Sanlúcar de Barrameda (40,335), the naval station of San Fernando (52,389), Algeciras (66,317), El Puerto de Santa María (35,505) (*qq.v.*), La Línea (59,456), Tarifa (18,042) and Puerto Real (18,138) on the coast; Jerez de la Frontera (130,900), Vejer de la Frontera (13,553), Medina-Sidonia (16,190) and Chiclana de la Frontera (21,524) inland; San Roque (17,126), Ubrique ([1950] 9,172), Jimena de la Frontera and Grazalema are lesser towns trading in farm produce, wine and leather; Rota ([1950] 15,482) is located on the northern shore of the Bay of Cádiz.

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CADMAN, CHARLES WAKEFIELD (1881–1946), one of the first U.S. musical composers to become interested in the music and folklore of the U.S. Indian, was born at Johnstown, Pa., on Dec. 24, 1881. His songs "At Dawning" (1906) and "The Land of the Sky Blue Water" (1908) became American classics. Among his operas are *Shanewis* (*The Robin Woman*), produced at the Metropolitan Opera house on March 23, 1918, and repeated in 1919, the first American opera to be carried over into a second season; *The Garden of Mystery,* produced in New York, March 18, 1925; *The Sunset Trail,* Denver, 1925; *A Witch of Salem,* Chicago Civic Opera company, Dec. 8, 1926. Other compositions include a cantata, *The Vision of Sir Launfal; American Suite* for strings; *Thunderbird Suite* for piano; *Huckleberry Finn Overture;* and *The Willow Tree* (1931), the first U.S. opera written for radio. Cadman was one of the founders of the Hollywood Bowl. He died in Los Angeles on Dec. 30, 1946.

CADMIUM, a metallic element, showing a close relationship to zinc, with which it is frequently associated. It was discovered in 1817 by Friedrich Strohmeyer in a sample of zinc carbonate yielding a yellow zinc oxide, although quite free from iron. Simultaneously K. S. L. Hermann discovered the new metal in a specimen of zinc oxide thought to contain arsenic, since it gave a yellow sulfide in acid solution on the addition of hydrogen sulfide.

Cadmium (Cd) does not occur naturally in the uncombined condition, and only one mineral is known which contains it in any appreciable quantity, namely, greenockite or cadmium sulfide, found at Greenock and at Bishopton in Scotland, and in Bohemia and Pennsylvania. It is, however, nearly always found associated with zinc blende (sphalerite) and with calamine (smithsonite and hemimorphite), although only in small quantities, rarely exceeding 3%.

The metal was first obtained from the blue powder (impure zinc dust) collected in the condensers, or prolongs, of a zinc retort furnace during the first three or four hours of the distillation cycle. Repeated redistillations of this blue powder enriched the cadmium in the final blue powder. The latter was dissolved in sulfuric or hydrochloric acid, and a high-grade cadmium sponge was precipitated by the addition of metallic zinc dust. Metallic cadmium was then produced by retort distillation of the sponge at a temperature of about 800° C.

Most cadmium is recovered from the fumes eliminated during the sintering of zinc concentrates, from the dust collected from the gases leaving lead blast furnaces and from various purification cakes produced during the electrolytic recovery of zinc. Smaller quantities are recovered during the refining of zinc and the production and refining of lithopone and zinc oxide.

The raw fume or cake usually contains from 5% to 20% Cd, and it is commonly dissolved in sulfuric acid. The resulting solution or slurry is clarified and purified to remove many of the impurities. A cadmium sponge containing from 75% to 95% Cd can then be precipitated by the addition of metallic zinc dust. This sponge can be melted under molten caustic soda or it can be charged to retorts. It can also be dissolved in the acidic spent electrolyte from an electrolytic cadmium plant. The latter produces sheets of relatively pure cadmium, which are remelted and cast into shapes for the market.

The United States is the world's largest producer of cadmium, with an annual output of about 5,000 short tons. Mexico is an important producer of cadmium-bearing dusts and fumes, but most of these are smelted in the United States. The Republic of South Africa, Belgium and Canada each produce from 500 to 900 tons per year. Australia, Poland, Italy, the United Kingdom, Japan, Norway, France and the Federal Republic of Germany are also important producers. The output is linked to the production of zinc and cannot be changed substantially by short-term variations in price; occurrences of commercial significance are those of commercially exploited zinc ores (*see* Zinc).

USES

Electroplating.—About two-thirds of all cadmium produced is used in the plating of steel, iron, copper, brass and other alloys to protect them from corrosion. The metal is deposited electrolytically from an alkaline cyanide bath, a typical solution having the composition: 25 g. per litre of cadmium oxide and 100 g. per litre of sodium cyanide. The cadmium oxide is dissolved in the cyanide solution with the formation of $Cd(CN)_4^{2-}$ and the liberation of two hydroxides, which render the solution alkaline. Cadmium anodes are used to replenish the metal as it is deposited on the cathode, and the process is carried out at room temperature, with a voltage of from 1 to 14 v., depending on the degree of stirring. Certain organic compounds are sometimes added during the electrodeposition, as their presence increases the brightness of the surface. Cadmium plating provides excellent resistance to outdoor corrosion and in this respect is at least the equal of zinc and superior to tin; it is especially resistant to attack by alkali. It is used on electrical parts because of the ease of soldering to it and because of its relatively low electrical conductivity.

Other Uses.—About one-fifth of the cadmium metal or purified metallic sponge is redissolved and converted to pigments; the sulfides and sulfoselenides provide the best yellow and red colorations in many finishes, including enamels and lacquers for automobiles.

Storage batteries using cadmium as one element have much longer lives than those using lead elements, and they have other advantages with respect to weight and ability to be stored in a discharged condition. They are particularly attractive for use in aircraft and special applications where first cost is not a dominant factor. (*See* also *Compounds,* below.)

One of the most interesting uses of cadmium results from its high neutron-absorption qualities (called cross section). It is therefore used in the control rods of some nuclear reactors.

PHYSICAL AND CHEMICAL PROPERTIES

Cadmium is a silver-white metal and is capable of taking a high polish; on breaking, it shows a distinct fibrous fracture. By sublimation in a current of hydrogen it can be crystallized in the form of regular octahedra; it is slightly harder than tin but is softer than zinc and, like tin, emits a crackling sound when bent. It is malleable and can be rolled out into sheets. The important atomic and physical properties of cadmium are shown in the accompanying table.

Atomic and Physical Properties of Cadmium

Atomic weight	112.40
Atomic number	48
Isotopes:	
mass	106, 108, 110, 111, 112, 113, 114, 116
per cent abundance	1.4, 1.0, 12.8, 13.0, 24.2, 12.3, 28.0, 7.3
Density, 20° C.	8.65 g./ml.
Melting point	320.9° C.
Boiling point	767° C.
Specific heat, 25° C.	0.0551 cal./g./° C.
Electrical resistance, 20° C.	7.14×10^{-6} ohm cm.
Coefficient of linear expansion, 20° C.	29.8×10^{-6}
Electron structure	1s, 2s, 2p, 3s, 3p, 3d, 4s, 4p, 4d, 5s 2, 2, 6, 2, 6, 10, 2, 6, 10, 2
Ionization potentials:	
1st electron	8.96 v.
2nd electron	16.84 v.
3rd electron	38.0 v.
Electrode potential	$Cd = Cd^{2+} + 2e^- \; E° = 0.4020$ v.

The metal unites with the majority of the heavy metals to for alloys; some of these, the so-called fusible alloys, find a usef application from the fact that they possess a low melting poin The metal on boiling forms a deep yellow vapour which has be shown to be monatomic. The metal is quite permanent in dry a but in moist air it becomes coated with a superficial layer of t oxide; it burns on heating to redness, forming a brown-colour oxide; it is readily soluble in mineral acids with formation of t corresponding salts.

Cadmium is chemically related to zinc and mercury and in ge eral has properties intermediate between these elements. It is readily oxidized to the +2 oxidation state, giving the colourless ion Cd^{2+}. Alkali precipitates the hydroxide $Cd(OH)_2$, which is insoluble in excess base. The cadmium ion, like the mercuric ion, forms many complexes in aqueous solution, such as $Cd(NH_3)_4^{2+}$, $Cd(CN)_4^{2-}$, $CdCl_3^-$, $CdCl_4^{2-}$, etc. In addition to compounds of the +2 oxidation state, the solids Cd_2O and Cd_2Cl_2, corresponding to the +1 state, have been reported.

Compounds.—Cadmium oxide, CdO, is a brown powder of specific gravity 6.5, which can be prepared by heating the metal in air or in oxygen or by ignition of the nitrate or carbonate, or by heating the metal to a white heat in a current of oxygen, when it is obtained as a dark-red crystalline sublimate. It does not melt at a white heat, and is easily reduced to the metal by heating in a current of hydrogen or with carbon. It is a basic oxide, dissolving readily in acids, with the formation of salts somewhat analogous to those of zinc.

Cadmium hydroxide, $Cd(OH)_2$, is obtained as a white precipitate by adding potassium hydroxide to a solution of any soluble cadmium salt. It is decomposed by heat into the oxide and water, and is soluble in ammonia but not in excess of dilute potassium hydroxide; the latter property serves to distinguish it from zinc hydroxide.

The chloride, $CdCl_2$, bromide, $CdBr_2$, and iodide, CdI_2, are soluble salts; and cadmium iodide, which is one of the few iodides which are soluble in alcohol, is sometimes used in photography. The cadmium ion is highly complexed by all of the halide ions in aqueous solutions, thus giving rise to anomalous chemical behaviour. In solutions of increasing halide concentration, the complexes containing one, two, three and four halide ions are successively formed.

Cadmium sulfate, $CdSO_4$, is known in several hydrated forms. It is largely used for making standard electric cells, which give a practically constant voltage under normal conditions (*see* BATTERY: *The Nickel-Cadmium Battery;* INSTRUMENTS, ELECTRICAL MEASURING: *Primary Electrical Standards: Standard Cell*).

Cadmium sulfide, CdS, occurs naturally as greenockite, and can be artificially prepared by passing hydrogen sulfide through acid solutions of soluble cadmium salts, when it is precipitated as a pale-yellow amorphous solid. It is used as a pigment (cadmium yellow), since it retains its colour in an atmosphere containing hydrogen sulfide; it melts at a white heat, and on cooling solidifies to a lemon-yellow micaceous mass. An enamel pigment known as fine red or cadmium red is prepared from a mixture of 80%–90% of cadmium sulfide and 10%–20% of selenium. The product corresponds in composition to Cd_3SeS_2.

Normal cadmium carbonate is unknown; a basic carbonate of variable composition is obtained on the addition of solutions of alkali carbonates to soluble cadmium salts.

Analysis.—Cadmium salts can be identified by the yellow precipitate formed when hydrogen sulfide is passed through their acidified solutions. This precipitate is insoluble in cold dilute acids, a behaviour which distinguishes it from the yellow sulfides of arsenic and tin. Cadmium may be determined quantitatively by precipitation as the sulfide, followed by the conversion of the latter to the sulfate. A better method involves the precipitation of the cadmium with trimethylphenylammonium iodide. This reagent is also an excellent qualitative indicator for cadmium under operating conditions at most cadmium plants.

TOXICITY

Certain cadmium compounds are very poisonous; others seem to have little effect when present in far larger quantities. The metal vapour itself and the very fine oxide which results from its combustion in air appear to cause the most violent reactions when taken into the lungs. Severe lung damage is noted in fatal cases, but exposed workers are usually warned by such symptoms as severe nausea and diarrhea before permanent damage is sustained. These disorders are not only warnings of an unsafe condition but also tend to force the affected workman to leave his job. In most cases of mild poisoning, the symptoms will have been relieved in 24 hours, and no permanent ill effects will be noted.

Soluble cadmium compounds are about as poisonous as those of lead and arsenic, and a few deaths have been ascribed to them in cases unrelated to cadmium recovery and production. Conditions causing mists or aerosols of cadmium solutions should be avoided if possible.

Cadmium sulfide is so insoluble that it can be tolerated in relatively large amounts. Coarse particles of cadmium oxide are also tolerated by most workmen, although in somewhat smaller quantities.

For areas continuously occupied by workmen sufficient ventilation should be provided to keep the concentration of fine metal fume or fine cadmium oxide below 0.1 mg. per cubic metre.

See also references under "Cadmium" in the Index volume.

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CADMUS, in Greek mythology, son of Phoenix or Agenor, king of Phoenicia, and brother of Europa. After his sister had been carried off by Zeus, Cadmus was sent out to find her. Unsuccessful in his search, he came to Delphi, where he consulted the oracle. He was ordered to give up his quest and follow a cow that would meet him, and to build a town on the spot where she lay down. The cow met him in Phocis and guided him to Boeotia, "cow land," where he founded the city of Thebes. Intending to sacrifice the cow, he sent some of his companions to a neighbouring spring for water. They were slain by a dragon, which in turn was destroyed by Cadmus, and by the instructions of Athena he sowed its teeth in the ground. From these sprang a race of fierce armed men, called Sparti (sown). By throwing a stone among them Cadmus caused them to fall upon each other till only five survived, who assisted him to build the Cadmea or citadel of Thebes and became the founders of the noblest families of that city (Ovid, *Metamorphoses*, iii, 1, ff.; Apollodorus III, i; iv). Cadmus, however, because of this bloodshed, had to do penance for eight years.

At the expiration of this period the gods gave him to wife Harmonia, daughter of Ares and Aphrodite, by whom he had a son, Polydorus, and four daughters, Ino, Autonoë, Agave and Semele, all ill-fated. At Cadmus' marriage all the gods were present; Harmonia received as bridal gifts a robe worked by Athena and a necklace made by Hephaestus, which caused much sorrow later (*see* HARMONIA). Cadmus is said to have finally retired with Harmonia to Illyria, where he and his wife were changed into snakes.

According to tradition, Cadmus brought the alphabet to Greece, and the Greek alphabet is in fact derived from a Phoenician script.

See H. J. Rose, *A Handbook of Greek Mythology* (1928); Edith Hamilton, *Mythology* (1942). (G. E. DK.; X.)

CADMUS of MILETUS, son of Pandion (date unknown), was, according to some ancient authorities, the inventor of history, or of prose, or simply the author of certain letters of the Greek alphabet. Despite this reputation for great antiquity there is no sign that any early Greek writer ever knew of Cadmus; in this he differs from Hecataeus and others. Dionysius of Halicarnassus was probably right in stating in his *De Thucydidis historia judicium* that the work current in his time under the name of Cadmus was a forgery. He was said to have written a book on the origins of Ionia.

See F. Jacoby, *Die Fragmente der griechischen Historiker*, vol. iii, no. 489 (1923 *et seq.*); Pauly-Wissowa-Kroll, *Real-Encyclopädie der klassischen Altertumswissenschaft*, vol. x, 2., pp. 1473–76 (1919). (G. T. GH.)

CADOGAN, WILLIAM CADOGAN, 1ST EARL (1672–1726), British soldier, was an outstanding staff officer who gained political influence as the friend and trusted colleague of the duke of Marlborough. He was born at Liscarton, County Meath, Ire., in 1672, the son of Henry Cadogan, a Dublin barrister. Cadogan began his military career as a boy cornet with William III at the battle of the Boyne (1690) and was later commissioned in the Inniskilling dragoons and served in Flanders. There he attracted the notice of Marlborough and was quartermaster to the Irish troops sent to Holland in 1701. When Marlborough became generalissimo of the allied armies in 1702, Cadogan became his quartermaster general and most trusted subordinate. Cadogan was present at Blenheim, rose rapidly in rank and distinguished himself not only in staff work, but in battle as colonel of the 6th (Cadogan's) Horse. In 1706 he served at Ramillies and received the surrender of Antwerp. In the later years of the war Cadogan took part in all the major actions, adding many diplomatic missions to his staff work. On Jan. 1, 1709, he was promoted to lieutenant general, and in 1710 served at Malplaquet and was wounded at Mons. Though the Tory party denigrated Marlborough by attributing the success of the campaign to Cadogan, he was in fact a first-class subordinate.

Cadogan figured largely in Marlborough's political following, and in 1705 entered parliament for Marlborough's pocket borough of Woodstock, which he retained until he entered the house of lords. He became lieutenant of the Tower of London in 1706. But from 1710 Cadogan suffered by his loyalty to the duke after Marlborough's political eclipse, and when the duke of Ormonde succeeded to the command of the army (1711), Cadogan retired to the Netherlands, losing his rank and offices. He was closely involved in plans to secure the Hanoverian succession, by force if necessary, and so on George I's accession his military promotion was resumed, and he was employed on various diplomatic missions abroad. In 1716, with the support of Marlborough, he displaced the duke of Argyll from the command of the campaign against the Jacobite earl of Mar, whose forces Cadogan crushed relentlessly. For these services he was made a baron. His diplomatic work as ambassador in the Netherlands, where he signed the Barrier treaty of 1715 and the triple alliance of 1717, earned him an earldom (1718). The divisions in the Whig party, however, exposed Cadogan (who, with Earl Stanhope and the earl of Sunderland formed the core of the ministry) to continuous attacks from Robert Walpole and his allies, while even his friends disliked his aspirations after political authority. Cadogan, like Marlborough before him, had become a thorough court politician and was more closely in league with the king and his Hanoverian advisers than any of the other ministers. His influence therefore suffered in the ministerial revolt against German influence and he had to accept a diplomatic mission to Vienna in 1720. After the death of Marlborough in 1722, Cadogan obtained his place of master general of the ordnance, and other offices, but without his patron's support he lost political significance. He died at Kensington on July 17, 1726. (W. R. Wd.)

CADORNA, LUIGI, Conte (1850–1928), Italian soldier, chief of the general staff for the first three years of World War I, was born on Sept. 4, 1850, at Pallanza in Piedmont. The son of Raffaele Cadorna, who had distinguished himself in the wars of the Risorgimento and the Crimea, he entered the Italian army in 1866. In 1914, on the death of Gen. Alberto Pollio, chief of the general staff, Cadorna was appointed to succeed him (July 10). The army was in a deplorable condition, and Cadorna worked unceasingly to restore it.

When Italy entered World War I by declaring war on Austria-Hungary in May 1915, Cadorna was given command on the Austro-Italian frontier. He directed operations on the basis of maintaining a defensive attitude in the Trentino and taking the offensive on the Isonzo, but the Italians had no real success in either sphere until the capture of Gorizia (Aug. 1916), which cost them very heavy casualties. In the same month Italy declared war on Germany.

After the overwhelming defeat of the Italians on the Isonzo front in the battle of Caporetto (Oct.–Nov. 1917), Cadorna was removed to the Allied military council at Versailles. Then the official inquiry into the defeat at Caporetto led to his being recalled from Versailles and placed on half pay. He retired from the army on Sept. 2, 1918.

In his retirement, Cadorna published *La Guerra alla fronte italiana,* two volumes (1921), which effectively answered much of the criticism that had been directed against his leadership. This was followed by *Altre pagine sulla Grande Guerra* (1925). He also wrote *Il generale Raffaele Cadorna nel Risorgimento italiano* (1922). He died at Bordighera on Dec. 21, 1928.

CADRE, a framework or skeleton, particularly the permanent establishment of a military corps, regiment, etc., which can be expanded on emergency. The modern tendency is for the cadre to be largely composed of commissioned and noncommissioned officers capable of filling higher grades on mobilization, and trained as instructors so that they may train the new recruits.

CADUCEUS (Caduceum), in classical times, was a badge showing that the bearer was a sacred person not to be molested. Originally it may well have been of magical potency, supposed to protect its bearer, as various other sticks or staves (*e.g.*, a king's sceptre) are reasonably thought to have been. "Caduceus" is a Latin loanword, Gr. *karykeion* from *karyx* ("herald"), hence "herald's badge of office." The change of "r" to "d" may originate in an idea that the word had something to do with *cadere, caducus* ("to fall," "fallen").

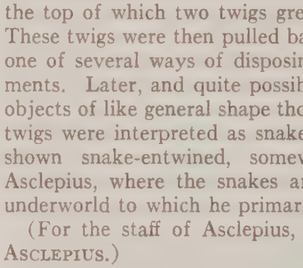
Its original form was in all probability a straight branch from the top of which two twigs grew, something like a dowser's rod. These twigs were then pulled back and twined around the branch, one of several ways of disposing of them attested by art monuments. Later, and quite possibly under the influence of oriental objects of like general shape though somewhat different origin, the twigs were interpreted as snakes, and thus the caduceus is ofte shown snake-entwined, somewhat like the staff carried b Asclepius, where the snakes are his familiars, creatures of th underworld to which he primarily belongs.

(For the staff of Asclepius, the symbol of the physician, *se* Asclepius.)

The most characteristic bearer of the caduceus is Hermes, who as described by Homer and later writers, runs errands for the greater gods, especially Zeus, and so is easily thought of as a herald; in cult he is the patron of heralds as of other wayfarers His *karykeion* is not to be confused with the magic wand which he and on occasion other gods, sometimes carry.

See F. J. M. de Waele, *The Magic Staff or Rod in Graeco-Roma Antiquity* (1927). (H. J. R.)

CAECILIAN, the best vernacular name for a group of tropica limbless, wormlike amphibians first described by Linnaeus as group of snakes but later recognized as an order of Amphibia t which the names Apoda and Gymnophiona have been given. Apod is the name generally used by systematists. (*See* Amphibia.)



LLOYD G. INGLES

PANAMAN CAECILIA (CAECILIA OCHROCEPHALA)

The caecilians are all limbless long-bodied Amphibia with a ver short tail, the vent being near terminal. Most are 12 in. c less in length, although one variety reaches 4 ft. Their bodie are usually more or less ringed b dermal folds, which gives ther the appearance of large eart worms. Within these folds i several genera are series of m nute scales, a structure otherwis unknown in living Amphibia. A genera are characterized by a p culiar protrusible tentacle on th side of the face near the nostril eye that is said to function as a tactile organ but is radically di ferent from such sense organs in other Amphibia.

Caecilians are primitive forms apparently directly derived fro the extinct Lepospondylia. They show no close affinity to oth living groups and are more primitive than the other living An phibia, the frogs and salamanders, in having certain bones of th skull (a postfrontal in *Ichthyophis,* etc.; an ectopterygoid *Hypogeophis,* etc.), a transitory spiracle cleft, a sixth gill sac, fo pairs of functional thymus glands and two additional pairs rudiments during development. The skull of caecilians is mu more consolidated than those of the other living Amphibia. T consolidation gives the skull rigidity and adapts it to the mechanical requirements of a burrowing existence. Reduction in the size of the eye, which in some species is hidden under the bones of the skull, is also an adaptation to burrowing. In spite of their primitive characters the caecilians are a highly aberrant and specialized group.

F. Nieden (1913) recognized 19 genera and 55 species, all referable as a whole to a single family, the Caecilidae. The primitive genera *Ichthyophis*, *Rhinatrema*, etc., have scales, exhibit the fewest fusions or skull elements and are the least modified for burrowing. The most specialized are either degenerate burrowers or aquatic (*Typhlonectes*). The structure of integument, skeleton or lungs may be modified as an adaptation to the habitat. The caecilians are seldom seen except after heavy rains or when uncovered by the plow.

The life histories of several genera of caecilians are known. *Ichthyophis* lays its eggs on land in damp situations, the larvae escaping to take up an aquatic existence. The more specialized *Hypogeophis* skips over the larval stage. Other genera, including the aquatic *Typhlonectes*, give birth to living young.

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CAECILIUS (fl. early 1st century A.D.), Greek rhetorician, was, next to Dionysius of Halicarnassus, the most important critic and rhetorician of the Augustan age. He was born at Calacte in Sicily. Only fragments of his works are extant, among which may be mentioned: *On the Style of the Ten Orators; On the Subime*, attacked by Longinus (?) in an essay on the same subject; *History of the Servile Wars*, or slave risings in Sicily; *On Rhetoric* and *Rhetorical Figures;* an *Alphabetical Selection of Phrases*, an Attic lexicon, mentioned in the later Suda lexicon as one of its authorities; and *Against the Phrygians*, probably an attack on the florid style of the Asiatic school of rhetoric.

See E. Ofenloch (ed.), *Caecilii Calactini fragmenta* (1907). (G. B. Kd.)

CAECILIUS STATIUS (Statius Caecilius) (d. 168 B.C.) was a Roman comic poet of the generation preceding that of Terence. Aulus Gellius says that he was a slave and "therefore" called Statius (a name given to slaves). Jerome says that he was an Insubrian Gaul; that some said his birthplace was Milan; that at first he lived with the poet Ennius; and that he died a year later than Ennius (*i.e.*, in 168 B.C.) and was buried near the Janiculum hill in Rome. Suetonius' *Life of Terence* states that the aediles (magistrates in charge of theatres, etc.) ordered Terence to read his *Andria* (produced 166 B.C.) to Caecilius; this looks like a mere anecdote. Caecilius had some difficulty in winning popularity; he owed his final success to the loyal support of the actor Ambivius Turpio. Of his comedies 42 titles and 280 lines or parts of lines are extant. Cicero speaks of him as a translator of the Greek comic poet Menander and quotes him in court in his peech *Pro Caelio;* Horace, in the *Epistles*, says that he was celerated for moral force (*gravitas*); Varro praises his plots and motional power; and the historian Velleius finds in him a vein of Latin wit. Volcacius Sedigitus, the literary critic, ranked him at the head of all Roman writers of comedy. Although Cicero riticized his Latinity, the fact that in his speech *De Finibus* he ould name Caecilius' *Hymnis* without any indication of the author is perhaps proof of its popularity. The fragments are free from topical allusions to Roman life. Gellius quotes considerable passages from his *Plocium* ("Necklace") side by side with the original by Menander to show how the Latin, though tolerable in itself, is inferior to the Greek in truth and delicacy. Caecilius has indeed translated with freedom, he has inserted crude jokes; his metres are varied; there is rhythmical effect and wordplay.

Information is too meagre to justify any very dogmatic statement. Perhaps it would be near the truth to say that Caecilius was a writer of considerable moral force, and that he was fond of Menander. He was probably less lively than Plautus and less polished than Terence.

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CAECINA, the name of a distinguished Etruscan family of Volaterrae (Volterra), and later used by Romans of other districts as a *gentilicium* or family name.

Aulus Caecina of Volaterrae (1st century B.C.) was defended by Cicero in 69 B.C. on a charge concerning a will. Either he or his son wrote an important work on Etruscan divination and was a close friend of Cicero during Julius Caesar's dictatorship, when he was banished for writing a tirade against Caesar.

Aulus Caecina Alienus (d. A.D. 79), Vitellius' general in A.D. 69, was born at Vicetia (Vicenza) in northern Italy, and as quaestor in Baetica (southern Spain) aided Galba's rebellion in A.D. 68. Legate of a legion in upper Germany, he was censured by Galba for embezzlement and took his revenge by supporting Vitellius (*q.v.*). He led an army from Germany over the Great St. Bernard pass in 69, attacked Placentia (Piacenza) without success, and was defeated by Otho's troops at Forum Gallorum (Castel Franco). But he held the front until his colleague Fabius Valens arrived and the two then overcame Otho's army east of Cremona. Caecina was made consul and was given charge of the first operations against the forces of Vespasian in Sept. 69. But he then betrayed Vitellius, whose leaderless legions were defeated at Cremona. Caecina was honoured (though apparently not employed) by Vespasian, but in 79 Titus, shortly before his accession, had him executed for an alleged conspiracy.

Other bearers of the name were Aulus Caecina Severus, consul in 1 B.C., and governor of lower Germany in A.D. 14; Aulus Caecina Paetus, who had to commit suicide in A.D. 42 after an abortive revolt against the emperor Claudius; Gaius Caecina Largus, who was a close friend of Claudius; and Aulus Caecina Tuscus, who was foster brother of Nero and prefect of Egypt, banished in A.D. 66. (G. E. F. C.)

CAEDMON, the earliest English Christian poet. His story is known only from Bede's *Ecclesiastical History*. He was (*see* Bede, Saint) a herdsman who received a divine call to poetry in a dream. One night, having quitted a company because, from want of skill, he could not comply with the demand made of each guest to sing, he dreamed that there appeared to him a stranger, who commanded him to sing of "the beginning of created things." He pleaded inability, but the stranger insisted, and he was compelled to obey. He found himself uttering "verses which he had never heard." Of Caedmon's song Bede gives a prose paraphrase, which, he says, represents the sense only, not the arrangement of the words. When Caedmon awoke he remembered the verses and added others. He related his dream to the farm bailiff under whom he worked, and was conducted by him to the monastery at Streaneshalch (now called Whitby). The abbess Hild (Hilda) recognized that the illiterate herdsman had received a gift from heaven, and, to test his powers, proposed that he should render into verse a portion of sacred history which the monks explained. By the following morning he had fulfilled his task. At the request of the abbess he became an inmate of the monastery. Throughout the remainder of his life his more learned brethren expounded to him Scripture history, and all he heard he reproduced in poetry. All his poetry was on sacred themes, and its unvarying aim was to turn men from sin to righteousness. Although many Englishmen after him essayed to compose religious poetry, none of them, in Bede's opinion, approached Caedmon.

Bede's account of Caedmon's deathbed has often been quoted, and is of singular beauty. It is often stated that he died in the same year as Hild, but for this there is no authority. Later evidence seems to point to his having died before her. All that is known certainly is that his dream took place during the period (658–679) in which Hild was abbess of Streaneshalch.

The hymn said to have been composed in his dream is extant in 17 manuscripts. The oldest version is added in a blank space in the Moore manuscript of Bede's *History*, in an 8th-century hand; it is in the Northumbrian dialect, and three other Latin manuscripts, including the 8th-century Leningrad manuscript, have it in this dialect, in the margin or text of Bede's account of the dream. Eight Latin manuscripts have the hymn transliterated into West Saxon. In the Old English translation of Bede's *History,* which survives in five manuscripts, a West Saxon text of the hymn replaces Bede's Latin paraphrase. Probably the Latin manuscript used by the translator contained this addition.

Several analogues have been brought forward to the story of a poet who composed in a dream; *e.g.,* Hesiod, Aeschylus, the anonymous author of the Old Saxon *Heliand* (though in his case influence from Bede's work is probable), the Icelandic skald Hallbjörn Hali, etc., but these need not discredit Bede's account. Nor is the lack of poetic merit a strong argument against the authenticity of the poem, which was Caedmon's first essay in verse.

The hymn is best edited by E. van K. Dobbie, *The Manuscripts of Cædmon's Hymn and Bede's Death Song* (1937). *See* also C. Plummer, *Venerabilis Baedae opera historica* II, pp. 251–258 (1896); A. H. Smith (ed.), *Three Northumbrian Poems* (1933); L. Pound, "Cædmon's Dream Song," *Studies in English Philology: a Miscellany in Honour of Frederick Klaeber* (1929); G. Shepherd, "The Prophetic Cædmon," *Review of English Studies,* new series, v (1954).

The "Caedmon Poems."—Although this poor fragment is all that can be confidently affirmed to remain of the voluminous works of the man whom Bede so highly admired, a considerable body of verse was known by his name and for convenience the use of the name has been retained. The so-called Caedmon poems are contained in a manuscript written about A.D. 1000, which was given in 1651 by Archbishop Ussher to the famous scholar Franciscus Junius, and is now in the Bodleian library, Oxford. They consist of paraphrases of parts of Genesis, Exodus and Daniel, and three separate poems, the first on the lamentations of the fallen angels, the second on the "harrowing of hell" and the third (a fragment) on the temptation. The subjects correspond so well with those of Caedmon's poetry as described by Bede that Junius unhesitatingly attributed the poems to him. The ascription was rejected in 1684 by G. Hickes, whose chief argument, based on the dialect, is known to be fallacious, as much "West Saxon" poetry is certainly of Northumbrian origin. Since, however, Bede says that Caedmon had many imitators, it is unsafe to assume that a collection of poems in a late 10th-century manuscript contains any of his work. Research has shown that the "Caedmon manuscript" cannot be all by one author; some portions of it are plainly the work of a Latin scholar. Some of the rest may be genuine; but the internal evidence can afford no certainty, although the unlikeness of any particular passage to the nine lines of the *Hymn* is no reason for denying Caedmon's authorship.

Genesis contains a long passage (ll. 235–851), which differs markedly in style and metre from the rest. This passage is one of the finest in all Old English poetry. In 1877 E. Sievers argued, on linguistic grounds, that it was mainly a translation from a lost poem in Old Saxon, probably by the author of the *Heliand,* a conclusion brilliantly confirmed in 1894 by the discovery in the Vatican library of a manuscript containing 62 lines of the *Heliand* and the original of 28 lines of the interpolated passage of the Old English *Genesis.* The Old Saxon biblical poetry belongs to the mid-9th century; the translation is consequently later. Similarities between passages in *Paradise Lost* and parts of the translation from Old Saxon have caused it to be suggested that some scholar may have talked to Milton about the poetry published by Junius, and that the poet may thus have gained some hints. The parallels, however, though interesting, are not conclusive.

As *Genesis* begins with a line identical in meaning with the opening of Caedmon's *Hymn,* it may perhaps be inferred that the writer knew Caedmon's genuine poems; but when, after treating of the revolt of Lucifer, the paraphrast comes to the biblical part of the story, he follows the sacred text with servile fidelity. The ages of the antediluvian patriarchs, for instance, are accurately rendered into verse. In all probability *Genesis* is of Northumbrian origin. The names assigned to the wives of Noah and his three sons (Phercoba, Olla, Olliua, Olliuani) have been traced to an Irish source, and this seems to point to the influence of the Irish missionaries in Northumbria.

Exodus is a fine epic poem, full of martial spirit, on how Moses led his people out of Egypt. It differs from other extant poetry in its condensation of style and its bold use of imagery, and it has much unique vocabulary. It cannot be by the same poet as any of the other poems in the manuscript.

Daniel is not a great poem, but the narration is lucid and interesting. The author has borrowed some 70 lines from a poetical rendering of the Prayer of Azarias and the Song of the Three Children, of which there is a copy in the *Exeter Book.* The borrowed portion ends with verse three of the canticle, the remainder of which follows in a version for the most part independent. Elsewhere the paraphrast draws only from the canonical book of Daniel. The poem is obviously the work of a scholar.

The three other poems, designated "Book II" in the Junius manuscript, are characterized by considerable imaginative powe and vigour of expression, but show an absence of culture and ar somewhat rambling. They abound in passages of fervid religiou exhortation.

Of poems not included in the Junius manuscript, the *Dream o the Rood* (*see* CYNEWULF) is the only one that has with any plausibility been ascribed to Caedmon. It was affirmed by G Stephens that the Ruthwell cross, on which a portion of the poem is inscribed in runes, bore on its top-stone the name "Cadmon"; but the traces of runes that are still visible exclude all possibilit of this reading. The poem is certainly Northumbrian and earlie than Cynewulf. It would be impossible to prove that Caedmo was not the author, though his authorship of such a work woul rank among the miracles of genius.

The name Caedmon (in the manuscripts of the Old Englis version of Bede written *Cedmon, Ceadmann*) has no simple philo logical explanation. The statement that it means "boatman" i founded on the corrupt gloss *liburnam, ced,* where *ced* is an erro for *ceol.* It is most probably the British *Cadman,* intermediate b tween the Old Celtic *Catumanus* and the modern Welsh *Cadfan* Possibly the poet was of British descent.

The oldest edition of the Caedmon poems is that of F. Junius (1655) There is a facsimile edited by Sir I. Gollancz (1927), and this work an the edition by G. P. Krapp, *The Junius Manuscript* (1931) conta bibliographies and full discussion of the various problems. The poe are translated by C. W. Kennedy, *The Cædmon Poems* (1916). *S* also C. W. Kennedy, *The Earliest English Poetry,* pp. 158–197 (1943 C. L. Wrenn, "The Poetry of Cædmon," *Proceedings of the Briti Academy,* xxxii (1946); J. W. Lever, "*Paradise Lost* and the Angl Saxon Tradition," *Review of English Studies,* xxiii (1947); E. B. I ving (ed.), *The Old English "Exodus"* (1953). (H. BR.; D. WK.)

CAELIUS, in full MARCUS CAELIUS RUFUS (82–48 B.C. Roman politician and protégé of Cicero (*q.v.*), was the son of Roman knight. Educated under the guidance of M. Licinius Cra sus and Cicero, he was constantly with Cicero during Cicer praetorship (66) and subsequently. In 63 he became friend with Catiline, but according to Cicero was not involved in th conspiracy. In 61 he went to Africa as *comes* (attendant) to t proconsul Q. Pompeius Rufus, and on his return in 59 successful prosecuted Gaius Antonius, who had been consul with Cicer in a brilliantly savage speech.

Caelius is probably the Rufus whom the poet Catullus accus of stealing his mistress Clodia from him. In 56 he was prosecut for violence (*vis*) at the instance of Clodia, whom he had deserte Caelius spoke in his own defense and Crassus and Cicero, who speech survives, also spoke for him. He was acquitted. In he was tribune and opposed Pompey's measures for bringi T. Annius Milo to trial for the murder of P. Clodius. He w induced by Pompey, against his own judgment, not to veto the l of the ten tribunes, allowing Julius Caesar to stand for the consu ship in absence.

In 51 Cicero went to Cilicia as proconsul, and Caelius by a rangement kept him supplied with news from Rome. His lette are preserved in the collection of Cicero's correspondence: 50 he was aedile (*q.v.*), and his letters to Cicero contain ma requests for panthers for his games. In Aug. 50 he foresaw ci war and seemed uncertain which side he should support. 49 he decided, and later fought for Caesar in northwestern Ita and Spain. In 48 he was *praetor peregrinus* (*see* PRAETOR), b he quarreled violently with the urban praetor Gaius Trebonius, a introduced measures amounting to a general cancellation of debts. The senate deprived him of his office, and he left Rome to join Milo and to start an insurrection, but he was soon killed at Thurii in Lucania. Brilliant and cynical, he was capable of impetuous acts of kindness or savagery. He lives more vividly than most of the men of his age, in his letters to Cicero.

See Cicero, *Pro M. Caelio oratio*, ed. by R. G. Austin, 3rd ed. (1960), *Epistolae*, ed. by R. Y. Tyrrell and L. C. Purser (1904–18).

(H. H. Sd.)

CAELIUS AURELIANUS, a physician of Sicca in Numidia, who probably flourished in the 5th century A.D., although some place him two or even three centuries earlier. A translation by Aurelianus of two works of Soranus of Ephesus (2nd century), the chief of the "methodist" school of medicine, on chronic and acute maladies—*Tardae*, or *Chronicae Passiones*, in five, and *Celeres*, or *Acutae Passiones*, in three books—is extant, as are also considerable fragments of his *Medicinales Responsiones*, also adapted from Soranus, a general treatise dealing with rules of health (*salutaria praecepta*) and the pathology of internal diseases (ed. Rose, *Anecdota Graeca et Latina*, ii, 1870).

CAEN, a city of northwestern France, capital of the *département* of Calvados (*q.v.*), 7½ mi. from the English channel and 149 mi. W.N.W. of Paris on the main railway to Cherbourg. Pop. (1954) 62,887; (1959 est.) 85,000. The city covers an area of approximately 6,000 ac., mostly on the left bank of the Orne river. The surrounding countryside is undulating, well-watered and fertile. To the southeast the extensive Plaine de Caen produces cereals; elsewhere, dairy farming and stock breeding are the chief agricultural activities.

Town Plan and Buildings.—Caen suffered great destruction following the Allied armies' invasion of Normandy in 1944; two-thirds of the buildings, including many ancient monuments, were destroyed or damaged. Rebuilding of the devastated area was completed by 1959. The central area of Caen is now an excellent example of modern town planning, with wide boulevards and spaced-out apartment buildings constructed of local freestone (as were many of the ancient buildings). The Avenue du Six Juin, the principal new thoroughfare, runs northward from the Orne to join the old Rue St. Pierre at its eastern end. The west side of the rebuilt area faces the open "Prairie," a green plain on which a race course is laid out.

The church of St. Étienne, or L'Abbaye-aux-Hommes, and the church of La Trinité, or L'Abbaye-aux-Dames, escaped damage in 1944; both date from the 1060s and both are fine specimens of Norman Romanesque. St. Étienne, in the west of the city, is characterized by its simplicity and purity of line. The west front, nave and two frontal towers rising to a height of 295 ft. are Romanesque; the spires were added in the early 13th century. The choir, one of the earliest examples of Norman Gothic, dates from the same period. The fine carved choir stalls date from the 17th century. A marble slab in front of the high altar marks he site of William the Conqueror's tomb. La Trinité, in the east, has a plain Romanesque front flanked by two square towers; the spires were destroyed during the Hundred Years' War. The tomb of Queen Matilda, wife of William, stands in the 12th-century choir; beneath it is a fine 11th-century crypt.

Halfway between the two abbey churches stands the highly decorated, beautiful church of St. Pierre; restoration of the wartime damage is complete. Its architecture is mainly Gothic, but the choir and the apsidal chapels are magnificent examples of French Renaissance. The Hôtel d'Escoville, on the Place St. Pierre, is a Renaissance mansion (1538) that has been faithfully restored. The castle, of which there are considerable remains, was built by William the Conqueror and was one of the largest of medieval times. Near St. Étienne is the secularized church of St. Nicholas, fine unaltered example of Benedictine Romanesque (*c.* 1090). The house where François de Malherbe was born (1555) stands in he Rue St. Pierre.

Caen is the seat of an academy for the whole of Normandy. ts university, founded in 1432 by Henry VI of England, was completely destroyed in 1944. A fine, spacious university, erected on the northern slopes of the city and having faculties of law, letters and science, was opened in 1957. There are two teachers' training colleges, a school of art and music and a preparatory school of medicine and pharmacy. Public buildings include the prefecture of the *département* of Calvados, which also contains the archives; a law court; a chamber of commerce; theatre; and branches of most leading French banks.

Economy.—Caen is a centre of road and rail communications. From the main railway station, on the right bank of the Orne, express trains connect with Paris, Cherbourg, Rouen, Le Mans and Tours. Coach services link Caen with the chief towns of Calvados and neighbouring *départements* and with the Le Havre-Southampton-London cross-channel route. Carpiquet airport, 4 mi. W. of Caen, has a customs and is open permanently to private aircraft. Weekly passenger and freight service is operated to the Channel Islands (Jersey), and air taxis can be hired.

The industrial development of Caen owes much to the iron-ore mines in the Orne valley to the south, which are the second in importance in France. The chief industries are iron and steel, heavy trucks and machinery. Manufactures include cement, tiles and ceramics, furniture and chemicals. The port of Caen, in the east of the city, through which more than 2,000,000 tons pass annually, is connected with the sea by a canal 9 mi. long, which enters the Channel at Ouistreham. Principal imports are coal, timber, phosphates; exports are chiefly iron ore, cement, machinery, wheat and dairy products. Caen serves as the main distributive centre for all lower Normandy.

History.—Caen first became an important place in the 10th and 11th centuries, under the dukes of Normandy, and was the capital of lower Normandy in the time of William the Conqueror. In 1346 Caen was besieged and taken by Edward III of England. It was again taken by the English in 1417 and held by them until 1450. During the Wars of Religion, Caen embraced the reform; in the succeeding century its prosperity was shattered by the revocation of the Edict of Nantes (1685). In 1793 the city was the focus of the Girondist movement against the Convention. In June 1944 the German army made Caen the hinge of resistance to the British advance, and it was finally liberated by the Canadians in July 1944.

(L. E. O.)

CAENEUS, in Greek mythology, son of Elatus, a Lapith. At the marriage of Pirithous, king of the Lapithae, the centaurs, who were guests, became drunk and attacked the bride and other women. Caeneus joined in the battle that resulted and, because he was endowed with an invulnerable body, killed five centaurs without trouble. In desperation, the other centaurs combined against him, piling huge pine trees upon him until the accumulated weight forced him, still standing, underground, never to appear again (Ovid, *Metamorphoses*, xii, 459 ff.). The centaurs' attack on Caeneus provided a favourite theme for Greek art, as in the friezes of the Theseum and the temple of Apollo at Bassae. A later story explained that Caeneus was originally a girl, Caenis, who yielded to Poseidon and received as reward the male sex and invulnerability (*Metam.* xii, 189 ff.). Ovid invents the metamorphosis of the buried Caeneus into a golden bird, perhaps a curlew.

(Wm. S. A.)

CAENOLESTID, a small shrewlike, pouched mammal (marsupial) of the family Caenolestidae, known also as the selva or opossum-rat. Three genera occur in the Andes of Colombia, Ecuador and Peru, and on Chiloé Island, off southern Chile. They are of special interest since they have characteristics intermediate between two groups of marsupials, having the lower first incisor teeth greatly enlarged, and all toes of the hind feet separate; they possess only small, rudimentary pouches.

Caenolestids inhabit the ground beneath thick underbrush, are nocturnal in habit, and feed on insects, on small birds and their eggs and on other small animals. Their fossil history dates back to the Eocene (about 40,000,000 years ago) of South America.

(R. H. Ma.)

CAEN STONE, a soft cream-coloured Jurassic limestone found near Caen, France. It is closely identified with the Bath oölite stone found in England.

The quarries are of great antiquity, and partly because they are easily accessible to sea transportation, considerable quantities of the stone were imported into England at an early date, probably from soon after the Norman conquest down to the middle of the 15th century. It was used extensively in building churches and cathedrals, in such well-known structures as Westminster abbey, Canterbury cathedral, Buckingham palace and the old Cathedral of St. Paul's in London. More than 400 tons were imported in 1443 to be used in building Eton college.

CAERE, an ancient city of Etruria (mod. CERVETERI; *i.e., Caere vetus*), about 5 mi. from the coast and about 20 mi. N.W. of Rome. According to ancient writers its original Pelasgian name was Agylla; the Etruscans took it and called it Caere but the former name lasted on into later times. It was one of the 12 cities of Etruria and had much trade through its port Pyrgi. After the invasion of the Gauls in 390 B.C., the vestal virgins and the sacred objects in their custody were conveyed to Caere for safety. A treaty was made between Rome and Caere in the same year. In 353, however, Caere took up arms against Rome out of friendship for Tarquinii (mod. Tarquinia), but was defeated and partially incorporated in the Roman state without voting rights for its members. The status is known as the *ius Caeritum,* and Caere was the first of a class of such municipalities. Under the Roman emperors Augustus and Tiberius its prosperity was to a certain extent restored, and inscriptions speak of its municipal officials (the chief of them called *dictator*) and its town council, which had the title of *senatus.* In the middle ages, however, it sank in importance, and early in the 13th century a part of the inhabitants founded Caere Novum (mod. Ceri) 3 mi. to the east.

The town lay on a hill of tufa, extending from northeast to southwest, isolated except on the northeast, and about 300 ft. above sea level. The modern town, at the western extremity, probably occupies the site of the acropolis. There seem to have been eight gates in the circuit of the city walls which was about 4 mi. in length. In the theatre many inscriptions and statues of Roman emperors were found. The necropolis on the hill to the northwest, known as the Banditaccia, is far more imposing. It has the aspect of a city of the dead, the tombs being in rows divided by paved streets. Other tombs are on the hills called Vignali and Monte Abetone in the place called the Sorbo. The larger tomb chambers are hewn in the rock and covered by mounds. Several of them are interesting from their architectural and decorative details. The most important tomb of all, the Regolini-Galassi tomb (taking its name from its discoverers in 1836), which lies southwest of the ancient city, is a narrow rock-hewn chamber about 60 ft. long, lined with masonry, the sides converging to form the roof. The objects found in it (a chariot, a bed, silver goblets with reliefs, rich gold ornaments, etc.) are in the Etruscan museum in the Vatican; they are attributed to the 7th century B.C. and are important evidence for the orientalizing style.

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CAERLEON, a village in the Monmouth parliamentary division of Monmouthshire (*q.v.*), on the Usk, 3 mi. N.E. of Newport. Pop. (1961) 4,184. It is important as the site of the Roman legionary fortress of Isca (not Isca Silurum), founded and garrisoned by the 2nd legion (Legio II Augusta) after the campaign against the Silures. This legion had formed the right wing of the expeditionary force of 50,000 men landed in Britain by the emperor Claudius in A.D. 43. According to Tacitus (*Annals* xii, 32) it first entered south Wales in A.D. 50, and from then on was engaged in the reduction of the Silures from its base at Kingsholm, Gloucester. Under Sextus Julius Frontinus, governor in Britain A.D. 74 to 77–78, this task was successfully concluded and the legion moved to new quarters at Caerleon *c.* A.D. 75. The site, close to the tidal Usk, was chosen for its accessibility and for its strategic command of the approaches to the south Wales coastal plain. Together with Chester (Deva) it was the seat of the main Roman military power in western Britain for 200 years. The modern name is said to be a corruption of Castra Legionis (the legion's fort; Welsh Caer = fort).

Excavations.—The systematic exploration of the site was begun by the National Museum of Wales in association with the Caerleon Excavation committee in 1926. Finds are exhibited in the Legionary museum at Caerleon, consisting of a notable series of inscribed and sculptured stones, small bronzes, much pottery and many coins. The best of the structural remains thus disclosed, the amphitheatre and the Prysg field barracks, are conserved by the ministry of works.

The Defenses.—The defenses of the fortress consisted originally of a V-shaped ditch 25 ft. wide and 8 ft. deep and a rampart of clay more than 20 ft. wide revetted with timber, enclosing a rectangle of about 50 ac. About A.D. 100 the timber stockade was replaced by a stone wall 5 ft. thick and still standing in places to a height of 12 ft. The wall was built on a cobble foundation offset on a sandstone plinth, and consisted of a rubble core faced externally with squared sandstone blocks set in yellow or pinkish mortar; the internal face was left rough as it abutted on the clay bank. The wall was probably 20 ft. high with a crenelated parape protecting the wall walk, access to which was by small interna turrets at intervals of 50 yd. It was pierced by four symmetrically placed gateways, imposing structures with double-arched doorways with guardrooms in the flanking towers. The space behind the rampart, the *intervallum,* was used for cookhouses, a latrine and other buildings after the completion of the fortress; debris from the cookhouses was deposited in the turrets which were disused in the mid-2nd century.

The Interior.—1. The street system. The planning of the interior of the fortress conformed to the normal military type The main road, the *via principalis,* crossed between the two lateral gateways and its line can be followed approximately in the Broadway and Backhall street. It was joined midway at right angle by the *via praetoria* leading in from the river crossing, a bridg over the Usk. Parts of two other lateral streets are indicated on the plan, lost beneath the medieval and modern streets. Excavation uncovered much of the rampart roadway, the *via sagulari* that made a circuit of the defenses.

2. The principal buildings. In a legionary fortress these consisted of the headquarters building (*principia*), the commander house (*praetorium*), the hospital (*valetudinarium*), the trainin schools (*scholae*), the workshops (*fabricae*), the granaries (*horrea*), the armoury and stores. Not all of these have been identifie at Caerleon.

The headquarters building was known to occupy its customar position facing the central road junction, so the greater part wa covered by St. Cadoc's church and churchyard. Immediate behind it, a large building covering more than an acre was tentatively identified as the *quaestorium,* used for the disposal hostages and booty. To the northeast of this, in Jenkins' fiel was the *fabrica* where the remains of smithies and workshops we found, and to the southeast beneath the primary school was large residential building, probably the commander's house.

3. The barracks. The soldiers lived in barracks placed on th perimeter of the fortress, of which at least 24 were located excavation. These buildings, which were of uniform constructio lay in pairs (*strigae*) facing inward into a narrow court. Ea barrack was a single-storied building holding a company of 1 men (a century) and measuring 250 ft. long by 40 ft. wide. Tw thirds of it was fronted by a paved veranda and divided into cubicles, in each of which 9 men slept and kept their accoutr ments; the other third was wider and contained a more spacio set of rooms for the centurion, the officer in charge, and his a sistants (*principales*). The buildings were substantially co structed of stone throughout, with roofs of red tile; windo were glazed and the floors paved or cemented.

The Environs.—The parade ground was identified outside t south gate, the *porta principalis sinistra.* There also was t amphitheatre for the staging of beast fights, gladiatorial sho or other entertainment. It was an oval structure 267 ft. long 222 ft. broad, with an area entered by two imposing main ga on the long axis. There was seating for about 6,000 persons wooden seats raised in tiers in the auditorium, an earthen ba buttressed and faced externally and internally by walls which ga the building the appearance of a stone structure. Access to the seats was by stairs entered through six vaulted passages. The amphitheatre was built in the late 1st century, reconstructed after partial collapse *c.* A.D. 125 and again rebuilt in the early 3rd century; it fell into final disuse at the end of that century.

The buildings that made up the civil settlement (Cannabae), which were being systematically explored at mid-20th century, lay nearer the river, separated by a precinct wall from the military installations. A street, shops and houses were uncovered. The sites of three or four bath buildings are also known to the south and east of the fortress. Inscriptions to Jupiter Dolichenus, Diana and Mithras are evidence of temples dedicated to these deities in the environs.

History.—The foundation of the fortress can be dated archaeologically to *c.* A.D. 75. At first buildings and defenses were constructed in timber, but in the last years of the 1st century they were rebuilt in stone. An inscription found in 1928 records the construction of the *principia* under the emperor Trajan in the year A.D. 100, but the whole task was not completed for a decade. The full occupation of the new stone buildings was of short duration for *c.* A.D. 120 the garrison was radically reduced to release men for the northern frontier, including work on Hadrian's wall. The first quarter of the 3rd century saw a renewal of military activity, following 50 years' neglect, at Caerleon, as in Wales generally, due to the initiative of the Severan dynasty. An inscription records the repair of the headquarters building (?) by Septimius Severus and his sons (198–211), and some barracks and the amphitheatre were found to have been also reconditioned during the period A.D. 212–222. A later rebuilding of barracks alone is recorded in the joint reign of Valerian and Gallienus.

In the later empire Caerleon declined rapidly in importance in consequence of the military reorganization of the province. Some troops were probably moved to Cardiff to garrison the new type of coastal fort erected there against the Irish pirate menace, but the *Notitia Dignitatum,* a document recording the 4th–5th-century disposition of troops and officials, shows that the 2nd legion was stationed at Richborough (Rutupiae), Kent, a fort for the defense of the Saxon shore. Excavation, however, has shown that certain barracks and buildings were occupied or reoccupied at Caerleon until *c.* A.D. 350 or 375–380, but that such occupation was partial and sporadic.

Post-Roman.—No remains have been found to show that Caerleon was occupied in the dark ages, between the end of Roman rule and the Norman conquest of Gwent (*c.* A.D. 1070); but the Urbs egionis recorded by Gildas (*De Excidio Brit.*, ch. 10) as the place of martyrdom of two Romano-British saints, Aaron and Julius, is almost certainly Caerleon, and land presumably belonging to a church dedicated to these martyrs was the subject of dispute in the th century.

That King Arthur held court at Caerleon on Usk or was crowned here is highly improbable, though the green circle of the amphiheatre was long known locally as his "Round Table" and Lord ennyson stayed at the Hanbury Arms, Caerleon, while writing he *Idylls of the King.* There is a tradition of a bishopric said o have been transferred to St. David's by St. David himself. o Giraldus Cambrensis (*c.* 1146–1220) Caerleon was recognizable s an ancient Roman city with many vestiges of its ancient splenour (*Itinerarium,* i, 5). The remains of a motte castle of the arly medieval period stand outside the northeast angle of the oman fortress; it was mostly in Welsh ownership and was burned own in 1235.

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CAERNARVON (Caernarfon), municipal borough and he county town of Caernarvonshire, north Wales, 9 mi. S.W. f Bangor by road near the west end of the Menai strait and roughly midway along the Arton sea plain which stretches to the foothills of Snowdonia. Pop. (1961) 8,998. The castle and town walls, built by Edward I following the final conquest of Wales in 1282–83, occupy a rocky peninsula between the estuary of the Saint (Seiont) river and the Cadnant stream (the latter now covered over) where they flow into the strait. The castle (*c.* 1283–1322), finely preserved, stands in the southern part of this peninsula and is the dominating feature of the town. Of the medieval borough (charter granted 1284), the walls and wall towers (built 1283–85; largely repaired, 1295, after Welsh attack in 1294), the original street plan and the Chapel of St. Mary remain. Within the walls, which are nearly ½ mi. in circumference, are the county hall (1863) and county offices, the main building of which was formerly the county jail. The guildhall (1874) is on the site of the east gate, the town's former principal gateway. The present main thoroughfare and shopping streets, Bangor and Pool streets, are outside the walls to the east and debouch into Castle square, an open space east of the castle. Statues of David Lloyd George, M.P. for Caernarvon borough (erected 1921) and Sir Hugh Owen, an education pioneer (1888) stand in the square. Residential areas have spread at different periods over the immediate hinterland of the town. Caernarvon is served by a branch line (1852) of the main London-Holyhead railway, which runs from Bangor to Afon Wen, where it joins the London-Pwllheli line. There is also a branch line from Caernarvon to Llanberis (1869). The road from Bangor to Pwllheli and Portmadoc passes through the town and those from Llanberis and Beddgelert also converge upon it. There is a small harbour which flourished in the 19th century with the export of slate, but the decline of the slate industry and other changes have greatly reduced its use. The port serves mainly as a distribution centre for petroleum and oil. Caernarvon is the county and assize town and is chiefly an administrative and shopping centre. In summer it is a tourist centre.

The Roman fort of Segontium, to which the name Caernarvon refers, (Welsh, Caernarfon, Caer yn Arfon, *i.e.*, the fort in the land over against Mona) was established *c.* A.D. 75 on a low hill, southeast of the present town. After Roman withdrawal (*c.* 380–390) the fort was occupied by local chieftains. Llanbeblig (after Peblig or Publicus), founded nearby probably in the 5th century, the church of the parish within which the later borough was established. The area around the Roman fort eventually became one of the "manors" of the princes of Gwynedd. Edward I by contrast built his castle on the strait, for easy access to the sea, on the site of a motte originally built by Earl Hugh of Avranches about 1090 during a brief period of Norman occupation. Edward fixed the capital of the principality of north Wales at Caernarvon. His fourth son, later Edward II, created prince of Wales in 1301, was born within the castle precincts in 1284. (W. O. W.)

CAERNARVONSHIRE (Caernarfon), a county of north Wales. Pop. (1961) 121,194. Area 569 sq.mi. The county, long in shape, is bounded chiefly by the sea, and stretches from the tip of the Llŷn (or Lleyn = lake) peninsula in the southwest Penrhyn bay near Llandudno in the northeast, a distance of approximately 55 mi.; its greatest width is approximately 23 mi. and the coast line is about 127 mi. long. The Llŷn peninsula, long and narrow, projects into the Irish sea between Caernarvon and Cardigan bays.

On the northwest, the Menai strait (*q.v.*) divides the county from Anglesey. East and southeast, the landward boundary is also largely formed by natural features, the county being separated from Denbighshire (east) by the Conway river for most of its course and from Merioneth (southeast) by high land and the lower course of the Glaslyn. Included within the county, though east of the Conway, are the Creuddyn peninsula (northeast of the Conway estuary) and the parish of Maenan.

Physiography.—The county is dominated by the great mass of the Snowdon mountains, rising on the east from the Conway valley and on the south from the Vale of Ffestiniog. This mass, called Snowdonia (Welsh, Eryri) is divided by valleys and passes into five tracts. The northernmost and largest is bounded by the Conway valley on the east and Nant Ffrancon and the Llugwy valley on the southwest. In the second tract are the Penrhyn and

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LLYN PADARN, WITH SNOWDON PEAKS IN THE BACKGROUND, LLANBERIS PASS, CAERNARVONSHIRE

Dinorwic slate quarries, among the greatest of their kind in the world. The third tract, divided from the second by the pass of Llanberis, contains Snowdon (Welsh, Y Wyddfa), the highest peak in England and Wales (3,560 ft.). The fourth, southwesternmost, tract is detached from that of Snowdon by the valleys of the Gwyrfai and Colwyn. The deeply eroded valleys between these four tracts trend from southeast to northwest, but the fifth tract, lying to the south and southeast, is separated by a gentler line of valleys stretching from Betws-y-Coed in the east to Traeth Mawr in the southwest. To the southwest of the main Snowdon mass is a line of conical hills stretching down to the tip of the Llŷn peninsula. Despite the dominance of the Snowdon mass, the highland region (above 1,400 ft.) occupies only 99 sq.mi. of the county. Lowland areas (below 600 ft.) occupy 308 sq.mi. and uplands (600–1,400 ft.) 162 sq.mi. The lowlands stretch mainly along the northern coastal plain, opening out into the Arfon sea plain where most of the main urban areas are situated. Beyond the line of the Llyn hills there are also large stretches of comparatively flat country reaching down to the southern coast of the peninsula.

There are more than 60 lakes in the county, varying in elevation from less than 176 ft. (Llyn Dinas) to more than 2,094 ft. (Melynllyn), with maximum depth from 10 ft. (Llyn Ogwen) to 222 ft. (Llyn Cowlyd), and in size from small pools to lakes such as Llyn Padarn (more than 2 mi. in length). Some supply water to towns and villages; others are potential sources of hydroelectric power. Rivers radiate from the central mountain mass and are mostly short and swift. The longest is the Conway, navigable by small craft for about 12 mi. from its mouth.

The Snowdon range originated in the mountain-building periods of the Pre-Cambrian Age. Volcanic activity and successive movements during the Paleozoic era were followed chiefly by long-continued denudation until the general shaping of the present mountains, with their northeast to southwest alignment, emerged in the later Cenozoic era. Quaternary glaciation gave to the county its chief surface features, its steep-sided valleys, narrow ridges, cwms (dingles) and glacial lakes. More than half the county is floored by rocks of Ordovician Age, consisting of a highly folded complex of grits, shales and slates with interbedded volcanic rocks in the form of lavas, tuffs and ashes. Igneous intrusions occur on a large scale, especially in the Llŷn peninsula and in the northeast around Penmaenmawr. Pre-Cambrian, Cambrian and Silurian rocks underlie some areas; an outcrop of Cambrian strata extends southwestward from near Aber toward Clynnog. Carboniferous limestone appears in the Great Orme's head and also in a narrow coastal strip fringing the Menai strait. Fault fissures in the Ordovician and Cambrian strata contain certain metalliferous minerals, mainly lead, zinc and copper, but these appear to have been worked out, excepting some lodes in the Conway valley.

Prevailing winds are from the southwest across the sea and with the mountain barrier also hindering the passage of warm air, the county has mainly the mild, moist climate characteristic of the western coastal regions of Britain. Rainfall is relatively heavy in Snowdonia but considerably less in the coastal areas and in the Llŷn peninsula. The soils of the upland region are chiefly podsolic; those of the lowlands vary in texture and character but mainly between light and fairly heavy loam. Almost half the land area of the county consists of grasslands. Remains of natura woodlands (oak and alder) exist on some of the lower slopes o valleys but afforestation with conifers has taken place and i being extended over an ever wider area. The lowlands are largel enclosed and cultivated but are of relatively low fertility. Th variation in contours and gradations between the Snowdonia summits and the coastlands produces a considerable variety i plant life, ranging from the rare mountain spiderwort of the alpin zone to the limestone flora of the Great Orme. In Snowdoni foxes are numerous, and there are occasional herds of wild goat and mountain ponies. The pine marten and polecat are also to b found. Otters are fairly common in the larger rivers and badger relatively so in woodlands. The chough, peregrine falcon an ring ouzel are among the many birds to be seen in the mountain while large colonies of sea birds nest on the Great Orme and alon the coasts of Llŷn. About 44% of the county lies within th Snowdonia National park. (*See* also SNOWDON.)

History.—Evidence (chambered tombs, pottery and axes o Penmaenmawr) indicates that the earliest human settlements i Caernarvonshire, chiefly in the Llŷn peninsula and on the hi slopes of the immediate hinterland, were Neolithic (*c.* 2000 B.C. The region was penetrated by the Beaker folk about 1500 B. and finds suggest that in the Bronze Age it was crossed by impo tant trade routes linking the Mediterranean, Ireland and norther Europe. Climatic changes, causing undergrowth to choke th valleys, and other disturbances in the later Bronze Age may ha driven the inhabitants back to the higher reaches of the hil and stone hut circles found at 800–1,000 ft. may belong to th period. Penetration by Celtic traders and settlers appears to ha taken place about 500–300 B.C., a Celtic tribe, the Ordovice occupying the region at the time of the Roman invasion (*c.* A. 61). Complete Roman conquest of the area was achieved in A. 71–78, forts subsidiary to Deva (Chester) being established Kanovium (Caerhun) near Conway and Segontium (Caernarvon the latter not being finally abandoned till *c.* 380–390. Christi tombstones from the 6th century were found at Penmachno an many ecclesiastical sites bearing the names of their saint-found date from this period.

In the early middle ages the region was divided into thr cantreds or districts containing 100 townships (Arllechwedd, Arf and Llŷn) and subdivided into *cymwds* or commots. These are were at one time ruled by chieftains descended from the dynas of Cunedda, who, coming from north Britain, appears to ha taken possession of the region in the dark ages. The *cymwds* Eifionydd and Creuddyn (joined in 1284 to the three cantre to form Caernarvonshire) lay in cantreds Dunoding and Rh respectively. The cantreds eventually became part of the prin pality of Gwynedd, ruled by the prince of Aberffraw and lo of Snowdon whose domain was protected from the west by t natural barrier of the Snowdon range.

Following his conquest of Wales in 1282–83, Edward I a nexed to the English crown the principality of Llewelyn the L (whose territories by 1282 had been much reduced by conflicts w England) and divided it into three counties, of which Caernarv was one, by the Statute of Rhuddlan (1284). He built castl founded English boroughs at Caernarvon and Conway and co ferred borough status on the native settlement near the old We castle of Criccieth. Charters were granted to two other We settlements, Pwllheli and Nefyn (Nevin), in 1355. The rev of Owen Glendower (1400–15) seriously affected the area. Fun mental changes in the county's economy culminated toward close of the 15th century in the rise of landowning families, mos

Welsh, who were to dominate the life of Caernarvonshire until mid-19th century. Tudor legislation (1536 and 1542) changed the administration introducing quarter sessions as the main organ of local government in the place of the offices of the Edwardian principality.

The late 18th and 19th centuries were the period of religious revival and of the Industrial Revolution. Slate and granite quarries were developed by their owners, quarrying villages (centres of Radicalism and Nonconformity) sprang up and ports flourished. At the same time, and especially after the railway to Bangor from Chester was built in 1848, the county became a popular tourist area. Seaside resorts developed on the northern coasts, notably at Llandudno (*q.v.*), and inland resorts at Betws-y-Coed (*q.v.*), Llanberis and Beddgelert. Throughout the centuries the county has remained mainly Welsh in speech and character, especially in areas away from the main lines of communication and the holiday resorts. At mid-20th century the bulk of the population was bilingual but English influences, already dominant in the Llandudno area, were affecting the inhabitants more strongly than ever before.

Administration.—There are 4 municipal boroughs (Caernarvon, the county town, Conway, Pwllheli and Bangor; *qq.v.*), 7 urban and 4 rural districts, 52 civil parishes and 2 parliamentary constituencies (Caernarvon division comprising the southern half and Conway division the northern half). The county is the diocese of Bangor except for a few northern parishes which are in that of St. Asaph.

The Economy.—The basic industries are agriculture (products, chiefly milk and meat), slate and stone quarrying and the tourist trade. Other industries included chemicals, metal manufacturing, engineering, shipbuilding, building and contracting, transport, the distributive trades and forestry. There are small hydroelectric power stations at Cwmdyli and Dolgarrog, where there is an aluminum works.

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CAERPHILLY (Caerffili), a market town and urban district in the Caerphilly parliamentary division of Glamorgan, Wales, 7 mi. N. of Cardiff, 11 mi. W. of Newport by road, and near the Monmouthshire border. Pop. (1961) 35,997. It was formerly in the ancient parish of Eglwysilan, which joined with Bedwas, Monmouthshire, to form an ecclesiastical parish in 1850. The parishes of Eglwysilan and Llanfabon were in 1893 constituted into an urban district. The ancient commot (early Welsh territorial and administrative unit) of Senghenydd, corresponding to the modern hundred of Caerphilly, comprised the mountainous district from the Cefn On ridge on the south to Brecknockshire on the north, being bounded by the Taff and Rhymney rivers on the west and east. Its inhabitants, though nominally subject to the lords of Glamorgan since Robert Fitzhamon's conquest, often raided the lowlands. To check this Gilbert de Clare, during the closing years of the reign of Henry III, built a castle on the southern edge of this district, in a wide plain between the two rivers. Prince Llewelyn ap Gruffydd laid siege to and destroyed it in 1270. The present castle, begun in 1271, became the earliest and most complete example in Britain of a concentric plan known as "Edwardian" and is the largest castle in England and Wales, excepting Windsor. The great hall is a fine example of Decorated architecture. This and other additions are attributed to Hugh le Despenser (1318–26). It was taken by Owen Glendower in 1403. Before the middle of the 15th century it had ceased to be a fortified residence and was used as a prison. It eventually passed to the Bute family (via the earls of Pembroke) and underwent restoration in the 1930s after which the 4th marquess of Bute gave it to the crown.

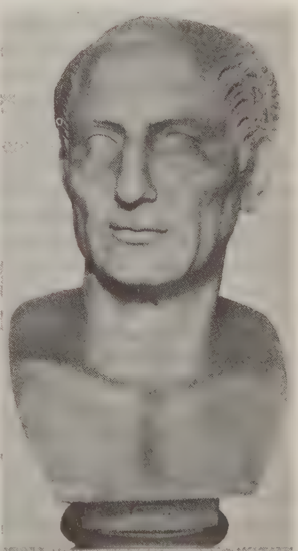
The town grew up around the castle but never received a charter. Its markets during the 19th century were chiefly noted for Caerphilly cheese which is still widely sold in England. The district was one of the chief centres of the Methodist revival of the 18th century, the first synod of the Calvinistic Methodists being held in 1743 at Watford farm. With the development of the south Wales coal field the prosperity of Caerphilly increased. This industrial progress was helped by the opening in 1858 of a railway from Rhymney to Caerphilly, which was subsequently extended. Trade depression in the 1930s had especially marked effects in this locality and unemployment was widespread. Coal remained the main industry in the early 1960s.

CAESAR, GAIUS JULIUS (100–44 b.c.), Roman general, dictator, and statesman, whose career changed the course of the history of the Greco-Roman world decisively and irreversibly. The Greco-Roman society has been extinct for so long that most of the names of its great men mean little to the average educated modern man. But Caesar's name, like Alexander's, is still on people's lips throughout the Christian and Islamic worlds. Even people who know nothing of Caesar as a historic personality are familiar with his family name as a title signifying a ruler who is in some sense uniquely supreme or paramount—the meaning of *Kaiser* in German, *tsar* in the Slavonic languages, and *qaysar* in the languages of the Islamic world.

Caesar's *gens* (clan) name, Julius (Iulius), is also familiar in the Christian world, for in Caesar's lifetime the Roman month Quinctilis, in which he was born, was renamed "July" in his honour. This name has survived Caesar's assassination and the fall of the Roman Empire. So has Caesar's reform of the calendar. The old Roman calendar was inaccurate and manipulated for political purposes. Caesar's calendar, the Julian calendar, is still partially in force in the Eastern Orthodox Christian countries, and the Gregorian calendar, now in use in the West, is the Julian as slightly corrected by Pope Gregory XIII.

Family Background and Early Career.—Caesar's *gens,* the Julii, were patricians, *i.e.,* members of Rome's original aristocracy, which had coalesced in the 4th century b.c. with a number of leading plebeian (commoner) families to form the nobility that had been the governing class in Rome since then. By Caesar's time, the number of surviving patrician *gentes* was small, and in the *gens Julia* the Caesares seem to have been the only surviving family. Though some of the most powerful noble families were patrician, patrician blood was no longer a political advantage; it was actually a handicap, since a patrician was debarred from holding the para-constitutional but powerful office of tribune of the plebs. The Julii Caesares traced their lineage back to the goddess Venus, but the family was not snobbish or conservative-minded. It was also not rich or influential or even distinguished.

A Roman noble won distinction for himself and his family by securing election to a series of public offices, culminating in the consulship, with the censorship possibly to follow. This was difficult for even the ablest and most gifted noble unless he was backed by family wealth and influence. Rome's victory over Carthage in the Second Punic War (218–201 b.c.) had made Rome the paramount power in the Mediterranean basin; an influential Roman noble family's clients (that is, protégés who, in return, gave their patrons their political support) might include kings and even whole nations, besides numerous private individuals. The requirements and the costs of a Roman political career in Caesar's day were high, and the competition was severe, but the potential profits were enormous. One of the perquisites of the praetorship and the consulship was the government of a province, which gave ample opportunities for plunder. The whole Mediterranean world was, in fact,



BY COURTESY OF MUSEO NAZIONALE, NAPLES

MARBLE BUST OF JULIUS CAESAR, OF THE 1ST CENTURY, A.D. IN THE MUSEO NAZIONALE, NAPLES, ITALY at the mercy of the Roman nobility and of a new class of Roman businessmen, the *equites* ("knights"), which had grown rich on military contracts and on tax farming.

(For details on the nature of the various offices referred to here and below, *see* AEDILE; CENSOR; CONSUL; EQUITES; PONTIFEX; PRAETOR; QUAESTOR; TRIBUNE.)

Military manpower was supplied by the Roman peasantry. This class had been partly dispossessed by an economic revolution following on the devastation caused by the Second Punic War. The Roman governing class had consequently come to be hated and discredited at home and abroad. From 133 onward there had been a series of alternate revolutionary and counterrevolutionary paroxysms. It was evident that the present misgovernment of the Roman state and the Greco-Roman world by the Roman nobility could not continue indefinitely, and fairly clear that the most probable alternative was some form of military dictatorship backed by dispossessed Italian peasants who had turned to long-term military service.

The traditional competition among members of the Roman nobility for office and the spoils of office was thus threatening to turn into a desperate race for seizing autocratic power. The Julii Caesares did not seem to be in the running. It was true that Sextus Caesar, who was perhaps the dictator's uncle, had been one of the consuls for 91, and Lucius Caesar, one of the consuls for 90, was a distant cousin, whose son and namesake was consul for 64. In 90 Rome's Italian allies had seceded from Rome because of the Roman government's obstinate refusal to grant them Roman citizenship, and as consul Lucius Caesar had introduced emergency legislation for granting citizenship to the citizens of all Italian ally states that had not taken up arms or that had returned to their allegiance. Whoever had been consul in this critical year would have had to initiate such legislation, whatever his personal political predilections. There is evidence, however, that the Julii Caesares, though patricians, had already committed themselves to the anti-nobility party. An aunt of the future dictator had married Gaius Marius (*q.v.*), a self-made man (*novus homo*) who had forced his way up to the summit by his military ability and had made the momentous innovation of recruiting his armies from the dispossessed peasants.

The date of Caesar the dictator's birth has been disputed. The day was July 12 or 13; the traditional (and perhaps most probable) year is 100, but, if this date is correct, he must have held each of his offices two years in advance of the legal minimum age. His father, Gaius Caesar, died when Caesar was 16; his mother, Aurelia, was a notable woman, and he owed much to her.

In spite of the inadequacy of his resources, Caesar seems to have taken a political career as a matter of course. From the start, he probably privately aimed at winning office, not just for the sake of the honours but in order to achieve the power to put the misgoverned Roman state and Greco-Roman world in better order in accordance with ideas of his own. It is improbable that Caesar deliberately sought monarchical power till after he had crossed the Rubicon in 49, though sufficient power to impose his will proved to mean monarchical power.

In 84 Caesar committed himself publicly to the radical side by marrying Cornelia, a daughter of L. Cornelius Cinna, a noble who was Marius' associate in revolution. In 83 L. Cornelius Sulla returned to Italy from the East and led the successful counterrevolution of 83–82; Sulla then ordered Caesar to divorce Cornelia. Caesar refused, and nearly lost not only his property (such as it was) but his life. He found it advisable to leave Italy and do military service, first in the province of Asia and then in Cilicia.

In 78, after Sulla's death, he returned to Rome and started on his political career in the conventional way, by acting as a prosecuting advocate—of course, in his case, against prominent Sullan counterrevolutionaries. His first target, Gnaeus Cornelius Dolabella, was defended by Q. Hortensius, the leading advocate of the day, and was acquitted by the extortion-court jury, composed exclusively of senators.

Caesar then went to Rhodes to study oratory under a famous professor, Molon. En route he was captured by pirates (one of the symptoms of the anarchy into which the Roman nobility had allowed the Mediterranean world to fall). Caesar raised his ransom, raised a naval force, captured his captors, and had them crucified—all this as a private individual, holding no public office. In 74, when Mithradates VI Eupator, king of Pontus, renewed war on the Romans, Caesar raised a private army to combat him.

In his absence from Rome, Caesar was made a member of the politico-ecclesiastical college of pontifices, and on his return he gained one of the elective military tribuneships. Caesar now worked to undo the Sullan constitution in cooperation with Pompey (Gnaeus Pompeius), who had started his career as a lieutenant of Sulla but had changed sides since Sulla's death. In 69 or 68 Caesar was elected quaestor (the first rung on the Roman political ladder). In the same year his wife, Cornelia, and his aunt Julia, Marius' widow, died; in public funeral orations in their honour, Caesar found opportunities for praising Cinna and Marius. Caesar afterward married Pompeia, a distant relative of Pompey. Caesar served his quaestorship in the province of Farther Spain (modern Andalusia and Portugal).

Caesar was elected one of the curule aediles for 65, and he celebrated his tenure of this office by unusually lavish expenditure, with borrowed money. He was elected pontifex maximus in 63 by a political dodge. By now he had become a controversial political figure. After the suppression of Catiline's conspiracy in 63, Caesar, as well as the millionaire Marcus Licinius Crassus was accused of complicity. It seems unlikely that either of them had committed himself to Catiline, but Caesar proposed in the Senate a more merciful alternative to the death penalty, which the consul Cicero was asking for the arrested conspirators. In the uproar in the Senate, Caesar's motion was defeated.

Caesar was elected a praetor for 62. Toward the end of the year of his praetorship, a scandal was caused by Publius Clodius (*q.v.*) in Caesar's house at the celebration there of the rites, for women only, of Bona Dea, and Caesar consequently divorced Pompeia. Caesar obtained the governorship of Farther Spain for 61–60. His creditors did not let him leave Rome till Crassus had gone bail for a quarter of his debts; but a military expedition beyond the northwest frontier of his province enabled Caesar to win loot for himself as well as for his soldiers, with a balance left over for the treasury. This partial financial recovery enabled him, after his return to Rome in 60, to stand for the consulship for 59.

The First Triumvirate and the Conquest of Gaul.—The value of the consulship lay in the lucrative provincial governorship to which it would normally lead. On the eve of the consula elections for 59, the Senate sought to allot to the two future consuls for 59, as their preconsular provinces, the unprofitable supervision of forests and cattle trails in Italy. The Senate also secured by massive bribery the election of an anti-Caesarean M. Calpurnius Bibulus. But they failed to prevent Caesar's election as the other consul. Caesar now succeeded in organizing an irresistible coalition of political bosses. Pompey had carried ou his mission to put the East in order with notable success; bu after his return to Italy and his disbandment of his army in 6 the Senate had thwarted him—particularly by preventing him from securing land allotments for his veterans. Caesar, who ha assiduously cultivated Pompey's friendship, now entered into secret pact with him. Caesar's master stroke was to persuad Crassus to join the partnership, the so-called first triumvirate Crassus—like Pompey, a former lieutenant of Sulla—had bee one of the most active of Pompey's obstructors so far. Onl Caesar, on good terms with both, was in a position to reconci them. Early in 59, Pompey sealed his alliance with Caesar b marrying Caesar's only child, Julia. Caesar married Calpurnia daughter of L. Piso, who became consul in 58.

As consul, Caesar introduced a bill for the allotment of Roma public lands in Italy, on which the first charge was to be a prov sion for Pompey's soldiers. The bill was vetoed by three tribune of the plebs, and Caesar's colleague Bibulus announced his intention of preventing the transaction of public business by watching the skies for portents whenever the public assembly was convened. Caesar cowed the opposition by employing some of Pompey's veterans to make a riot, and the distribution was carried out. Pompey's settlement of the East was ratified *en bloc* by an act negotiated by an agent of Caesar, the tribune of the plebs Publius Vatinius. Caesar himself initiated a noncontroversial and much-needed act for punishing misconduct by governors of provinces. Another act negotiated by Vatinius gave Caesar Cisalpine Gaul (between the Alps, the Apennines, and the Adriatic) and Illyricum for his province instead of the forests and cattle trails. His tenure was to last till Feb. 28, 54. When the governor-designate of Transalpine Gaul suddenly died, this province, too, was assigned to Caesar at Pompey's instance. Cisalpine Gaul gave Caesar a military recruiting ground; Transalpine Gaul gave him a springboard for conquests beyond Rome's northwest frontier.

Between 58 and 50, Caesar conquered the rest of Gaul up to the left bank of the Rhine and subjugated it so effectively that it remained passive under Roman rule throughout the Roman civil wars between 49 and 31. This achievement was all the more amazing, considering that the Romans did not have any great superiority in military equipment over the north European barbarians. Indeed, the Gallic cavalry was probably superior to the Roman, horseman for horseman. Rome's military superiority lay in strategy, tactics, discipline, and military engineering. In Gaul, Rome also had the advantage of being able to deal separately with dozens of relatively small independent states. Caesar conquered these piecemeal, and the concerted attempt made by a number of them in 52 to shake off the Roman yoke came too late.

Great though this achievement was, its relative importance in Caesar's career and in Roman history has been overestimated in Western tradition (as have his brief raids on Britain). In Caesar's mind his conquest of Gaul was probably only a means to his ultimate end. He was acquiring the military manpower, the plunder, and the prestige that he needed to secure a free hand for reorganizing the Roman state and the rest of the Greco-Roman world. This final achievement of Caesar's looms much larger than his conquest of Gaul when it is viewed in the wider setting of world history, and not just in the narrower setting of the Greco-Roman civilization's present daughter-civilization in the West.

In 58 Rome's northwest frontier, established in 125, ran from the Alps down the left bank of the upper Rhône to the Pyrenees, skirting the southeastern foot of the Cévennes and including the upper basin of the Garonne without reaching the Gallic shore of the Atlantic. In 58 Caesar intervened beyond this line, first to drive back the Helvetii, who had been migrating westward from their home in what is now central Switzerland. He then crushed a German soldier of fortune from beyond the Rhine, Ariovistus. In 57 Caesar subdued the distant and warlike Belgic group of Gallic peoples in the north, while his lieutenant Publius Licinius Crassus subdued what are now Normandy and Brittany. In 56 the Veneti, in what is now southern Brittany, started a revolt in the northwest which was supported by the still unconquered Morini on the Gallic coast of the Straits of Dover and the Menapii along the south bank of the lower Rhine. Caesar reconquered the Veneti with some difficulty and treated them barbarously. He could not finish off the conquest of the Morini and Menapii before the end of the campaigning season of 56, and in the winter of 56–55 the Menapii were temporarily expelled from their home by two immigrant German peoples, the Usipetes and Tencteri. These were exterminated by Caesar in 55. In the same year he bridged the Rhine just below Coblenz to raid Transrhenane Germany, and then crossed the Channel to raid Britain. In 54 he raided Britain again and subdued a serious revolt in northeastern Gaul. In 53 he subdued further revolts in Gaul and bridged the Rhine again for a second raid.

The crisis of Caesar's Gallic war came in 52. The peoples of central Gaul found a national leader in the Arvernian Vercingetorix. They planned to cut off the Roman forces from Caesar, who had been wintering on the other side of the Alps. They even attempted to invade the western end of the old Roman province of Gallia Transalpina. Vercingetorix wanted to avoid pitched battles and sieges and to defeat the Romans by cutting off their supplies—partly by cavalry operations and partly by "scorched earth"—but he could not persuade his countrymen to adopt this painful policy wholeheartedly. The Bituriges insisted on standing siege in their town Avaricum (Bourges), and Vercingetorix was unable to save it from being taken by storm within one month. Caesar then besieged Vercingetorix in Gergovia near modern Clermont-Ferrand. A Roman attempt to storm Gergovia was repulsed with heavy Roman losses—the first outright defeat that Caesar had suffered in Gaul. Caesar then defeated an attack on the Roman army on the march and was thus able to besiege Vercingetorix in Alesia, to the northwest of Dijon. Alesia, like Gergovia, was a position of great natural strength, and a large Gallic army came to relieve it; but this army was repulsed and dispersed by Caesar, and Vercingetorix then capitulated.

During the winter of 52–51 and the campaigning season of 51, Caesar crushed a number of sporadic further revolts. The most determined of these rebels were the Bellovaci, between the rivers Seine and Somme, around Beauvais. Another rebel force stood siege in the south in the natural fortress of Uxellodunum (perhaps the Puy d'Issolu on the Dordogne) till its water supply gave out. Caesar had the survivors' hands cut off. He spent the year 50 in organizing the newly conquered territory. After that, he was ready to settle his accounts with his opponents at home.

Antecedents and Outcome of the Civil War of 49–45.—During his conquest of Gaul, Caesar had been equally busy in preserving and improving his position at home. He used part of his growing wealth from Gallic loot to hire political agents in Rome.

Meanwhile the cohesion of the triumvirate had been under strain. Pompey had soon become restive toward his alarmingly successful ally Caesar, and Crassus toward his old enemy Pompey. The alliance was patched up in April 56 at a conference at Luca (Lucca), just inside Caesar's province of Cisalpine Gaul. It was arranged that Pompey and Crassus were to be the consuls for 55 and were to get laws passed prolonging Caesar's provincial commands for another five years and giving Crassus a five-year term in Syria and Pompey a five-year term in Spain. These laws were duly passed. Crassus was then eliminated by an annihilating defeat at the Parthians' hands in 53. The marriage link between Pompey and Caesar had been broken by Julia's death in 54. After this, Pompey irresolutely veered farther and farther away from Caesar, till, when the breach came, Pompey found himself committed to the nobility's side, though he and the nobility never trusted each other. (*See* also POMPEIUS; CRASSUS.)

The issue was whether there should or should not be an interval between the date at which Caesar was to resign his provincial governorships, and, therewith, the command over his armies, and the date at which he would enter his proposed second consulship. If there were to be an interval, Caesar would be a private person during that time, vulnerable to attack by his enemies; if prosecuted and convicted, he would be ruined politically and might possibly lose his life. Caesar had to make sure that, till his entry on his second consulship, he should continue to hold at least one province with the military force to guarantee his security.

This issue had already been the object of a series of political maneuvers and countermaneuvers at Rome. The dates on which the issue turned are all in doubt. As had been agreed at Luca in 56 Caesar's commands had been prolonged for five years, apparently until Feb. 28, 49, but this is not certain. In 52, a year in which Pompey was elected sole consul and given a five-year provincial command in Spain, Caesar was allowed by a law sponsored by all ten tribunes to stand for the consulship *in absentia.* If he were to stand in 49 for the consulship for 48, he would be out of office, and therefore in danger, during the last ten months of 49. As a safeguard for Caesar against this, there seems to have been an understanding—possibly a private one at Luca in 56, between him and Pompey—that the question of a successor to Caesar in his commands should not be raised in the Senate before March 1, 50. This would have ensured that Caesar would retain his commands till the end of 49. However, the question of replacing Caesar was actually raised in the Senate a number of times from 51 onward; each time Caesar had the proposals vetoed by tribunes of the plebs who were his agents—particularly Gaius Scribonius Curio in 50 and Mark Antony in 49.

The issue was brought to a head by one of the consuls for 50, Gaius Claudius Marcellus. He obtained resolutions from the Senate that Caesar should lay down his command (presumably at its terminal date) but that Pompey should not lay down his command simultaneously. Curio then obtained on Dec. 1, 50, a resolution (by 370 votes to 22) that both men should lay down their commands simultaneously. Next day Marcellus (without authorization from the Senate) offered the command over all troops in Italy to Pompey, with power to raise more, and Pompey accepted. On Jan. 1, 49, the Senate received from Caesar a proposal that he and Pompey should lay down their commands simultaneously. Caesar's message was peremptory, and the Senate resolved that Caesar should be treated as a public enemy if he did not lay down his command "by a date to be fixed."

On Jan. 10–11, 49, Caesar led his troops across the little river Rubicon, the boundary between Cisalpine Gaul and Italy. He thus committed the first act of war. But this was not the heart of the matter. The question of substance was whether the misgovernment of the Greco-Roman world by the Roman nobility should continue or whether it should be replaced by an autocratic regime. Either alternative would mean a disastrous civil war. The subsequent partial recuperation of the world under the principate suggests, however, that Caesarism was the lesser evil.

The civil war was a tragedy, for war was not wanted either by Caesar or by Pompey, or even by a considerable part of the nobility, while the bulk of the Roman citizen body ardently hoped for the preservation of peace. By this time, however, the three parties that counted politically were all entrapped. Caesar's success in building up his political power had made the champions of the old regime so implacably hostile to him that he was now faced with a choice between putting himself at his enemies' mercy or seizing the monopoly of power at which he was accused of aiming. He found that he could not extricate himself from this dilemma by reducing his demands, as he eventually did, to the absolute minimum required for his security. As for Pompey, his growing jealousy of Caesar had led him so far toward the nobility that he could not come to terms with Caesar again without loss of face.

The first bout of the civil war moved swiftly. In 49 Caesar drove his opponents out of Italy to the eastern side of the Straits of Otranto. He then crushed Pompey's army in Spain. Toward the end of 49 he followed Pompey across the Adriatic and retrieved a reverse at Dyrrachium by winning a decisive victory at Pharsalus on Aug. 9, 48 (*see* DYRRACHIUM CAMPAIGN; PHARSALUS, BATTLE OF). Caesar pursued Pompey from Thessaly to Egypt, where he was murdered by an officer of King Ptolemy. Caesar wintered in Alexandria, fighting with the populace and dallying with Queen Cleopatra. In 47 he fought a brief local war in northeastern Anatolia with Pharnaces, king of the Cimmerian Bosporus, who was trying to regain his father Mithradates' kingdom of Pontus. Caesar's famous words, *Veni, vidi, vici* ("I came, I saw, I conquered"), are his own account of this campaign. Caesar then returned to Rome, but a few months later, now with the title of dictator, he left for Africa, where his opponents had rallied. In 46 he crushed their army at Thapsus and returned to Rome, only to leave in November for Farther Spain to deal with a fresh outbreak of resistance, which he crushed on March 17, 45, at Munda. He then returned to Rome to start putting the Greco-Roman world in order. He had less than a year's grace for this huge task of reconstruction before his assassination in the Senate House at Rome on March 15, 44 (the Ides of March).

Caesar's death was partly due to his clemency and impatience, which, in combination, were dangerous for his personal security. Caesar had not hesitated to commit atrocities against "barbarians" when it had suited him, but he was almost consistently magnanimous in his treatment of his defeated Roman opponents. Thus clemency was probably not just a matter of policy. Caesar's earliest experience in his political career had been Sulla's implacable persecution of his defeated domestic opponents. Caesar amnestied his opponents wholesale and gave a number of them responsible positions in his new regime. Gaius Cassius Longinus, who was the moving spirit in the plot to murder him, and M. Junius Brutus, the symbolic embodiment of Roman republicanism, were both former enemies. *Et tu, Brute* ("You too, Brutus") was Caesar's expression of his particular anguish at being stabbed by a man whom he had forgiven, trusted, and loved. There were, however, also a number of ex-Caesareans among the 60 conspirators. They had been goaded into this volte-face by the increasingly monarchical trend of Caesar's regime, and, perhaps at least as much, by the aristocratic disdain that inhibited Caesar from taking any trouble to sugar the bitter pill. Some stood to lose, not to gain, personally by the removal of the autocrat who had made their political fortunes. But even if they were acting on principle, they were blind to the truth that the reign of the Roman nobility was over beyond recall and that even Caesar might not have been able to overthrow the *ancien régime* if its destruction had not been long overdue. They also failed to see that, by making Caesar a martyr, they were creating his posthumous political fortune.

If Caesar had not been murdered in 44, he might have lived on for 15 or 20 years. His physical constitution was unusually tough, though in his last years he had several epileptic seizures. What would he have done with this time? The answer can only be guessed from what he did do in the few months available. He found time in the year 46 to reform the Roman calendar (*see* CALENDAR). In 45 he enacted a law laying down a standard pattern for the constitutions of the *municipia* which were by this time the units of local self-government in most of the territory inhabited by Roman citizens. In 59 Caesar had already resurrected the city of Capua, which the republican Roman regime more than 150 years earlier had deprived of its juridical corporate personality; he now resurrected the other two great cities, Carthage and Corinth, that his predecessors had destroyed. This was only a part of what he did to resettle his discharged soldiers and th urban proletariat of Rome. He was also generous in grantin Roman citizenship to aliens. (He had given it to all of Cisalpin Gaul, north of the Po, in 49.) He increased the size of the Senat and made its personnel more representative of the whole Roma citizenry.

At his death, Caesar was on the point of starting out on a ne military campaign to avenge and retrieve Crassus' disastrou defeat in 53 by the Parthians. Would Caesar have succeeded in recapturing for the Greco-Roman world the extinct Seleucid monarchy's lost dominions east of the Euphrates, particularly Babylonia? The fate of Crassus' army had shown that the terrain i northern Mesopotamia favoured Parthian cavalry against Roma infantry. Would Caesar's military genius have outweighed th handicap? And would Rome's hitherto inexhaustible reservoir o military manpower have sufficed for this additional call upon it Only guesses are possible, for Caesar's murder condemned th Romans to another 13 years of civil war, and Rome never agai had sufficient manpower to conquer and hold Babylonia.

Caesar's Personality.—Caesar was not and is not lovable. Hi generosity to defeated opponents, magnanimous though it wa did not win their affection. He won his soldiers' devotion by th victories that his intellectual ability, applied to warfare, brough them. Yet, though not lovable, Caesar was and is attractiv indeed fascinating. His political achievement required abilit amounting to genius, in several different fields, including a ministration and generalship besides the minor arts of wire-pullin and propaganda. In all these, Caesar was a supreme virtuos But if he had not also been something more than this he woul not have been the supremely great man that he undoubted was.

Caesar was great beyond—and even in conflict with—the r quirements of his political ambition. He showed a human spiritu greatness in his generosity to defeated opponents, which was part responsible for his assassination. (The merciless Sulla abdicat and died in his bed.)

Another field in which Caesar's genius went far beyond the r quirements of his political ambition was his writings. Of thes his speeches, letters, and pamphlets are lost. Only his accoun (both incomplete, and supplemented by other hands) of the Gal war and the civil war survive. Caesar ranked as a masterly pub speaker in an age in which he was in competition first with H tensius and then with Cicero.

All Caesar's speeches and writings, lost and extant, apparently served political purposes. He turned his funeral orations for his wife and for his aunt to account, for political propaganda. His accounts of his wars are subtly contrived to make the unsuspecting reader see Caesar's acts in the light that Caesar chooses. The accounts are written in the form of terse, dry, factual reports that look impersonal and objective; yet every recorded fact has been carefully selected and presented. As for the lost *Anticato,* a reply to Cicero's eulogy of Caesar's dead opponent M. Porcius Cato, it is a testimony to Caesar's political insight that he made the time to write it, in spite of the overwhelming military, administrative, and legislative demands on him. He realized that Cato, in giving his life for his cause (46), had made himself posthumously into a much more potent political force than he had ever been in his lifetime. Caesar was right, from his point of view, to try to put salt on Cato's tail. He did not succeed. For the next 150 years, Cato the martyr continued to be a nuisance, sometimes a menace, to Caesar's successors. The mark of Caesar's genius in his writings is that, though they were written for propaganda, they are nevertheless of outstanding literary merit. A reader who has seen through their prosaic purpose can ignore it and appreciate them as splendid works of art.

Caesar's most amazing characteristic is his energy, intellectual and physical. He prepared his seven books on the Gallic war for publication in 51 when he still had serious revolts in Gaul on his hands, and he wrote his books on the civil war and his *Anticato* in the hectic years between 49 and 44. His physical energy was of the same order. For instance, in the winter of 57–56 he found time to visit his third province, Illyricum, as well as Cisalpine Gaul; and in the interval between his campaigns of 55 and 54 he transacted public business in Cisalpine Gaul and went to Illyricum to settle accounts with the Pirustae, a turbulent tribe in what is now Albania. In 49 he marched, within a single campaigning season, from the Rubicon to Brundisium and from Brundisium to Spain. At Alexandria, probably aged 53, he saved himself from sudden death by his prowess as a swimmer.

Caesar's physical vitality perhaps partly accounts for his sexual incontinence. His sexual escapades were out of the ordinary, even by contemporary Greek and Roman standards. It was rumoured that, during his first visit to the East, he had had homosexual relations with King Nicomedes of Bithynia. The rumour is credible, though not proved, and was repeated throughout Caesar's life. There is no doubt of Caesar's heterosexual affairs, many of them with married women. Probably Caesar looked upon these as trivial recreations. Yet he involved himself at least twice in escapades that might have wrecked his career. If he did in fact have an affair with Pompey's wife Mucia, he was risking his entente with Pompey. A more notorious, though not quite so hazardous, affair was his liaison with Cleopatra. By dallying with her at Alexandria, he risked the loss of what he had just won at Pharsalus. By allowing her to visit him in Rome in 46, he flouted public feeling and added to the list of tactless acts that, cumulatively, goaded old comrades and amnestied enemies into assassinating him.

This cool-headed man of genius with an erratic vein of sexual exuberance undoubtedly changed the course of history at the western end of the Old World. By liquidating the scandalous and bankrupt rule of the Roman nobility, he gave the Roman state—and with it the Greco-Roman civilization—a reprieve that lasted for more than 600 years in the East and for more than 400 years in the relatively backward West. Caesar substituted for the Roman oligarchy an autocracy that could never afterward be abolished. If he had not done this when he did it, Rome and the Greco-Roman world might have succumbed, before the beginning of the Christian era, to barbarian invaders in the West and to the Parthian Empire in the East. The prolongation of the life of the Greco-Roman civilization had important historical effects. Under the Roman Empire the Near East was impregnated with Hellenism for six or seven more centuries. But for this, the Hellenic element might not have been present in sufficient strength to make its decisive impact on Christianity and Islam. Gaul, too, would have sunk deeper into barbarism when the Franks overran it, if it had not been associated with the civilized Mediterranean world for more than 500 years as a result of Caesar's conquest.

Caesar's political achievement was limited. Its effects were confined to the western end of the Old World and were comparatively short-lived by Chinese or ancient Egyptian standards. The Chinese empire that Shih Huang Ti founded in the 3rd century B.C. still stands, and its future may be still greater than its past. Yet, even if Caesar were to prove to have been of lesser stature than this Chinese colossus, he would still remain a giant by comparison with the common run of human beings.

See also ROMAN HISTORY and references under "Caesar, Gaius Julius" in the Index.

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CAESAREAN SECTION, in obstetrics, is the surgical removal of a fetus, at or before full term, from the uterus through an abdominal incision. It is named after a branch of the ancient Roman family of the Julii, whose cognomen Caesar (cf. *caedere,* "to cut") originated, according to Pliny and others, from a birth by this means. The operation is certainly ancient: it is mentioned in the Talmud; the Roman authorities in antiquity and the Venetian senate in 1608 required that it be performed on women dying in advanced pregnancy; and the Persian epic *Shah-Nama* (10th–11th century) describes it in a case of obstructed labour. The first recorded instance of its being performed successfully on a living woman occurred about 1500, when a Swiss pig-gelder is said to have operated on his wife. It was subsequently tried in many ways and under many conditions, but almost invariably resulted in death of the mother from sepsis or hemorrhage. Even in the first half of the 19th century the recorded mortality was about 75%, and fetal craniotomy—in which the life of the child is sacrificed to save that of the mother—was usually preferred. Antiseptic procedures and improved suturing of the uterine wall later so reduced the mortality that caesarean section came to be frequently performed as an alternative to normal childbirth.

CAESAREA PALESTINAE, an ancient seaport on the coast of Palestine, the site of the modern village of Qisarya, 22 mi. S of Haifa, in northern Israel. The town was originally built (25–13 B.C.) by Herod the Great, king of Judaea, as port for his capital Sebaste on an ancient Phoenician fortified site known as Strato's Tower. Josephus describes the palaces, temple, theatre, amphitheatre, hippodrome, aqueducts, and other monumental structures (*Antiquitates,* xv, 9, 6). From 1958 on, A. Frova, leading an Italian expedition, uncovered the theatre and a portion of the 10-mi. aqueduct; an Israeli team excavated the podium of the great temple, the Crusader fortifications, and additional portions of the aqueduct. The harbour was constructed by reinforcing two reefs with vast stone blocks so that the mouth faced north away from the rough seas whipped up by the prevailing southerly winds. A coin found in the harbour floor during undersea explorations shows the plan of the installation. Caesarea played a prominent role in the lives of the early Christians. An inscription found by the Italian expedition in 1961 includes the name of Pontius Pilate, who governed Judaea (A.D. 26–36) from Caesarea. Peter first preached to Gentiles there at the invitation of the Roman centurion, Cornelius. Philip the Evangelist lived there (Acts 21:8) and entertained Paul and his friends. Paul was tried by Felix and imprisoned in Caesarea for two years (A.D. 57–59); he appeared there before Festus, Felix' successor, and Herod Agrippa II and sailed from there to Italy for his final appeal to the emperor. Caesarea saw the first incidents in the Jewish revolt against the Romans (A.D. 66), and Vespasian, who made the town his headquarters, was proclaimed emperor there in 69. In the reign of Alexander Severus (A.D. 222–235) it became the metropolis of Syria. Its bishop, therefore, became metropolitan of Syria, an office which the historian Eusebius held from *c.* 314 to 318. Caesarea was also the home of the historian Procopius and of Origen, the theologian. By A.D. 640 when the Muslims occupied the town its sea power had faded, and it rapidly shrank in size and importance. Under the crusaders the city revived, for they rebuilt and walled about one-tenth of the Roman city adjacent to the harbour to serve as a citadel. It was successively captured: in 1101 by Baldwin I, on which occasion the "Holy Grail" was discovered; by Saladin in 1187; and by Richard I in 1191. Louis IX strengthened its fortifications (1251), and it was finally demolished by the Mameluke sultan Baybars I in 1265. Stones from the ruin were transported to Acre and Jaffa (Joppa) for building purposes during the 19th century.

In modern Israel an agricultural settlement, Sdot Yam, adjoins the ancient site. (J. S. I.)

CAESAREA PHILIPPI, an ancient city (modern BANIYAS, in the Damascus *mohafazet* of Syria), lying at the southern end of the Hermon range where the main source of the Jordan river flows from a cave. Baal worship may have been practised there in Old Testament times, and the site may be Baal-gad of Josh. xi, 17 ff., or Baal-hermon of I Chron. v, 23. Worship of Baal later gave way to that of the Greek god Pan, and the name Paneas was applied to the city and the district. It was the site of the battle (*c.* 198 B.C.) in which the Seleucid king Antiochus III wrested Palestine from the Egyptian Ptolemy V (Polybius xvi, 18). Caesar Augustus presented the region to Herod the Great (king of Judaea from 37 to 4 B.C.) and Herod erected a temple to the emperor and installed his image in it.

Philip the Tetrarch (d. A.D. 34), Herod's son, enlarged the town, naming it Caesarea after Augustus and adding "Philippi" to distinguish it from Caesarea Palestinae (*q.v.*). Jesus visited the region and gave the famous charge to Peter there (Mark viii, 27 ff.). Vespasian rested his army there for three weeks before advancing into Galilee to crush the Jewish revolt in A.D. 67. The city was the scene of fighting during the second crusade. Some broken columns and carved stones, parts of the old wall and citadel, traces of an aqueduct and some niches in the rock beside the spring are now the only visible remains of the ancient city. (J. S. I.)

CAESARIUS, SAINT, OF ARLES (*c.* 470–542), a monk of Lérins, celebrated preacher and opponent of Semi-Pelagianism (*q.v.*), was born in the environs of Chalon-sur-Saône about the year 470. At the age of 20, against his family's wishes, he entered the monastery at Lérins, and later held there the post of cellarer. Either because of poor health, with which he was constantly plagued, or because of differences with his colleagues, he left Lérins and, having been ordained priest, became abbot of a monastic community on an islet in the Rhône near Arles. He succeeded his kinsman, Aeonius, as archbishop of Arles, the see of which Pope Symmachus made primatial for Gaul and Spain. In his capacity as primate, Caesarius held various regional synods of importance. Among these, the second Council of Orange (529) is a landmark in the history of dogma because it decisively rejects the grace theories of Cassian and Faustus of Riez (Semi-Pelagianism) in favour of a moderate Augustinianism. The Orange decrees have become the Roman Catholic norm for doctrines on grace, predestination and free will. Caesarius was no great theologian, but he was a great preacher whose many sermons were preserved and frequently used after his death. He wrote a rule, *Regula ad virgines,* for the women's monastery of which his sister, St. Caesaria, was abbess, and also a directory for monks. He died in 542 and his liturgical feast is Aug. 27.

Caesarius' works were published in J. P. Migne, *Patrologia Latina,* vol. 67, col. 997–1166. The complete critical edition is Germain Morin, *Opera omnia S. Caesarii,* 2 vol. (1937–42). The Morin edition of the sermons appears as vol. 103 and 104 in *Corpus Christianorum* (1953). An English translation of the sermons by Sister Mary Magdeleine Mueller appears in vol. 31 of *The Fathers of the Church* (1956). (G. WL.)

CAESARIUS OF HEISTERBACH (*c.* 1170–*c.* 1240), German preacher and writer of ecclesiastical histories and ascetical works, was born at Cologne. He joined the Cistercian order in 1199 and became prior of the Heisterbach house in 1228.

Caesarius was one of the most popular authors of 13th-century Germany and for that reason is of interest to cultural historians. His *Dialogue on Miracles* (*c.* 1223; Eng. trans., 2 vol., 1929) consisting of edifying narratives dealing with Cistercian life, was his most widely read work. He also composed eight books or miracles (edited by Meister, 1901), a life of St. Engelbert (edited by Gelenius, 1663; Ger. trans., 1955), a life of St. Elizabeth of Hungary (edited by Hyskens, 1908) and a biographical list of the archbishops of Cologne from 94 to 1238 (in *Monumenta Germaniae Historica,* vol. xxiv). Caesarius was noted for his practical sermons and opposition to the rationalistic tendency of scholastic philosophy. (WM. J. B.)

CAETANI (GAETANI), the name of a Roman princely house which according to family tradition is descended from the 10th century dukes of Gaeta and which documentary record carries back at least to the 12th century, when Caetani appear in Naples, Rome Anagni and Pisa. Of these the Caetani of Anagni were raised to sudden prominence on the election of Benedetto Caetani as Pope Boniface VIII in 1294. It was at once the ambition and the policy of Boniface to increase the territorial power of his family and to diminish that of the Colonna (*q.v.*), the dominant feudal family of Rome. As a result the Caetani themselves became in the 14t century the dominant feudal family with lands and lordship throughout the Campagna, Marittima and Terra di Lavoro, whic included Anagni itself, Sermoneta, Fondi and Piedimonte. Th possession of domains in two different states, that of Naples an that of the church, induced the Caetani about 1420 to divide the patrimony. From this partition derive the two modern lines of th family, the Caetani of Rome, princes of Teano and dukes o Sermoneta, and the Caetani of Naples (dell' Aquila d'Aragona princes of Piedimonte and dukes of Laurenzana. The Roma Caetani were created dukes of Sermoneta by Sixtus V in 1586 an received the principality of Teano in 1750 by exchange for Casert which they had acquired in 1659 as the result of a marriage. Th Neapolitan Caetani were granted the surname d'Aragona by roy privilege from the Aragonese king of Naples in 1466. The duch of Laurenzana came to them by marriage in 1606, and the lord ship of Piedimonte was raised to a principality in 1715.

See F. Gregorovius, *History of the City of Rome in the Middle Age* Eng. trans. (1900–09); G. Caetani, *Domus Caietana* (1927). (P. J. J.)

CAFFIÉRI, the name of a large family of French sculpto and bronzeworkers, of Italian descent, founded by FILIPPO CA FIÉRI (1634–1716). Filippo, after serving Pope Alexander VI was taken to France in 1660 by Cardinal Mazarin and later a pointed sculptor to Louis XIV; he worked in wood, stucco an bronze.

The most celebrated member of the family was JACQUES CA FIÉRI, sixth son of Filippo. In 1715 Jacques designed a pall, h first recorded work, for a guild of which he had recently be elected a member. From 1736 until his death, payments appe regularly (though frequently in arrears) in the royal accounts f work he carried out at Versailles and other royal residences.

Little of this is now identifiable, but among his most importa surviving works are the signed mounts for the chest of drawers d livered by R. A. Gaudreau for Louis XV's bedchamber at Versail in 1739 (Wallace collection, London), and the mounts execut in 1747 for the chimney piece in the dauphin's bedchamber, whi are still in position at Versailles. He was a master of the rocc style which he redeemed from triviality by his vigorous and spo taneous handling and which he was still using in the 1750s wh it was already becoming retardatory. The most important of these late works are the two monumental chandeliers in the Wallace collection (both signed and one dated 1751), and the case of the astronomical clock designed by Claude Simon Passemant, completed in 1753 for the Cabinet Ovale at Versailles where it still stands. Jacques Caffiéri also executed portrait busts, notably of the baron de Bezenval and his son (both signed and dated 1737 and 1735 respectively).

Jacques seems always to have used the signature "Caffiéri" even when he was collaborating with his elder son Philipe Caffiéri (1714–74). At Jacques's death the latter succeeded to his father's royal appointments. His most important works were the new altar furniture executed in 1759 for Notre Dame, Paris, which disappeared during the Revolution, and the surviving cross and candlesticks commissioned for Bayeux cathedral in 1771. He seems to have signed his own works "P. Caffiéri," sometimes adding *l'aîné,* to distinguish himself from his younger brother JEAN JACQUES CAFFIÉRI (1725–92). Jean Jacques became sculptor to Louis XV and also provided ornamental designs for metalwork, notably for the staircase at the Palais Royal.

See Lady Dilke, *French Furniture and Decoration of the 18th Century* (1901); F. J. B. Watson, *Catalogue of the Furniture in the Wallace Collection* (1954). (F. J. B. W.)

CAGE, JOHN (1912–), U.S. composer whose work and ideas had a revolutionary influence on mid-20th-century music, was born in Los Angeles, Calif., on Sept. 5, 1912. Arnold Schoenberg, Henry Cowell, and Edgard Varèse were among his teachers, and he himself taught (1936–38) at the Cornish School in Seattle, at which time he began giving concerts with a percussion ensemble and working in collaboration with the Merce Cunningham dance group. He traveled extensively lecturing and performing his compositions, often with the virtuoso pianist David Tudor.

By 1939 Cage was writing for unusual combinations of percussion instruments and variable-speed phonograph turntables. He was a pioneer in the "prepared piano" devices; *i.e.,* of placing objects in the strings of a piano in order to produce a wide range of sounds and effects. As early as 1951 he, together with Christian Wolff, Earle Brown, and Morton Feldman, was experimenting with music on tape. His aim in these experiments was to attempt to step outside the bounds of Western music and of individual self-expression (*e.g.,* in *Sonatas and Interludes* [1946–48] the prepared piano recalls the sound and spirit of Far Eastern musics and philosophies). In his later concerts, which frequently included Zen tales, fables, conversation, and discussion, the music was designed to be only a single part of the performance, as, in Cage's view, audiences must first learn to listen to sounds "for themselves," and not for any construction fabricated out of them. He maintains that all the activities that make up concert giving must be seen in perspective as part of man's life, and as part of a natural process; and he believes that this can best be achieved by the deliberate rejection of any predetermined plan of performance.

In his later works in order to eliminate the possibility of any expression of personal taste on the part of the performer, Cage uses a number of devices to ensure randomness. The sounds are often separated from one another by extremely long silences; one piece (*4′33″*; 1954) is for any instrument or combination of instruments (silent); the *Concert for Piano and Orchestra* (1957–58) may be played by any number of players up to full symphony orchestra size. *Atlas Eclipticalis* (1961–62) may be played by up to 6 players, and may be combined with another work, *Winter Music* (1957), for 1 to 20 pianists. *Imaginary Landscape no. 4* (1951) uses 12 radios, tuned randomly, 24 performers, and conductor. *Fontana Mix* (1958) is based on a series of programmed transparent cards which, when superimposed, give a graph for the random selection of electronic sounds, the alterations of frequency, duration, timbre, and the processes of looping, splicing, etc.; it may be combined in performance with a vocal piece, *Aria* (1958).

In the introduction to a phonograph record of stories accompanied by sounds, Cage says: "My intention in putting 90 stories together in an unplanned way is to suggest that all things, sounds, stories (and, by extension, beings) *are* related, and that this complexity is more evident when it is not oversimplified by an idea of relationship in one person's mind."

A collection of his writings was published in 1961, under the title *Silence.* *See* also MUSIC, 20TH-CENTURY.

See R. Dunn (ed.), *John Cage,* a catalogue of his works with elaborate notes and supplementary material (1962). *See* also the recording of *25-year Retrospective Concert of the Music of John Cage,* on three discs, which includes informative notes. (D. J. SI.)

CAGLIARI, the capital of Sardinia and the chief town of Cagliari province, is by sea 434 km. (270 mi.) WSW of Naples and 604 km. (375 mi.) S of Genoa. Pop. (1969 est.) 219,852. It lies at the northern extremity of the Gulf of Cagliari, in the centre of the south coast of the island, and is exposed to winds in winter, while in summer the climate is hot and dry. The medieval town occupies a long narrow hill running north and south. On each side of the town are lagoons. The upper town retains in part its fortifications, including the two great Pisan towers at the two extremities; near one is the university (founded 1806) and near the other the archaeological museum. On the edge of the cliffs on the east is the cathedral of Sta. Cecilia, built 1257–1312 (rebuilt 1676), which retains two of the original transept doors. North of the town is the Roman amphitheatre. At the south extremity of the hill a large terrace, the Passeggiata Umberto Primo, was constructed. Below it are covered promenades, and steps descend to the lower town, the oldest part of which (the Marina) slopes toward the sea. The quarter of Stampace lies to the west, and beyond it again the suburb of Sant' Avendrace. East of the Marina is the quarter of Villanova, which contains the 8th-century domed church of S. Saturnino. The harbour was expanded in 1938. The chief exports are lead, zinc and other minerals, and salt. Agriculture is the main occupation.

The province of Cagliari (area 3,590 sq.mi.; pop. [1969 est.] 804,715) is the most southerly of the three Sardinia divisions. It covers about one-third of the island and extends much farther northward on the west of the island than on the east. Other towns include Iglesias, Guspini, Oristano, and Carloforte.

The Ancient City.—Known to the Greeks as Caralis and to the Romans as Carales, the ancient city was the most important of Sardinia. It is attributed to the Phoenicians, and Punic tombs exist in considerable numbers. It first appears in Roman history in the Second Punic War, and probably obtained full Roman civic rights from Julius Caesar. In imperial times it was the most important town in the island, and in the 4th and 5th centuries it was probably the seat of the governor (*praeses Sardiniae*). It is mentioned as an important harbour in the Gothic and Gildonic wars. It was also the chief point of the road system of Sardinia. The site of the medieval town with its Pisan fortifications must have been the Carthaginian acropolis. The nucleus of the Roman *municipium* is probably represented by the present quarter of the Marina. The western quarter seems to have been far more important and a large Roman house (or group of houses) is still visible. Beyond this begins an extensive Roman necropolis.

It is probable that the acropolis of Carales was occupied even in prehistoric times; but more abundant traces of prehistoric settlements have been found on the Capo Sant' Elia to the southeast of the modern town. The museum contains objects collected from many of the local sites. *See* also SARDINIA.

CAGLIOSTRO, ALESSANDRO, CONTE DI (GIUSEPPE BALSAMO) (1743–1795), Sicilian charlatan and adventurer reputed to have magical powers, was born in Palermo. He later claimed to have spent some of his youth in Alexandria learning alchemy. In Rome he married the beautiful Lorenza Feliciani, called Serafina. In 1776 they appeared as Count and Countess Cagliostro in London, where Cagliostro was initiated into Freemasonry.

After traveling in eastern Europe practising hypnotism, Cagliostro appeared in Strasbourg, France, in 1780 and made the acquaintance of the disgraced cardinal Louis de Rohan, who invited him to Paris. There his séances became the rage of fashionable society. A contemporary witness thus describes one of them: "I only stole a look at him, and I still do not know what to make of him: that face, that headdress, the whole appearance of the man, impressed me in spite of myself. I waited for him to speak. He talked some gibberish, a mixture of Italian and French, and gabbled quotations in something which passed for Arabic, but which he did not trouble to translate." Like the comte de Saint-Germain, he claimed to be 2,000 years old. The Affair of the Diamond Necklace (*q.v.*), in 1785, ruined Cagliostro's career in France. Although innocent in that swindle, he had previously promised the infatuated cardinal de Rohan to reconcile the queen, Marie Antoinette, to him. To the cardinal's delight he went through a performance of producing an apparition of her in a carafe of water—visible, however, not to the cardinal himself, but only to a child, who was supposed to have the "purity of an angel." This performance aroused great enthusiasm among Cagliostro's admirers, but the subsequent scandal over the necklace affair caused Louis XVI to banish him from France (1786).

In 1789 Cagliostro and his wife took refuge in Rome, but there she denounced him to the holy inquisition as a heretic, magician, conjuror of demons and Freemason. Condemned to life imprisonment, he died in the fortress of San Leo, in the Apennines, in 1795. (An. Ca.)

CAGNIARD DE LA TOUR, CHARLES, Baron (1777–1859), French engineer and physicist, is best known for his invention in 1819 of a siren, known by his name, which he used to determine the number of vibrations corresponding to a sound of any particular pitch. He was born in Paris on March 31, 1777, and attended the École Polytechnique. He was made a baron in 1818, and died in Paris on July 5, 1859.

He was the author of numerous inventions, including the cagniardelle, a blowing machine, which consists essentially of an Archimedean screw set obliquely in a tank of water in such a way that its lower end is completely, and its upper end partially, immersed, and operated by being rotated in the opposite direction to that required for raising water.

In course of an investigation, in 1822–23, on the effects of heat and pressure on certain liquids, he found that for each there was a certain temperature above which it refused to remain liquid, but passed into the gaseous state, no matter what the amount of pressure to which it was subjected. In the case of water he determined this critical temperature to be 683.3° F., a remarkably accurate figure for his day.

Cagniard de la Tour also made experiments on the mechanism of voice production.

CAGOT (Span. Agotes), people belonging to communities of outcasts in the Basque country, southwestern France and Brittany. A common phenomenon in the later middle ages and after, they were known as Capots, Gafets, Gahets, Gafos, Cacous, Caqueux and Caquins. The community which preserved its character until most recently was at Bozate de Arizcun in the valley of the Baztán (Navarre). Regarded as unclean and credited with physical characteristics denoting degeneracy or leprosy, they were originally subject to severe restrictions such as inferior legal status, exclusion from political life, the professions and physical contact with others, and were even buried apart. They were forbidden to carry arms or to walk barefoot, and were obliged to wear a mark in the shape of a duck's foot or a piece of red cloth. In church they had a place reserved for them, sometimes with a separate door and a separate stoup, and the sacrament was administered to them on the end of a stick. They made their livelihood as woodcutters, carpenters, barrelmakers, masons, quarrymen, saddlers, fishermen and weavers, and in certain cases were noted as musicians, a role in which they were admitted to popular festivals.

Various explanations of their origin have been offered on ethnic, religious and physiological grounds, suggestions being that they were descendants of Romans or Goths or Moors, that they were descended from excommunicated Albigenses or that they were afflicted with cretinism or leprosy. Attempts were first made to liberate them in the 17th century and it has long been recognized that they are in no way abnormal. Pilar Hors, who studied them in 1952 in Bozate de Arizcun, found that their physical characteristics and blood groups resembled the population of southern France and were significantly different from the surrounding Spanish Basques, a circumstance exaggerated by the ban on mixed marriages which had continued into the 20th century. She suggests that they were descendants of persons who took sanctuary in a leper colony, preferring the risk of disease to the dangers outside, and in support of her argument she refers to the use of the French word *cagot* to mean "hypocrite."

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CAGUAS, an important industrial city situated on an extensive and fertile plain in the east central part of Puerto Rico. A four-lane divided highway, 25 mi. long, connects Caguas with San Juan, the capital and principal port of the island. Pop. (1960) mun., 65,098; town, 32,015. Sugar cane, tobacco, some fruits and vegetables are the main products of the Caguas rural district. Cigars, leather goods, glassware, foam rubber and electronic products are manufactured.

In the centre of the town is a beautiful plaza surrounded by attractive stores and public buildings. Founded in 1775, Caguas derived its name from the Indian chief Caguax, who lived in the surroundings and who was one of the first Indian chiefs to embrace the Christian faith. (T. G. Ms.)

CAHIR (Cathair Dhúin Iascaīgh), a market town of County Tipperary, Republic of Ireland, lies in a good agricultural district at the foot of the eastern end of the Galty mountains, on the river Suir, midway between Clonmel and Tipperary. Pop. (1956) 1,731. An ancient fortress on an island in the river, called *Dhúin Iascaīgh* ("abounding in fish"), was destroyed in the 3rd century. The present castle was built in 1142 (restored 1840) by Conor O'Brien, prince of Thomond, and is the largest of its type in Ireland. It was besieged by the earls of Essex (1599) and Inchiguin (1647) and by Cromwell in 1650. There is very good salmon and trout fishing in the Suir and the Aherlow; the latter river joins the Suir above the town.

CAHITA, a group of North American Indian tribes who inhabited the northwest coast of Mexico along the lower courses of the Sinaloa, Fuerte, Mayo and Yaqui rivers. They numbered about 100,000 when first encountered by the Spaniards in 1533 and were the most numerous of any single language group in northern Mexico. They spoke closely related dialects of the Taracahitian family of the Uto-Aztecan stock and were thus similar i language to the Nahuatl-speaking Aztecs in central Mexico an the Shoshonean-speaking Hopis of northern Arizona. They wer agriculturalists and demonstrated a capacity for effective militar organization.

Despite initial resistance to the Spanish conquest, they wer rapidly gathered around missions by the Jesuit missionaries an during the 17th century were all converted to Christianity. The developed a complex fusion of native and Christian religion an became noted for their distinctive Easter ceremonies.

The chief surviving tribes are the Mayos and Yaquis. The latt played an important role in Mexican history, maintaining virtu autonomy of their church-centred communities until the 1890 when the Mexican government inaugurated a program of deportation. Thousands of Yaquis and Mayos were sent to Yucatán between 1905 and 1910. Others fled their homeland and scatter widely through northwestern Mexico and southwestern Unite States. The last Yaqui rebellion took place in 1927.

The Yaqui deer dancer occupies a central place in the offici seal of the state of Sonora, and the vigorous music of the dee dance was utilized by the Mexican composer Carlos Chávez as symphonic theme.

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CAHOKIA MOUND, the largest prehistoric American eart work north of Mexico, one of a group formerly numbering 45 co siderable mounds (not including a great number of smaller ones standing in Illinois, 6 mi. E. of St. Louis, Mo. The great mou is a quadrangular pyramid 998 ft. by 721 ft. by 99 ft. in heigh with a terrace, 30 ft. high, extending outward about 200 ft. from one side and with a width of 500 ft. The area of the base is more than 16 ac.

The mound is named for the Cahokia, a tribe of the Illinois confederacy, who occupied the neighbourhood in historic times and who were gathered into a mission settlement near the site of the present town of Cahokia, Ill., around 1698 by the Jesuit Pierre Pinet.

Various Indian artifacts and relics, including pipes, shells, etc., are preserved in a museum at Cahokia Mounds State park.

See also MOUND BUILDERS; NORTH AMERICA: *Prehistory and Archaeology.* (H. B. Cs.; X.)

CAHORS, a city of southern France, capital of Lot *département* and formerly capital of Quercy, is situated on a rocky peninsula surrounded by the Lot river, 111 km. (69 mi.) N. of Toulouse. Pop. (1954) 12,760. The city is divided by the Boulevard Gambetta, which runs north and south, and continues national route 20; to the east is the old town, dominated by the cathedral of St. Étienne. Built in 1119, and rebuilt in part between 1285 and 1500, it was the first cathedral in France to have cupolas; the two cupolas form the roof of the aisleless nave. Another remarkable feature is the finely sculptured north portal (*c.* 1190). Adjoining the cathedral are the remains of a cloister (1494–1509). The church of St. Urcisse is nearby on the river bank. It dates from the 12th and 13th centuries and preserves Romanesque capitals recarved in the 14th century. Of the palace of Pope John XXII, the great Avignon pope who was born at Cahors, only a square tower stands, the rest being in ruins or unfinished. The residence (mainly 14th-century) of the seneschals of Quercy, the Château du Roi, is near the river, upstream from the church of St. Urcisse. To the west of the Boulevard Gambetta is the newer quarter, with wide streets and spacious squares. There, too, is the Porte de Diane, probably the entrance to the Roman baths.

Four bridges span the Lot: the Pont Valentré (13th and 14th centuries), the finest medieval fortified bridge in France, with three towers, to the west; the railway bridge and Pont Louis Philippe, built in the reign of the king whose name it bears, which carries the main road to Toulouse and the south; and to the east the Pont Neuf, an iron bridge built in 1906, which replaced the humpbacked 13th-century stone bridge, by which Henry of Navarre took the town in 1580. A medieval rampart protected the city on the northern side. Just outside the loop of the river to the southeast is Mont St. Cyr, from which a fine view of the city can be obtained. Cahors is on the main railway from Paris and Orléans to Toulouse and Spain. Electrical equipment, door handles and sandals are manufactured and printing is carried on. An important market of geese and truffles is held between November and February.

The Divona of the Romans, Cahors was the capital of the Cadurci, the sacred Fons Divona (Divonne spring) now providing the city with water. It was famous for its linen cloth under the Romans and had a bishop from the 3rd century. It was later occupied by the Visigoths and the Saracens. Until after the Albigensian crusade it was a fief of the counts of Toulouse and in the 13th century became well known as a financial centre. From 1316 to the Revolution the administration was in the hands of royal officers, coseigneurs with the bishops. Pope John XXII founded a university at Cahors which survived until 1751 when it combined with that at Toulouse.

In addition to Pope John XXII, other famous natives of Cahors include the statesman Léon Gambetta and the poet Clément Marot. (E. D. DE G.)

CAILLAUX, JOSEPH MARIE AUGUSTE (1863–1944), French statesman, an outstanding finance minister and an able diplomat who is remembered also for the charges brought against his conduct in World War I, was born on March 30, 1863, at Le Mans. His father, Eugène Caillaux, was twice minister in conservative governments (1874–75 and 1877). In 1882, after a brilliant academic career, Joseph Caillaux entered the civil service as inspector of finance. In 1898 he was elected deputy for Mamers and soon joined the Radical-Socialist group in the chamber. Finance minister in René Waldeck-Rousseau's cabinet (1899–1902), he showed great ability. Georges Clemenceau gave him the same post in his cabinet of 1906–09. During this second term Caillaux was responsible for a bill introducing income tax, which brought upon him the enmity of the conservatives.

When Ernest Monis resigned in June 1911, Caillaux succeeded him as prime minister. He immediately had to deal with the Agadir crisis, which for a short time seemed likely to provoke war between France and Germany. A pacifist and a "European" at heart, Caillaux personally conducted the difficult negotiations over the head of his foreign minister, Justin de Selves. By ceding a small part of the French Congo, he successfully won Germany's acquiescence to the establishment of a French protectorate over Morocco. Nevertheless his many adversaries in France bitterly attacked him, and the hostility of the inquiry committee of the senate, led by Raymond Poincaré and Clemenceau, obliged him to resign.

Finance minister again in Dec. 1913, Caillaux secured the passing of the income tax bill. A virulent press campaign was started against him in *Le Figaro* and letters which had passed between himself and his wife before their marriage were published. Madame Caillaux, considering her honour assailed, shot the editor, Gaston Calmette. She was tried and was acquitted, but her husband had been forced to resign.

On the outbreak of World War I Caillaux was for a short time sent on an economic mission to South America. He came back to take his seat in the chamber but was systematically left out of the successive war governments. Thinking that the indefinite prolongation of hostilities was highly detrimental to Europe as a whole, he was indiscreet both in his talk and in the choice of his associates. When, in Nov. 1917, Clemenceau came to power fully determined to carry on the war till complete victory, Caillaux was accused of seeking a premature peace and of preparing a *coup d'état.* On Dec. 11, 1917, Clemenceau moved the suspension of Caillaux's parliamentary immunity. This was voted by the chamber and, on Jan. 4, 1918, Caillaux was imprisoned. It was not, however, until Feb. 1920, when Clemenceau was no longer head of the government, that Caillaux was brought before the senate, sitting as high court of justice, and indicted as having "plotted against the security of the state abroad." After a long debate it was felt that nothing definite could be proved against him. Nevertheless the court found him guilty of "communications with the enemy, but without premeditation." He was sentenced to three years' imprisonment and to five years' compulsory residence outside Paris. As he had already spent three years in prison, he was released next morning. Retiring to Mamers, he wrote two books: *Mes Prisons* (1921) and *Où va la France? Où va l'Europe?* (1922; Eng. trans. 1923).

The amnesty of 1924 restored to Caillaux his political rights. When Paul Painlevé formed a government in April 1925 he invited Caillaux to join it as the one man capable of putting the shaky French finances in order. Caillaux accepted and started by tackling the problem of inter-Allied debts. He began negotiations in Washington and in London, but in the French parliament the right was against him on general principles while the left disapproved of his financial orthodoxy. On Oct. 28, 1925, Painlevé formed a new ministry without him.

Meanwhile Caillaux had been elected senator for the Sarthe *département.* In June 1926 he was again finance minister in Aristide Briand's cabinet. The chamber, however, refused to grant him the almost dictatorial powers that he requested in order to restore the financial situation, and he had to resign after only three weeks in office.

Caillaux was finance minister for the last time in Fernand Bouisson's short-lived cabinet (June 1–4, 1935). As chairman of the finance committee of the senate he was instrumental in bringing about the fall of Léon Blum's ministry in June 1937. Caillaux died at Mamers on Nov. 21, 1944.

Although for some time he led the Radical Socialist party, Caillaux was always primarily a *grand bourgeois.* He was an excellent debater and a man of far-reaching vision, but in political circles his great qualities were somewhat impaired by his ostentatious self-esteem and his rather supercilious manner.

See R. de Fleurieu, *Joseph Caillaux* (1951). (J. C. DE C.)

CAILLETET, LOUIS PAUL (1832–1913), French physicist and ironmaster, is noted for his work on the liquefaction of gases. Born at Châtillon-sur-Seine on Sept. 21, 1832, he worked in his father's ironworks and later was in charge of the works. He was also active in scientific research. On Dec. 2, 1877, Cailletet liquefied oxygen at a pressure of 300 atm. and at −27° C. The oxygen was obtained in the form of a cloud, but later he repeated his experiments at the École Normale at Paris, when he liquefied hydrogen, nitrogen and air. This work was carried on independently of the work of R. P. Pictet on liquefaction and there was considerable discussion as to which of the two had succeeded first.

Cailletet was the author of a number of papers in *Comptes Rendus* and other French scientific periodicals on the liquefaction of gases and the production of low temperatures, on the passage of gases through metals, on manometers for measuring high pressures, on critical points and on the state of matter at low temperatures. He was interested in aeronautics and devised an apparatus for measuring the altitude of an airplane. He was a member of the Paris Academy. He died in his native town on Jan. 5, 1913.

CAILLIÉ, RENÉ AUGUSTE (1799–1838), French explorer and the first European to visit Tombouctou (Timbuktu) and to return alive, was born at Mauzé, near La Rochelle, France, on Nov. 19, 1799. Before he was 20 he had made two voyages to Senegal and had traveled in the country. In 1824 he returned and prepared for an attempt to reach Tombouctou by learning Arabic and being educated as a convert to Islam. Pretending to be an Arab returning to Egypt he left the coast in April 1827, proceeded inland, crossed the upper Niger at Karoussa and after five months delay due to illness reached Tombouctou on April 20, 1828. He remained there a fortnight and then crossed the Sahara to reach Fès (Fez) in August. For his achievement he received a prize of 10,000 fr. from the Geographical Society of Paris. His *Journal d'un voyage à Tomboctou et à Jenné dans l'Afrique centrale* (ed. by E. F. Jomard) was published in three volumes in 1830; an English version was published in the same year entitled *Travels through Central Africa to Timbuctoo* . . . . Caillié died at La Badère, Champagne, probably on April 17, 1838.

See A. Lamandé and J. Nanteuil, *La Vie de René Caillié* (1928); G. Welch, *The Unveilling of Timbuctoo: The Astounding Adventures of Caillie* (1938); A. Demongeot, *René Caille* (1948). (R. M. P.)

CAIN, according to Gen. iv, 1, the first-born son of Adam and Eve (*q.v.*). Gen. iv, 2–16, interrupting the genealogy, relates how Cain, a farmer, enraged because the Lord accepted the offering of his shepherd brother Abel in preference to his own, murdered Abel. For this crime he is cursed and banished from the settled country. Before he departs to the land of Nod (wandering), feeling that in his exile he will be the victim of any man who encounters him, he obtains from the Lord a sign of protection, and a promise that if he is slain despite it he shall be avenged sevenfold. The story is probably intended to explain how a certain tribe, bearing the name of Cain, came to have a certain tattoo mark, and to be noted for the plenteous vengeance it took upon any other tribe by whose hands one of its members was killed. It explains, too, from the point of view of the settled peoples, how this tribe came to live a nomad life. It has been argued that the tribe in question is the Kenites. In the parallel genealogy in Gen. v, the Kenan who appears fourth in the list is probably to be identified with Cain. The representation of Cain as a city-builder accords ill with the picture of Cain the nomad.

Irenaeus and other early writers mention a Gnostic sect of the 2nd century called the Cainites, who believed that Cain derived his existence from the superior, Abel from the inferior power, and that Cain was the first of a line which included Esau, Korah and the Sodomites. They are said to have had a Gospel of Judas. *See* also ABEL; GENESIS. (W. L. W.; X.)

CAINE, SIR (THOMAS HENRY) HALL (1853–1931), English writer whose novels achieved great popularity, was born at Runcorn, Cheshire, May 14, 1853. After working in a builder's office, and as a journalist and lecturer, he attracted D. G. Rossetti's interest by sending him a copy of a lecture in his defense, and in 1881 became his secretary. When Rossetti died Caine earned a living by journalism, and in 1885 published *The Shadow of a Crime*, the first of many novels which combined strong characterization, sentiment, moral fervour and skill in conveying local atmosphere. Among the best known were *The Deemster* (1887), *The Manxman* (1894), *The Eternal City* (1901), *The Woman Thou Gavest Me* (1913) and *The Woman of Knockaloe* (1923). He settled in the Isle of Man, where he sat in the House of Keys, 1901–08, and died there, Aug. 31, 1931. In 1918 he received a knighthood of the British empire for his work as an Allied propagandist in the United States and in 1922 was made companion of honour.

ÇA IRA, a song of the French Revolution, with the refrain:

> Ah! ça ira, ça ira, ça ira!
> Les aristocrates à la lanterne.

The words, written by one Ladré, a street singer, were put to an older tune, called "Le Carillon National," and the song rivaled the "Carmagnole" (*q.v.*) during the Terror. It was forbidden by the Directory.

CAIRD, EDWARD (1835–1908), British philosopher, one of the leaders of the Neo-Hegelians, was born at Greenock, Scot., on March 23, 1835, a younger brother of the theologian John Caird. Educated at Glasgow university (1850–56), at St. Andrews (1856–57) and at Balliol college, Oxford (1860–63), Caird was tutor of Merton college, Oxford, from 1864 to 1866, professor of moral philosophy at Glasgow from 1866 to 1893 and master of Balliol from 1893 to 1907, when a paralysis obliged him to retire. He died at Oxford on Nov. 1, 1908.

Caird was one of the most influential British exponents of German idealism (*see* NEO-HEGELIANISM). While his friend Thomas Hill Green (*q.v.*) did more to develop the system positively, particularly in the field of ethics, Caird was chiefly distinguished for applying its principles to the interpretation of philosophy and theology both ancient and modern. His works include: *A Critical Account of the Philosophy of Kant* (1877); *Hegel* (1883); *The Social Philosophy and Religion of Comte* (1885); *The Critical Philosophy of Immanuel Kant,* two volumes (1889); *Essays on Literature and Philosophy,* two volumes (1892); *The Evolution of Religion,* two volumes (1893; the Gifford lectures for 1890–91 and 1891–92); and *The Evolution of Theology in the Greek Philosophers,* two volumes (1904; Gifford lectures, 1900–01 and 1901–02).

See Sir Henry Jones and J. H. Muirhead, *The Life and Philosophy of Edward Caird* (1921).

CAIRD, JOHN (1820–1898), British theologian and preacher, an exponent of theism in Hegelian terms, was born at Greenock, Scot., on Dec. 15, 1820, the son of an engineer. Ordained as a Presbyterian minister on graduating from Glasgow university (1845), he made a nation-wide reputation with his learned and eloquent sermons and was appointed professor of theology a Glasgow in 1862 and principal of the university in 1873. He died at Greenock on July 30, 1898.

In *An Introduction to the Philosophy of Religion* (1880) and in *The Fundamental Ideas of Christianity,* 2 vol. (1899; the Gifford lectures for 1892–93 and 1894–96), both of which follow Hegelian teaching closely, Caird argues that universal thought is the reality of all things and that the existence of this Infinite Thought, namely God, is demonstrated by the limitations of finite thought. Hi *Spinoza* (1888) is also Hegelian in its approach. His sermon "Religion in Common Life" (1855) was many times reprinte and translated into Gaelic, German, Czech and Hungarian. Ther are collected editions of his *Sermons* (1858), *University Sermons 1873–1898* (1898) and *University Addresses* (1898).

See Charles L. Warr, *Principal Caird* (1926).

CAIRN, a term used to denote a pile of stones. This ca be of various shapes, depending upon the purpose for which it ha been constructed. Cairns are used as boundary and track marks and for burials, and are often erected on high ground. Buria cairns, also called barrows, show a great variety in shape and size from the conical form covering a single grave to a more elaborat structure comprising several chambers.

In the British Isles there are a number of different types of cairns of the Neolithic and Early Bronze Ages. They may be horned, double horned, lobster claw (as in Donegal or Sligo, Ire., where the horns curve round the forecourt), long (often pear shaped, and higher at one end than the other), ring (as in Scotand), long cists or gallery graves, wedge shaped (also called Paris cists, found usually in the north of France and Cornwall), heel shaped and chambered.

In Britain the burial chamber is seldom excavated in the soil under the cairn, but is enclosed within the structure itself. In the Mediterranean region a subterranean vault is often to be found. Both long and round cairns were originally delimited by a curb built of dry stone masonry; these were probably covered, ike the main structure, by a blanket of earth and stones. As monuments they were carefully built to conform to certain ceremonial requirements, and appear to have been reused as family vaults for more than one generation.

Cairns are still used in various parts of the world as burial places, particularly where the soil is difficult to excavate or where wild animals might disturb the body. (M. V. S.-W.)

CAIRNES, JOHN ELLIOTT (1823–1875), Irish economist, often described as "the last of the classical economists," was born at Castle Bellingham, Ire., on Dec. 26, 1823. He was educated at Trinity college, Dublin, where he became professor of political economy (1856), subsequently holding chairs at Queen's college, Galway, and University college, London (1866–72). He died at Blackheath, London, on July 8, 1875.

His first book was *The Character and Logical Method of Political Economy* (1857; new ed., 1888), one of the main classical works on the methodology of the subject. He emphasized the abstract deductive nature of classical political economy and advocated its scientific neutrality as between different policies and political principles, in particular in respect of the *laissez faire* maxim. His "Essays on the Gold Question" (published in *Essays in Political Economy,* 1873) dealt with the effects of the discoveries of gold n Australia and California, analyzing how different prices would be differently affected in time and degree, and are among the most important works of the 19th century on monetary theory. His book *The Slave Power* (1862 and 1863) expounded the inherent disadvantages of slave labour and considerably influenced British opinion in favour of the North in the U.S. Civil War.

Cairnes's last and largest work was *Some Leading Principles of Political Economy Newly Expounded* (1874). Most of the more haracteristically "classical" doctrines are all restated here. For xample, he expounds a cost-of-production theory of competitive values; he is about the last to defend a reformulated version of he wage-fund doctrine; he insists on what he calls "the great Malthusian difficulty" in bettering the condition of the mass of he people; and he repeatedly proclaims the identity of aggregate emand and aggregate supply. His analysis of "noncompeting" roups, in particular in the labour market, may be said to have oreshadowed the more systematic treatment of imperfectly cometitive and monopolistic conditions. (T. W. H.)

CAIRNGORM, a yellow or brown variety of quartz, named rom Cairngorm or Cairngorum, one of the peaks of the Grampian mountains in Banffshire, Scot., is a favourite ornamental stone n Scotland and is used in brooches worn with Highland costume.

Also known as smoky quartz, the mineral occurs in crystals lining avities in highly inclined veins of a fine-grained granite running hrough the coarser granite of the main mass. Shallow pits were formerly dug in the decomposed granite for the sake of the cairnorm, and the mineral was also found as pebbles in the bed of he river Avon.

CAIRNS, HUGH McCALMONT CAIRNS, 1st Earl (1819–1885), Irish statesman, lord chancellor of Great Britain, of great parliamentary influence in ecclesiastical and legal issues, was born at Cultra, County Down, Ire., on Dec. 27, 1819, and was ducated at Belfast academy and Trinity college, Dublin, graduating in classics in 1838. In 1844 he was called to the bar by the Middle Temple, to which he had migrated from Lincoln's Inn. During his first years at the chancery bar, Cairns showed little promise of the eloquence which afterward distinguished him. In 1852 he entered parliament as member for Belfast, and his Inn, on his becoming a queen's counsel in 1856, made him a bencher.

In 1858 Cairns was appointed solicitor general and was knighted. In 1866, when Lord Derby returned to office, he was made attorney general and in the same year, after a breakdown in health, he became a lord justice of appeal. In 1867 he became Baron Cairns of Garmoyle.

As soon as Benjamin Disraeli took office in 1868 he offered the lord chancellorship to Cairns in place of Lord Chelmsford. Less than a year later his party lost office and Cairns became leader of the opposition in the house of lords. In the commons he had distinguished himself by his resistance to the Roman Catholics' Relief bill in 1865, and in the lords his efforts on behalf of the Irish church were equally strenuous. When privately offered concessions if he withdrew his opposition to W. E. Gladstone's Suspensory bill, he had no time to consult his party, and accepted. In consequence he resigned his leadership, but was soon induced to resume it, and in 1870 he took a strong part in opposing the Irish Land bill. In 1874 the Conservatives returned to power and Cairns was lord chancellor again until his party's defeat in 1880. He had become Viscount Garmoyle and Earl Cairns in 1878. He died at Bournemouth on April 2, 1885.

Cairns combined strength with clarity and cogency, despite what was usually a somewhat reserved manner. His judgments were in the main expositions of principle, with a few decisions cited at the end as illustrations. In the legislation of the day, particularly on questions involving the church or legal reform, his influence was great, and the harmony with which he could work with his great friend and opponent, Lord Selborne, led to this influence being felt while he was in opposition as well as when he was in office.

Among the statutes with which he was concerned were the Judicature acts, 1873–75, the Conveyancing acts, 1881–82, the Settled Land act, 1882, and the Married Women's Property act, 1882.

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CAIRNS, a city and seaport of northeastern Queensland, Austr., lies on Trinity bay on the narrow lowland strip between the Atherton plateau and the sea, 860 mi. N.W. of Brisbane by rail. Pop. (1966) 26,555. Area 14.2 sq.mi. The climate is tropical (average maximum temperature 84.6° F.; average minimum 68.3° F.; average annual rainfall 87.6 in., falling mainly from December to April). Cairns is well laid out, with wide tree-lined streets and attractive parks. In Abbott street are the city council chambers (1930), built of reinforced concrete in bungalow style and surrounded by gardens, while other public buildings include a Roman Catholic cathedral and the School of Arts library. Railways connect Cairns with Brisbane and with the hinterland; there are air services to Brisbane, Sydney, Melbourne and New Guinea; and during the winter tourist coaches travel to and from the south. The port is well equipped with slipways, warehouses and concrete wharves.

Cairns is the outlet for an important agricultural and mining area. Dairying and the growing of sugar, maize, tobacco and peanuts are carried on, while timber is extracted from the forests on the seaward portions of the Atherton plateau. The plateau is highly mineralized; tin is dredged near Mount Garnet (96 mi. S.W.) and there are numerous deposits of wolfram, fluorspar and scheelite. In the district there are sugar mills, sawmills, a brewery, a fertilizer works; while other local industries include a meat freezing plant and butter, bacon and tobacco factories. Exports include sugar, timber, plywood, maize, meat, tobacco and metals. Fertilizers, petroleum products, galvanized iron and general cargo are imported. Thousands of tourists visit Cairns annually, attracted by the mild winter climate and by the scenery of the highlands and the gorge and falls of the Barron river.

Cairns was founded in 1876 and named after the then governor of Queensland, Sir William Wellington Cairns. Its prosperity was assured when sugar growing started in 1882. It became a municipality in 1885 and a city in 1923. (C. de G. W.)

CAIRO (Al Qahirah), the capital city of Egypt, is also a governorate (*muhafaza*). It lies on the east bank of the Nile about 12 mi. (19 km.) S of the apex of the delta, with extensive suburbs on the west bank. Immediately east of Cairo are the desert hills of Al Mokattam (Jabal al Muqattam), from which a splendid view stretches across the great city, the Nile, and the fields beyond, to the Libyan Desert and the Pyramids at Giza. It is by far the largest city in Africa and the Middle East.

The population of Cairo was 2,090,654 in the census of 1947; it increased rapidly and in 1966 was 4,196,998.

The climate is dry and reasonably stable throughout most of the year, average day temperatures ranging from 65° F (18° C) in January to 96° (36°) in July and August. Between December and March strong, cold winds from the desert may lower the temperature to the freezing point at night, and in April and May the sand-laden hot southerly wind, or khamsin, may raise it to 100° or more. The maximum summer temperature is around 108°. Agreeable sunny days are the rule and rain falls only three or four times a year, always in winter.

The City.—The road from the civil airport, to the northeast, leads through the big modern suburb of Heliopolis and branches into Sharia Ramses (formerly Nahdet Misr) and Sharia al Geish (formerly Faruk). Sharia Ramses opens into a large square facing the railway station, Ramses Square (formerly Bab al Hadid), dominated by a colossal statue of Ramses II moved in 1955 from the site of Memphis. From there Sharia al Gumhuria, one of several main streets, leads to Opera Square. The Opera House was opened in 1869 as part of the celebrations for the inauguration of the Suez Canal. In the centre of Opera Square is a fine equestrian statue of Ibrahim (d. 1848), son of Mohammed Ali Pasha.

Opposite is the Continental-Savoy Hotel, and located nearby are restaurants and a public garden, Al Ezbekia. Through this garden runs a long street, Sharia July 26 (formerly Fuad al Awal), which leads over the river to Gezira Island, and to the north of which lies a poor quarter, Bulaq, part of which has been cleared and rebuilt. From this street Sharia Suleiman Pasha leads southward into Suleiman Pasha Square (officially known as Sharia Talaat Harb and Talaat Harb Square), and from there runs, in an easterly direction, Sharia Kasr al Nil, in which stands the National Bank of Egypt (founded 1898). Off Sharia Suleiman Pasha are some of the chief newspaper offices, from which magazines and newspapers circulate throughout the Arabic-speaking world. Close by is Mohammed Ali Club, the leading club for men. In Suleiman Pasha Square stands a statue of the soldier of that name (d. 1860), and in Mustafa Kamil Square (formerly Emad al Din), along Sharia Kasr al Nil, is a statue of Mustafa Kamil, an Egyptian nationalist (d. 1908). This square contains the Cairo Women's Club. Between Suleiman Pasha Square and the Nile is Liberation (Tahrir) Square (formerly Ismailia), a large space, divided by grass plots and flower beds, where ten streets meet. On its southern side is a modern block of government offices, and opposite stands the great Egyptian Museum (built 1902), where the Tutankhamen treasures are housed with many other unique and priceless works of ancient Egyptian art. Nearby also is the Museum of Modern Art (founded in 1928) in a fine Arab-style house. On the western side of Liberation Square stood the Kasr al Nil barracks, demolished in 1955–56. The site was taken by the Nile-Hilton Hotel; south of the Kasr al Nil Bridge, facing the river, are the Semiramis and the new Shepheard's hotels (the old Shepheard's Hotel in Sharia al Gumhuria was burned down during the riots of Jan. 26, 1952).

Between modern Cairo and Al Mokattam Hills lies much of the Arab city built between the 11th and 16th centuries. In this area is gathered a greater quantity of Arab architectural riches than is to be found in any other city of the world. The scheduled historical monuments alone number nearly 400. The scene is dominated by the Ottoman-style mosque built by Mohammed Ali, where he was buried in 1849. It stands in the citadel originally built by Saladin in the 12th century and refortified and occupied by invading or nationalist armies ever since. There the British Army handed over authority to the Egyptian Army in 1946. Below the citadel is the great Salah al Din (Saladin) Square in which polo matches, parades, and executions were held from the 12th to the 19th century. Across this square from the main citadel entrance is the mosque of Sultan Hasan, built about 1361. Its magnificent proportions are considered by many experts to be unsurpassed in Islamic architecture. Opposite it is the modern mosque of Al Rifa'i, finished in 1912, where lie the remains of King Fuad and members of his family.

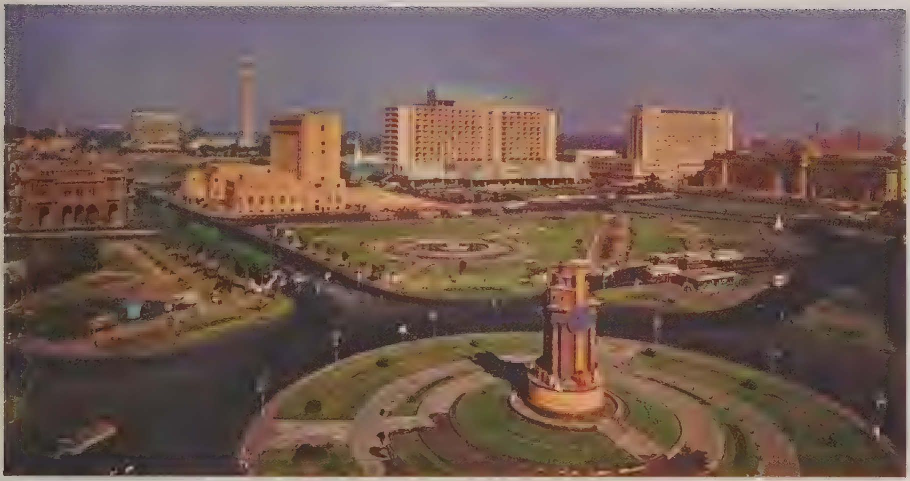
A vast network of streets surrounds this point and is, especially northward, a delight and of interest to the tourist, the artist, and the scholar alike for its medieval aspect and its bazaars of local produce and handicraft, as well as for its historical and architectural treasures. Near the centre of this area is the famous university mosque of Al Azhar founded by the north African Fatimid invaders in 970. Students of the Koran, Islamic law and jurisprudence, Arabic in all its branches, philosophy, and history gather there from as far afield as China, Indonesia, Morocco, and Somaliland. Students and professors wear the traditional robes and turban worn by Azharites for centuries. The influence that emanates from this edifice to the whole Islamic world is out of all proportion to the signs visible to the passing visitor. A wide street, Sharia al Azhar, cuts through the mesh of medieval lanes from Al Azhar to modern Cairo near Opera Square.

The Muski and the Khan Khalil, well known to tourists, lie to the north of Sharia al Azhar, and beyond these bazaars are severa fine old buildings, including the 13th-century mausoleum of Sultan Kala'un. At the north of the old city is an imposing 11th-century gateway, the Bab al Futuh. This, with the Bab al Nasr close by and the Bab al Zuweila southwest of Al Azhar, form part of the defenses built by Badr al Gamali in the 11th century during the Fatimid regime. They contain features of military architecture which antedate similar developments in medieval European for tresses. Beyond the Bab al Nasr is a vast burial ground on th edge of the desert, sometimes misleadingly called the Tombs o the Caliphs. No caliph is entombed therein, but it is embellished with splendid mausoleums dating from the end of the 14th century to the beginning of the 16th, and with all manner of subsequent tombs and funereal edifices, including a dignified war memorial to Egyptian soldiers who lost their lives in the 1948 fighting in Pales

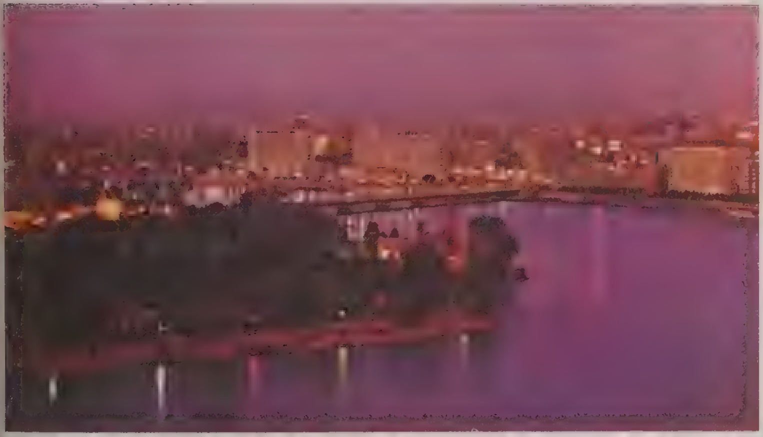
A. F. KERSTING

ABLUTION FOUNTAIN IN COURTYARD OF THE MOSQUE OF SULTAN HASA CAIRO; *c.* 1361

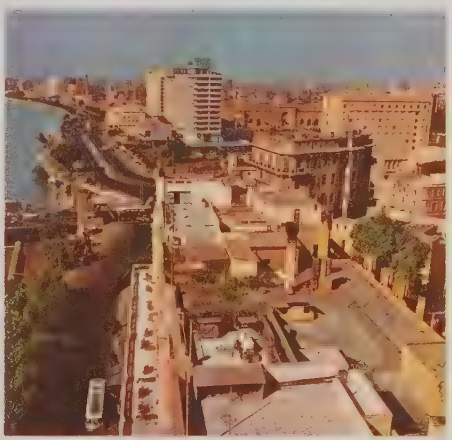
CAIRO



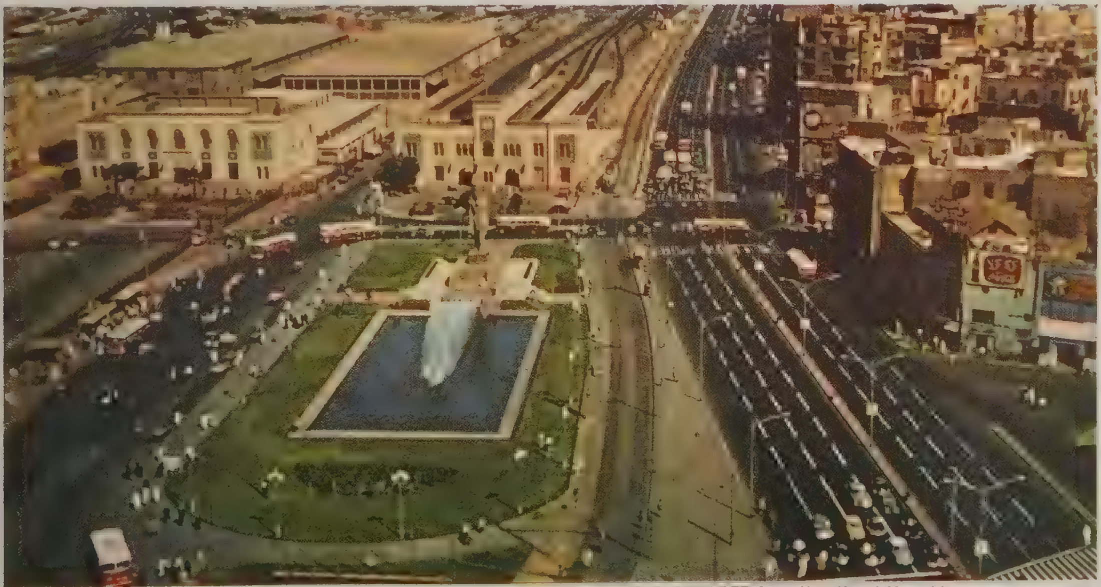
Liberation (Tahrir) Square looking westward toward the Nile. Buildings facing the large open space are (left to right) the Foreign Office, the Arab League Building, the Nile-Hilton Hotel, the new Municipal buildings, and the Egyptian Museum. Across the Nile is the Tower of Cairo



odern Cairo from the west side of the Nile; in the foreground, Gezira Island and the Kasr al Nil ridge which connects the island with the east bank of the Nile



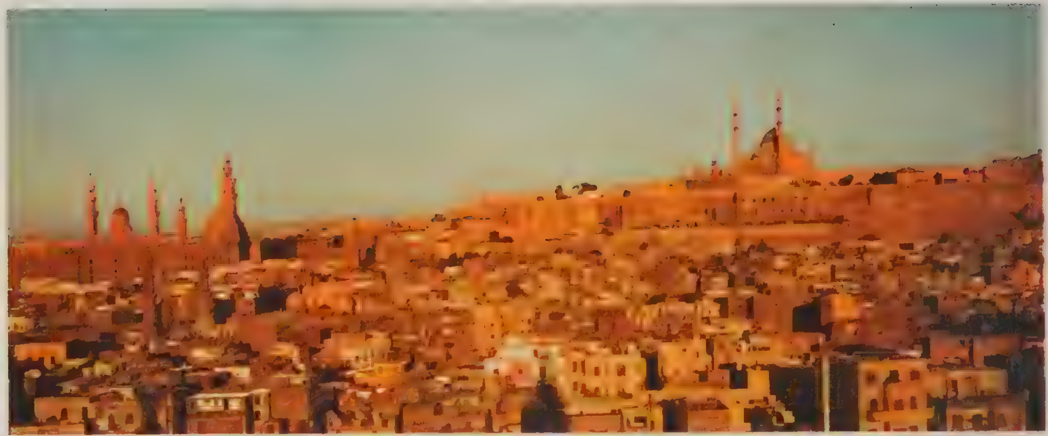
East bank of the Nile along Corniche Road, Cairo



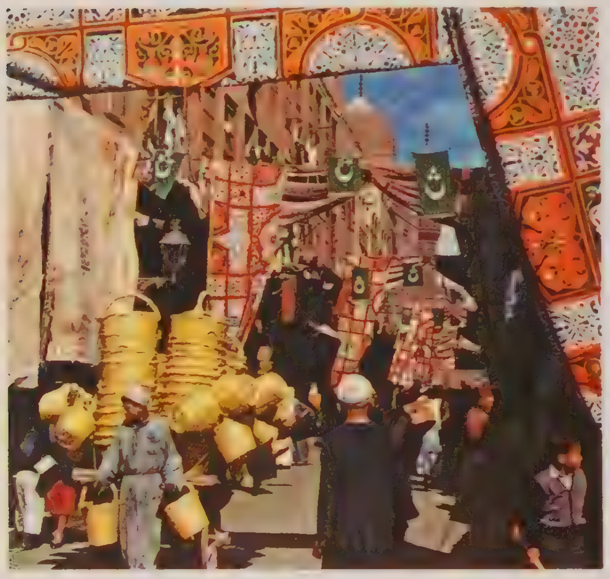
Ramses Square dominated by the ancient statue of Ramses II, moved in 1955 from the site of Memphis

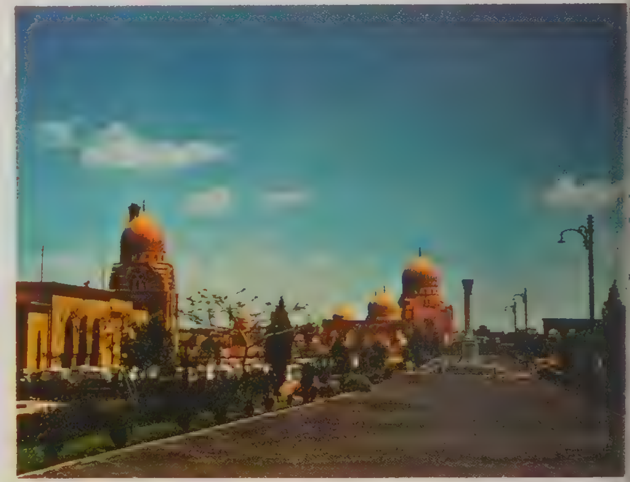
COURTESY OF (BOTTOM) UNITED ARAB REPUBLIC INFORMATION DEPARTMENT; PHOTOGRAPHS, (TOP) A. F. KERSTING, (CENTRE LEFT) JOHN G. ROSS—PHOTO RESEARCHERS, INC., (CENTRE RIGHT) YSTONE PRESS AGENCY

CAIRO



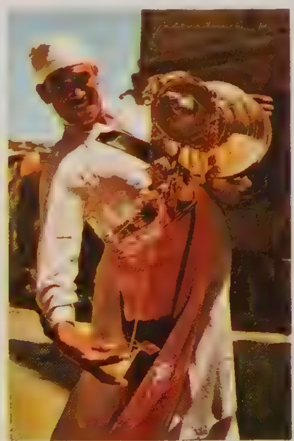
The medieval city between modern Cairo and Al Mokattam Hills. The Mosque of Sultan Hasan, left, was built about 1361; the Citadel, right, erected in the late 12th century by Saladin, was the site of the formal military transfer of authority from the British

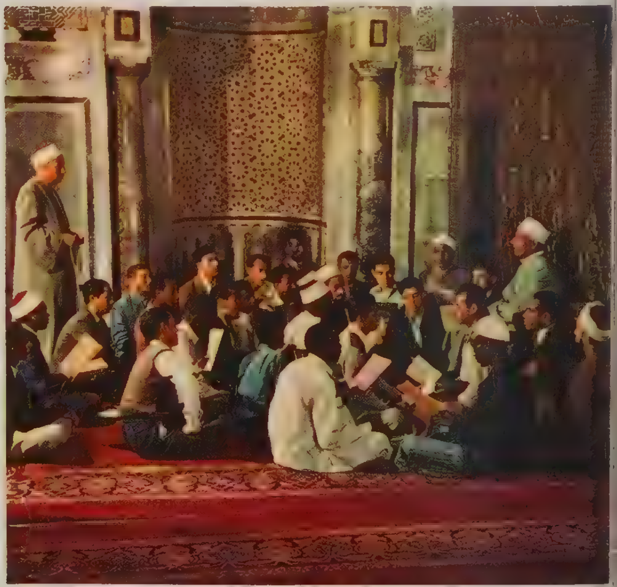




Modern part of the great burial ground known as the Tombs of the Calip which comprise a group of mausoleums near Al Mokattam Hills and the old c of Cairo

A bazaar (suq) in the old section of Cairo which specializes in carpets, silks, and brocades. Below left, a man carries bread in a basket on his head. Below right, a street vendor dispenses a popular, sugary refreshment





One of the few remaining old-style classes in the university Mosque of Al Azh founded in 970 for Islamic studies

PHOTOGRAPHS, (TOP) A. F. KERSTING, (CENTRE LEFT) JOHN G. ROSS—PHOTO RESEARCHERS, INC., (CENTRE RIGHT) ELMAR SCHNEIWIND—RAPHO GUILLUMETTE, (BOTTOM LEFT AND CENTRE) CESCO CIAPANNA—PHOTO RESEARCHERS, INC., (BOTTOM RIGHT) JOE BARNELL—IMAGE INTERNATIONAL

tine. An insignificant tomb, not far from the Bab al Nasr, covers the bones of the great scholar and traveler J. L. Burckhardt. To the north are the army barracks of Abbassia, beyond which is the residential suburb of Kubba, where a former royal palace is used by the president for the reception of guests.

The most notable mosque in the southern part of the old city is that of Ahmad ibn Tulun, called after the sultan who built it in 876–879. It is designed on the oldest mosque plan, of an open courtyard flanked by arcades. The patterns cut in plaster in the soffits of the arches are remarkably beautiful, resembling early Islamic decoration in Samarra, near Baghdad, from where Ahmad ibn Tulun originally came. To the southeast of this mosque lies the great southern cemetery (Al Karafa), containing the Tombs of the Mamelukes. There are tombs and mausoleums of many centuries, including the 20th. In this vicinity is the fine domed mausoleum (built 1211) of the imam al Shafi'i (d. 820), a founder of one of the four great rites of orthodox Islam to which belong the large majority of Egyptian Muslims. On Al Mokattam Heights above this cemetery stand a fort of the Turkish era and the beautiful small mosque-tomb of Al Giyushi (1085). These relics now keep company with a casino (for tourists only) and with the beginnings of a housing estate. A fine road has been made to the top of the cliff where before only a rough track existed, and many trees have been planted in an erstwhile barren zone nearby. An interesting monastery of the Bektashi dervishes is there, on the side of the hill.

Some way southwest of the Tombs of the Mamelukes is the desolate area of Al Fustat where stood the earliest Arab settlement formed at the time of the Arab conquest in 641. Between Al Fustat and the Nile is the quarter known as Old Cairo (Misr al 'Atika), where, since the early days of Christianity, an Egyptian Christian (Coptic) community has lived. There are some old Coptic churches, and a charming museum of Coptic art founded in 1910. Close to it is a Roman Byzantine gateway. From Old Cairo several roads lead to modern Cairo. One of these, Sharia Kasr al 'Aini, passes the Cairo University medical school and the Antirabic hospital, which is one of the very few in the world. Between Sharia Kasr al 'Aini and the Nile are the residential quarters of Kasr al Dubara, where are some of the embassies, and Garden City, and to the other side of the road are several of the ministries and also the parliament houses (built 1923). Nearby are the tomb of Saad Zaghlul, the well-known nationalist (d. 1927), the Geological Museum (1923), and the American University.

In the large Gumhuria Square, to the east, is the Presidency, official residence of the republic's president, which was the Abdin Palace of King Faruk and his immediate forebears. It is a fine building, with a spacious garden, standing in a comparatively poor district.

Behind the palace is Ahmed Maher Square (formerly Bab al Khalk), where are the Museum of Islamic Art, an outstanding collection, and the Egyptian Library, founded by the khedive Ismail in 1869, which contains magnificent collections of Middle Eastern illuminated manuscripts and coins.

The Islands.—In the Nile opposite Cairo are two islands, Gezira (Jazirat al Zamalik) and Roda (Jazirat ar Rawdah), which almost form part of the town itself, as they are linked to both banks by several large bridges. Gezira is 3¾ mi. long and just under 1 mi. at its widest. The northern end is mostly residential with large blocks of flats, villas, and gardens. There are also various educational establishments. Sharia July 26, with its eastern end in Cairo, runs over a bridge, across Gezira and past the Egyptian Army Officers' Club, and over another bridge to the western mainland. In the centre of the island is the Gezira Sporting Club with racecourse, golf links, polo grounds, squash courts, swimming bath, etc., and tennis courts, where zone matches for the Davis Cup are played. A public garden, running along the east bank, is much frequented on holidays, and at the southern end of the island are a large exhibition ground, a horticultural experimental garden of the Ministry of Agriculture, sports clubs, public gardens, a hospital, and a tall tower with revolving restaurant.

Roda Island, a mile or so upstream, is rather smaller than Gezira. It contains the big government hospital of Kasr al 'Aini, the former palace and gardens of Prince Mohammed Ali, and many blocks of flats. On the southern tip of Roda is the Nilometer, first constructed in A.D. 716, where the annual rise of the Nile was measured and proclaimed to the country for more than 1,000 years.

Suburbs.—On the mainland west of Gezira and Roda are various villages and suburbs, among them, to the north, Embaba, where Napoleon defeated the Mamelukes in 1798 and which now contains one of several new housing estates for workmen. The Upper Egypt railway bridge crosses the Nile north of Embaba, while to the south is Dokki, a residential area with treelined roads and some nursery gardens, where stands the remarkable Museum of Agriculture. Giza, farther south, has a poor and populous old town, but also contains villas, embassies, and the fine zoological gardens. There, too, is Cairo University, an imposing domed building surrounded by gardens; founded on a different site in 1908, it did not function as a full university till 1924. A new bridge was built in 1958 across the Nile opposite the university, and an ornamental fountain lit by coloured lights plays in the river nearby. The main road to the Pyramids and Sphinx runs from Giza to the base of the Great Pyramid and the Mena House Hotel. This road was originally built for the empress Eugénie to visit the Pyramids in comfort when she came to open the Suez Canal in 1869. Three motor roads branch south from this road and all lead past the ancient Egyptian site of Saqqarah, about 11 mi. (18 km.) S of the Great Pyramid.

A few miles south of Cairo, on the east bank, is the garden suburb of Al Ma'adi, and south of that again, past the prisons and stone quarries of Tura, is Hulwan, on the edge of the desert, well known for its sulfur springs. This area is partly industrialized. About 15 mi. (24 km.) NW of Cairo is the delta barrage across the Nile, an irrigation work of great interest, standing as it does at the control point for the whole delta. There are beautiful surrounding gardens and an irrigation museum close by.

Cultural and Social Institutions.—Cairo has a great variety of cultural and social institutions, among which are a co-operative training centre, popular cultural institutes, the Academy of Arabic, the Academy of Arabic Music, a society of arts, a productivity and vocational training centre, an audio-visual aid centre (in Heliopolis). There are also numbers of voluntarily run centres, schools, homes, clinics, etc., for helping the underprivileged. These are in addition to government establishments administered by the Ministry of Social Affairs. Besides the old Al Azhar, there are two other national universities—Cairo University at Giza, with more than 27,000 students, including 3,000–4,000 women students, and 'Ain Shams (founded 1950), with more than 18,000 students. The American University (founded 1919) has over 700 students. All the chief churches of the Christian faith have their places of worship in Cairo, and there are several synagogues. The Anglican Cathedral, which occupies a fine site on the Nile, was consecrated in 1938.

Communications.—Cairo is linked to the rest of Egypt by main-line trains (steam and diesel) and by a network of minor lines. The first railway in Africa was built in Egypt by George Stephenson's son Robert. It linked Alexandria with Cairo in 1855.

The main roads out of Cairo run to Alexandria through the delta; to Port Said via Ismailia and to Suez; up the Nile Valley to the south; and via the desert to Alexandria. Along this desert road, 20 telephone and first-aid posts have been set up between Cairo and Alexandria. Another desert road links Cairo to Al Fayyum. One of the most imposing features is the Corniche Road, which runs along the Nile front for the whole length of the city and continues southward for a further 12 mi. (19 km.).

Cairo airport is 16 mi. NE of Cairo, in the desert beyond Heliopolis. It is served by most international airlines and internal airways.

The Nile is a means of transport for merchandise. Sailing vessels carry produce such as onions, chopped straw, melons, and Upper Egypt pottery. Their wharves are south of Old Cairo. Steam launches and barges carry such freight as baled cotton northward, agricultural machinery and vehicles southward.

Cairo is intersected by a network of bus and trolley-bus routes, which also serve the suburbs. Outlying districts are connected to

Cairo by buses of a rougher type, but Alexandria and Port Said are linked to the capital through desert or delta by fast, comfortable buses.

Industries and Occupations.—In the Hulwan area several heavy industries were started during the 1950s as part of Egypt's five-year industrialization plan. They include steel, iron, cement, pharmaceutical, glass, textile, and rolling-stock plants. The people of Cairo and its vicinity are employed in government administration; in educational, medical, legal, and other professions; in the processing of tobacco, leather, basic chemicals, cement, etc.; in food processing and petroleum industries; in building construction; in business and trade of many sorts; and in the film industry. The first Egyptian film was produced in 1926, and from the suburb of Al Jizah have come virtually all Arabic-language films.

History.—The ancient Egyptian capital of Memphis was on the west bank of the Nile south of Gezira. There is very little left of this once great city. The next forerunner of Cairo was the Roman-Byzantine town of Babylon, where Old Cairo now stands. The Arab conqueror of Egypt, 'Amr ibn-al 'As, entered its great bastioned gateway in A.D. 641 and built Al Fustat, on the site of his camp immediately east of Babylon. In the 9th century, when Egypt was controlled by Arab governors from Baghdad, one of them, Ahmad ibn Tulun (who subsequently made himself the first independent Muslim ruler of Egypt), founded Al Kata'i to the northeast, where his famous mosque still stands. When the Fatimids invaded Egypt in the 10th century their general, Jauhar (Gohar) al Rumi, built a new capital northward of Al Kata'i, calling it Al Kahira ("the victorious"), from which the name Cairo is derived. Part of the encircling wall and three great gateways still survive. The Ayyubids next ruled Egypt (1169–1250), the most famous and first of the dynasty being Saladin, the great opponent of Richard Coeur de Lion. Saladin extended the walls round the citadel, which he built on a spur of Al Mokattam Hills. A small portion of his original wall can still be seen in the southeastern corner. From 1250 to 1517 Egypt was governed by two dynasties of Mameluke sovereigns who, though ruthless and unscrupulous, embellished Cairo with architectural and other works of art in great quantity and of high quality, many of which can be enjoyed today. A few outstanding buildings still preserved are the mosques and mausoleums of Sultan Hasan (1361), Al Mu'ayyad (1422), Barkuk (1386), Al Ghuri (1508), Al Mardani (1340), and Qa'itbay (1475). They are scattered over the whole present area of medieval Cairo. At its height the Mameluke Empire incorporated Egypt and Syria, the present Lebanon, Israel, and Jordan. Cairo and Damascus were joint capitals and were in frequent communication despite the 500 mi. (804 km.) between them. Baybars, a great Mameluke sultan, was proud of the fact that he could play polo in Cairo and in Damascus in the same week; and a carrier pigeon post was maintained between the two cities.

In 1517 Cairo fell to the invading forces of Ottoman Turks, who hanged the body of the last Mameluke sultan from the gateway of Zuweila. The Turkish domination of Egypt had a deadening effect on the flowering of the arts in Cairo. Mosques built during the next 300 years were mostly to a stereotyped pattern often recognizable today by the "pencil point" minarets. Some of them have charm, notably the small mosque known as Sidi Sarai in the citadel, the first to be built after the Ottoman conquest. The tomb-mosque of Mohammed Abu Dahab (1774) near Al Azhar is impressive. Mohammed Abu Dahab was one of the Mamelukes who remained in Egypt after the Ottoman conquest and who often carried greater weight in governing Cairo than did the Turkish pasha sent from Constantinople for the purpose. A few fine houses of the Turkish era can still be seen. There are also numerous small buildings called *sebil kuttab,* endowed by pious men of the time, which had as a function providing free drinking water on the street level and a small free school on the floor above, for learning the Koran.

In 1798 Cairo was captured by the French, who were driven out in 1801 by Turkish and British forces; the city was then handed over to the Turks. The people of Egypt chose Mohammed Ali as their governor in 1805. He finally made himself master of the country by massacring, in 1811, the remaining Mamelukes who were still an obstacle to his ambition. The Mamelukes were killed as they were leaving the citadel by the Bab al 'Azab after attending a ceremony to which he had invited them. Cairo thus became once more the capital of a virtually independent kingdom, and from that time the city's western part expanded. In 1882 Cairo was occupied by the British and its history was merged in that of Egypt. It was the headquarters of the British Middle East command in World War II; the British forces left the city in 1946.

Much modern development in Cairo is evident from the functional and administrative buildings such as its hospitals, schools, embassies, ministries, flats, factories, telephone exchange, and a large television building. Considerable development of telegraph and telephone networks has been made, including modern carrier systems linking Cairo and Damascus.

See EGYPT: *History. See* also references under "Cairo" in the Index.

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CAIRO, the southernmost city of Illinois, U.S., at the confluence of the Ohio and Mississippi rivers, 150 mi. S.E. of St. Louis, Mo.; the seat of Alexander county. Built upon a low-lying delta formed by a prehistoric Ohio river that emptied into the nearby gulf, Cairo was so named because its site was thought to resemble that of its Egyptian counterpart, and southern Illinois has become known as "Little Egypt." Cairo and the Bank of Cairo were chartered in 1818 when there was no settlement and there were no depositors. A second and successful try at establishing a town was made in 1836–37 by the Cairo City and Canal company; the company, however, came to a disastrous end in 1840. Finally in 1846, 10,000 ac. were purchased by the trustees of the Cairo City property, a group of eastern investors, who were closely identified with the Illinois Central Railroad company and were interested in making the town the prosperous terminus of the projected railroad. City government was not established in Cairo until 1855. In the American Civil War Cairo was Ulysses S. Grant's headquarters during the western campaigns.

The city is a shipping centre for the entire Ohio and Mississippi river valleys as well as for southern Illinois. Industries include lumber and woodworking and the manufacture of cottonseed and soybean products. Cairo is protected by levees; in 1937, when the Ohio river rose to 59.6 ft., it was the only city in the entire Ohio river valley that was not flooded.

Cairo's population (9,348 in 1960 and 6,277 in 1970) has bee steadily decreasing, mainly due to a depressed economy. (Fo comparative population figures *see* table in ILLINOIS: *Population.*) In the late 1960s and early 1970s the city was the scene of much racial strife. There was a boycott of white-owned businesses by the black community and state troops were sent in on orders o the governor. (N. M. BE.; X.)

CAIRO CONFERENCE: *see* WORLD WARS: *World War II Allied Strategy and Conferences, September–December 1943.*

CAIROLI, BENEDETTO (1825–1889), Italian statesma whose policy of neutrality and peace was ill-suited to the nationalism and imperialism of his time, was born in Pavia on Jan. 28 1825. From 1848 until the completion of Italian unity in 1870, hi whole activity was devoted to the Risorgimento, as Garibaldia officer, political refugee, anti-Austrian conspirator and deputy t parliament. One of his brothers was killed and another wounde during Garibaldi's rebellion and attempt to march on Rome i 1867. When in 1876 the left came into power, Cairoli becam important in politics and, after the fall of Agostino Depreti formed his first cabinet in March 1878 with a Francophile an irredentist policy. Italian nationalists were affronted by his an Luigi Corti's policy of "clean hands" at the Berlin congres (1878), where Italy obtained nothing while Austria-Hungary s cured a European mandate to occupy Bosnia and Hercegovin The attempt of G. Passanante to assassinate King Humbert a Naples (Nov. 17, 1878) caused Cairoli's downfall on Dec. 19, i spite of the fact that he himself was wounded. He returned to power, however, on July 14, 1879, and on Nov. 29 formed with Depretis his third coalition ministry, in which he retained the premiership and the foreign ministry. Confidence in French assurances and belief that Great Britain would never permit the extension of French influence in north Africa prevented him from foreseeing the French occupation of Tunis (May 11, 1881). In view of nationalist indignation he resigned three days later. He died at Capodimonte near Naples on Aug. 8, 1889.

See M. Rosi, *I Cairoli*, 2nd ed., 2 vol. (1929).

CAISSON has a variety of distinctly different meanings. When employed in military parlance, it denotes an ammunition wagon or chest; in architecture, a sunken panel; and in civil engineering, a boxlike structure that is used to install structures that extend below water level. In this latter sense there are three types—box caissons, open caissons and pneumatic caissons.

Box Caissons.—These are open at the top and closed at the bottom. They are usually constructed on land, then launched, floated to position and sunk onto a previously prepared foundation. The sides of the caisson, when it is sunk in position, emerge above the water level. This structure serves as a shell for a bridge pier, sea wall, breakwater, jetty or similar work. The box-caisson method of construction is suited for the installation of structures in open water where foundation conditions are such that the caisson need not be sunk below the bottom of the water bed.

Open Caissons.—These are open at the bottom as well as at the top. The open bottom, which is provided with a cutting edge, permits removal of soil beneath the caisson by dredging through shafts from the top of the caisson. As excavating proceeds, the caisson sinks and, as it sinks, additional sections are added to the top so that the caisson sides always extend above water. This process is continued until the caisson has been sunk to the required depth. The surface to which the caisson has been sunk is then carefully cleaned, usually by divers, and concrete is deposited under water to provide a bottom seal. The dredging wells can then be unwatered and filled to complete the structure. An open caisson may be of single- or multiple-dredging well type, circular or rectangular in plan and of double- or single-wall construction.

Pneumatic Caissons.—These are similar to open caissons except that they are provided with an airtight bulkhead installed about six to eight feet above the cutting edge. The space between the bulkhead and the cutting edge, which is called the working chamber, is pressurized to the extent necessary to control the inflow of soil and water; thus the excavating can be performed by workmen operating in the working chamber at the bottom of the caisson. Pressure in the working chamber is maintained by means of an air lock. Provision can be made to convert an open caisson to a pneumatic caisson when, during sinking operations, conditions develop that require it. This conversion is made by the addition of the necessary airtight bulkhead and air lock.

The word caisson is sometimes used to designate any cast-in-place type pier. Strictly speaking, however, it refers only to the shell that is used in the installation of the pier and that becomes an integral part of it. *See* also CONCRETE: *Applications: Harbour Facilities.*

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(R. E. FM.)

CAISSON DISEASE, or decompression sickness, a group of symptoms brought on by sudden reduction of the atmospheric pressure, *i.e.*, too rapid for the body to accommodate to the change.

It occurs in men who work in deep caissons or tunnels where very high atmospheric pressure must be maintained in order to exclude water. Symptoms do not appear while the air pressure is being increased nor so long as it is maintained but appear only after it has been reduced too quickly. The condition may also occur in deep sea divers or men escaping from sunken submarines who come to the surface too rapidly. It may also occur in aviators inadequately protected against sudden decompression.

The symptoms include pains in the muscles and joints (the bends), fainting, vomiting, deafness, paralysis (divers' palsy) and even sudden death. The symptoms are produced by effervescence of gas, principally nitrogen, that has been dissolved in the blood and other body fluids. When the atmospheric pressure is suddenly reduced, the dissolved gas comes out of solution as tiny bubbles that occlude capillaries and other small blood vessels. If the atmospheric pressure is diminished gradually, dissolved nitrogen comes out of solution slowly enough to be removed by the lungs without the formation of bubbles.

Caisson disease can, therefore, be prevented by slow decompression. A decompression rate of at least 20 minutes for each atmosphere (about 15 lb. per square inch) of pressure has been recommended. Younger men seem to be less susceptible to caisson disease than older men.

See DIVING, DEEP-SEA: *Physiological Research.*

(C. P. M.)

CAITHNESS, a county occupying the extreme northeast of Scotland, is bounded on the west by Sutherland, on the north by the Pentland firth and on the east and southeast by the North sea. Its land area is 697 sq.mi.

Physical Features.—Caithness is a plateau sloping mostly northward and northeastward and truncated on the north and east by an almost continuous line of sea cliffs. This plateau is mainly cut across Old Red Sandstone, with Highland schists in the high ground of the south and west, which, at 1,000 ft., is one of the largest flat surfaces at such an altitude in Britain. Above this southern plateau a series of massive hills rise abruptly. Morven (2,313 ft.) and Maiden Pap (1,587 ft.) are in Old Red Sandstone conglomerate, Scaraben (2,054 ft.) is in schist and the granites of Knockfin heights swell more gently in the west. The Old Red Sandstone conglomerates include the famous gray flagstones, rich in fossil fish, of many a field boundary in Caithness. In the southeast the Berriedale, Dunbeath and Latheronwheel burns (streams) cut through the plateau in deep, sheltered glens. To the north, the plateau sinks to where the Wick and Thurso rivers flow slowly over alluvial haughs (plains) just above sea level. There, small lochs are numerous, the largest being Loch Calder, the county's main source of water, and Loch Watten. Several of the lochs were left by the flow of glaciers from the northwest Highlands. These glaciers deposited great spreads of blue shelly boulder clay whose lime content is important for agriculture, but the western two-thirds of the county are still under peat.

The cliffs, which are varied by deep eroded inlets known as goes or geos and some spectacular offshore stacks, reach 400 ft. in height near the southern border but fall to frame long, sandy beaches at Sinclair's bay, Freswick, John o'Groat's (*q.v.*) house, Dunnet Head, Thurso and Reay. Caithness is separated from the Orkney Islands by the Pentland firth, through which tides race at up to 10 knots. Sunken rocks called the Boars of Duncansby create breakers, and eddies from St. John's point break on the Men of Mey, while off Stroma island is the Swelkie whirlpool.

Despite its northern latitude Caithness has a fairly moderate climate, though it is subject to strong winds. Spring comes later and winter earlier than in the south of the British Isles, but mean summer and winter temperatures (54.5° F. in July and 37.8° F. in February) are similar to those in the Lothians. By the 19th century Caithness was practically treeless, except for a few stunted birches and hazels in the straths. Small private plantations succeeded and after 1944 the Forestry commission planted at Humster and Dunnet. Moor burning and deer threaten the alpine plants and in the east agricultural drainage has radically altered the flora, but the flowering plants near the coast are of great interest, including *Saussurea alpina* in its most northerly habitat. Foxes and an occasional wildcat are found and the pine marten has been trapped near the north coast, while the sea cliffs form natural sanctuaries for many rare birds, including the great skua.

History.—Caithness is rich in prehistoric remains dating from Neolithic times onward. Cairns, standing stones, hill forts, etc., abound and there are more brochs (ancient dry stone buildings) than in any other county. There are traces of early Christian chapels in every parish, a very early example being St. Mary's, Forse, Thurso. The ruins of old St. Peter's church, Thurso, and the parish churches of Dunnet, Canisbay and Reay are all pre-Reformation. The coast castles of Dunbeath and ruined Auld Wick, Girnigoe, etc., date from medieval times, while later in date are inland castles such as Mey, owned by Queen Elizabeth, consort of George VI, and Braal.

A Pictish province named Cait or Cat at the dawn of history, Caithness was early invaded by the Norsemen and place names testify to their domination. Caithness was for a time integrated firmly into the kingdom by William the Lion and divided into parishes by Bishop St. Gilbert. Till 1231 the earldom of Caithness was held by the Norse earls of Orkney. Then it passed to several Scottish noble families until in 1455 William Sinclair, third Sinclair earl of Orkney, was invested with the Caithness earldom by James II of Scotland (*see* Sinclair). At the Reformation the earls gained both land and power which they held until debts forced the sixth Sinclair earl to sell his title and estates to Sir John Campbell of Glenorchy, later earl of Breadalbane and Holland. As the Sinclairs rejected his claim, Glenorchy invaded Caithness and defeated the Sinclairs at the battle of Altimarlach (1680), the last clan battle in Scotland. Later a Sinclair regained the earldom, but Glenorchy sold the estates to various Caithness families. Thereafter interest centres mainly on the agricultural improvements encouraged by such of them as the Traills of Castletown in the 18th century, the development of town life with the great herring fisheries of the 19th century and the then great export industry in Caithness flagstones.

Population and Administration.—In 1966 the population of Caithness was 28,470. Wick (*q.v.*), the county town (7,570), and Thurso (*q.v.*) are small burghs. The county joins with Sutherland to send a member to parliament and it forms a sheriffdom with Sutherland, Orkney and Shetland, a sheriff substitute sitting at Wick.

Industries and Communications.—Farming and fisheries are the two main industries, although after 1955 the construction and working of the Atomic Energy authority's breeder-reactor at Dounreay provided employment for many people. Formerly a stock-raising county, after 1938 Caithness began to change over to dairy cattle, which by 1954 had increased by 62%. The main breed is the Shorthorn. Sheep are also very important, the breeds being Border Leicester and especially North Country Cheviot, introduced in the 18th century by Sir John Sinclair of Ulbster and now bred chiefly in Caithness. In the early 1960s about two-thirds of the land was rough grazing and more than 70,000 ac. (16% of the total) was arable land, the chief crops being oats, turnips and swedes. Small holdings predominate, more than half being of 15 ac. or less.

White fishing and salmon fishing both flourish, but the herring fishery has almost come to an end. There is a shellfish processing factory at Thurso, while at Wick are a distillery and knitwear, ice and glass factories. In the early 1960s tourism became a significant industry.

There are bus services throughout the county, which has good roads; and railway services connect Wick and Thurso with Inverness. The mail steamer for the Orkneys calls at Scrabster and air services from Wick airport connect with Inverness, Aberdeen and the south, and the Orkneys.

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CAIUS (Kees, Keys, Kay, Kaye, etc.), **JOHN** (1510–1573), English physician and second founder of the modern Gonville and Caius college, Cambridge, was born at Norwich, Oct. 6, 1510. He was admitted a student at what was then Gonville hall, Cambridge, where he seems to have studied divinity. In 1533 he visited Italy, studying under Montanus and Andreas Vesalius at Padua. After an extended tour in Europe he practised medicine in London, where he was for several years president of the College of Physicians. In 1557 he enlarged the foundation of his old college, named it Gonville and Caius college and endowed it generously. In Jan. 1559 he accepted the mastership of the college. His large body of literary work, together with a *Memoir* by John Venn, was edited by E. S. Roberts (1912). His medical writings are of particular interest; his name is associated especially with the sweating sickness (*q.v.*), of which his account is classical. As a Catholic in a period of strong anti-Catholic feeling, Caius suffered numerous indignities, but always retained the high regard of members of his profession. He died in London on July 29, 1573.

CAJAMARCA, a northern sierra department of Peru (pop. [1966 est.] 900,100); area 13,675 sq.mi. (35,417 sq.km.), bounded north by Ecuador, west by Piura and Lambayeque, east by Amazonas, and south by La Libertad. The department is watered by the Marañón River, which forms nearly the whole of its eastern boundary, and by tributaries entering the river from the west. The cultivated valleys produce alfalfa, cereals, coffee, sugarcane, fruits, and vegetables. The breeding of cattle and a hardy type of sheep is carried on where conditions are favourable. Mineral resources worked in the department include gold, silver, coal, and copper. The population is predominantly Indian and mestizo. Cajamarca city, the historic capital, Cajabamba, and Cutervo are its most important centres. (J. L. Tr.)

CAJAMARCA (Caxamarca), a city of northern Peru (pop. [1966] 47,800), capital of the department and of the province of the same name. It lies at 8,597 ft. (2,621 m.) above sea level on the bank of the Cajamarca River, a tributary of the Marañón. The mean temperature is 61° F (16° C). It was an ancient Inca city and historically it is notable as the scene of the capture in 1532 of the Inca ruler Atahualpa by Francisco Pizarro. Standing on the old northern overland route to Iquitos via Chachapoyas and Yurimaguas, it is the point of union and crossroads for the tropical products of Chachapoyas and the coastal products of the Pacific. It is one of the principal commercial and industria centres in northern Peru, manufacturing textiles, hats, leather and metal goods. In nearby valleys alfalfa, cereals, coffee, an sugarcane are cultivated, and cattle and sheep are raised. Minera resources worked in the region include gold, silver, coal, an copper. The city is notable for its Inca ruins, and it also preserve colonial character to a remarkable degree. Cajamarca and th surrounding region are the focus of the northernmost clusters o predominantly Indian population in highland Peru. The city i 188 mi. (302 km.) from Trujillo by road and lies 16 mi. (2 km.) by road from the Chilete station on the Pacasmayo railroad (J. L. Tr.)

CAJETAN, SAINT, of Thiene (Gaetano da Tiene (1480–1547), co-founder of the Theatines and an important figur of the Catholic Reformation, was born of a noble family at Vicenz in Oct. 1480. He won his doctorate in both civil and canon law a Padua on July 17, 1504, and by March 1508 was a prothonota in the Roman curia. Associated with the local Oratory of Divin Love, established in Rome about 1513, he was ordained a prie on Sept. 30, 1516, and continued the charitable works characteristic of the association. Leaving Rome for Vicenza in 1518, h revitalized oratories there and at Verona (1519). At Venice, during Lent 1522, Cajetan founded a hospital for the incurably i and a local branch of the oratory.

Subsequent to his return to Rome late in 1523, he met Archbishop Giovanni Pietro Caraffa, the future Pope Paul IV. Together they established and entered, Sept. 14, 1524, the Congregation of Clerics Regular (Theatines) to further among diocesa priests the ideals of the Oratory of Divine Love. After the sac of Rome, Caraffa and Cajetan succeeded in reaching Venice o June 17, 1527. Following his dispatch in Aug. 1533 as Theatir superior to Naples, Cajetan created at the church of St. Paul Maj (May 1538) a centre of Catholic reform. There, except for 154 43, when he was at Venice, he remained until his death on Aug. 1547. Cajetan was canonized by Pope Clement X on April 1 1671. His feast is celebrated on Aug. 7.

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CAJETAN (Cajetanus or Gaetano; Tommaso de Vi (1468?–1534), a major Catholic theologian of the Thomist scho was born at Gaeta in the kingdom of Naples, probably on Feb. 20, 1468 (some say 1469). Entering the Dominican order in 1484, he studied at Bologna and then at Padua, where he became professor of metaphysics (1494) and came into contact with the theology of Duns Scotus and with the Averroism of Pietro Pomponazzi; of Scotism in particular Cajetan became, and remained, a relentless critic. In 1494, as a result of his brilliance in a public disputation with Pico della Mirandola at Ferrara, he was made a master in theology. From 1501 to 1508 he taught theology at Rome, during which time he began his great commentary on the *Summa theologiae* (more commonly, *theologica*) of St. Thomas Aquinas. In 1508 he was elected Dominican master general, remaining in this office until 1518. As general, Cajetan felt obliged to check certain manifestations of the cult of Savonarola which threatened to divide the order; but he was himself an ardent upholder of the Dominican ideal, especially with regard to poverty and the study of theology. Between 1511 and 1517 he was occupied with defending papal authority against the schismatical council of Pisa (1511) and with work in connection with the fifth council of the Lateran (1512–17), at which he urged the reform of the church. In 1517 Leo X made him a cardinal.

In 1518 Cajetan came into personal contact with Martin Luther. As the papal legate in Germany, he was authorized to examine Luther on points of doctrine, and they met at Augsburg in October a year after the reformer had published his theses at Wittenberg. On Luther's own admission, Cajetan dealt kindly with him, but the two men could not agree doctrinally. The meeting however helped to convince Cajetan of the need for meeting the reformers on their own ground, and he devoted the later years of his life to an attempt to provide a literal interpretation of the Bible, based on a fresh translation from the original tongues. His commentary on the Psalms (1527) was followed by others on the New Testament and on most of the books of the Old Testament. Meanwhile, recalled to Rome in 1519 and made bishop of Gaeta in the same year, he helped to draft the bull *Exsurge Domine,* condemning Luther (1520). In 1522 he was influential in the election of the reforming pope Adrian VI, to whom he dedicated his commentary on the third part of the *Summa.* In 1523–24 he was papal legate in Hungary, Poland and Bohemia. Recalled by Clement VII, he retired to Gaeta in 1527. He died in Rome probably on Aug. 10, 1534.

Cajetan's fame rests chiefly on his difficult but profound commentary on the *Summa.* Much of this work is, in form, a reply to the criticisms of Scotus and others; but in effect it is something ar more valuable, a rigorously analytical examination of the asic principles of natural and Christian theology. Without some cquaintance, indeed, with Cajetan's commentary one can have o adequate idea of the resources of Thomism. It may be read in the critical *editio Leonina,* begun under Pope Leo XIII (1882 onward), of St. Thomas, vol. iii–xii. Cajetan also wrote commentaries on Aristotle and many opuscula.

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CAJORI, FLORIAN (1859–1930), U.S. educator and athematician, who was noted as a historian of science, was born t St. Aignan, Switz., on Feb. 28, 1859, and emigrated to the U.S. n 1875. He was graduated from the University of Wisconsin, Madison, in 1883, and received a Ph.D. degree from Tulane university, New Orleans, La., in 1894. He was a member of the aculty of Tulane (1885–88) and of Colorado college, Colorado prings (1889–1918), where he was dean of the department of ngineering from 1903. In 1918 he became professor of the history of mathematics at the University of California, Berkeley.

His major works included *A History of Mathematics,* 2nd ed. 1919), and *A History of Mathematical Notations,* two volumes 928–29); he also wrote *A History of Physics* (1899) and the iographies *William Oughtred, a Great Seventeenth-Century Teacher of Mathematics* (1916) and *The Chequered Career of Ferdinand Rudolph Hassler* (1929). His revised translation of Sir aac Newton's *Principia* was published posthumously in 1934 and s *A History of Elementary Mathematics,* 2nd ed. (1917), was reissued in 1950. Cajori died at Berkeley on Aug. 14, 1930.

CAKCHIQUEL, the language spoken by about 350,000 Indians of highland Guatemala. Most Cakchiquel speakers are in the departments of Sololá, Chimaltenango, Sacatepéquez and Escuintla. The language is part of the Quichean family of the Mayan stock and very similar to Quiché and Zutuhil. Language is not the basis of forming social units nor does it correlate with cultural distinctiveness in this region of Guatemala. Cakchiquel-speaking Indians, like other Mayan peoples of the highlands, are organized on the basis of a *municipio* with its own variations from the broad pattern of Indian culture in the area. A Cakchiquel-speaking community differs from other Cakchiquel communities to about the same degree and in the same ways as it varies from neighbouring Quiché or Zutuhil-speaking communities. (*See* Quiché; Zutuhil.) Each community has its own political and religious hierarchy, a distinct costume (at least for the women), a local patron saint, and an economic specialty. The general culture of the area is a fusion of Spanish and Indian elements in the context of a peasantry stabilized in the region centuries ago.

Prior to the Spanish conquest (1524) the Cakchiquels were a principality which contested with other Indian principalities, especially the Quiché, for political domination. The archaeological site, Iximché, was the fortified capital city of the principality, covering about three miles. The ruins suggest class distinctions between nobles and commoners, as well as the warfare concerns of the people just prior to Spanish conquest. Their history is preserved in a manuscript written in Cakchiquel but using the Spanish alphabet. The Cakchiquel peoples received the Spanish peacefully and did not offer resistance until Spanish demands for tribute and forced labour occasioned a revolt a year after conquest.

The distribution of Cakchiquel-speaking Indians reflects their preconquest sites but is largely derived from the Spanish administrative policy of grouping Indians in manageable units for political control and religious conversion. *See* also Central America: *Ethnology;* Maya Indians; for the early Cakchiquel calendar and chronology, *see* Calendar: *Middle American Calendars,* and Chronology: *Pre-Columbian American.*

See F. W. McBride, *Cultural and Historical Geography of Southwest Guatemala* (1947). (M. Na.)

CAKES: *see* Food Preparation.

CAKEWALK, a dance of American Negro origin. The couples form a square with the men on the inside and, stepping high to a lively tune, walk in this square formation. There are several judges who consider the precision with which the corners are turned, the elegant bearing and carriage of the men and the grace and ease of their partners as they are swung about. The couples are eliminated one by one, the last being presented with a highly decorated cake as a reward. This is the original cakewalk, as it was danced in slavery days. From it many modifying steps have been evolved, all of which are called cakewalks.

ÇAKMAK, FEVZI (1876–1950), Turkish marshal and statesman who played a leading role in the creation of modern Turkey, was born at Istanbul on Jan. 12, 1876, the son of an artillery colonel. He was educated at the Kulili military college and the general staff academy at Harbie, in Istanbul. A lieutenant in 1895, he was made lieutenant colonel and appointed chief of staff of an army corps in 1910. He fought in the Balkan Wars of 1912–13 as commander of a division and in World War I as commander of an army corps and (in 1917–18) of an army. War minister in 1920, he resigned the commission and office granted him by the sultan and joined Mustafa Kemal Atatürk's "rebellion" in Ankara. There he was made prime minister and minister of defense. Promoted to the rank of full general during the Greek invasion of Anatolia, he resigned his premiership in 1922 and became deputy to Ismet Inönü, then chief of staff. After the victorious conclusion of the War of Liberation, he was promoted as the new republic's first marshal and appointed chief of staff, holding that position for 20 years. In the 1946 elections he stood as an Independent and was elected to the grand national assembly with a great majority. In 1948 he accepted the honorary leadership of the conservative Millet (Nation's) party.

Çakmak died at Istanbul on April 10, 1950.

CAKSTE, JANIS (1859–1927), promoter of Latvian independence and first president of the Republic of Latvia, was born at Lielsesava in Courland on Sept. 14, 1859. He was educated at the Jelgava (Mitau) gymnasium, studied law at the University of Moscow and was for some years in the public prosecutor's office of the Courland government. Leaving the public service in 1888, he practised law in Jelgava and edited a Latvian newspaper *Tevija* (Fatherland). He served on a committee appointed by the local administration to inquire into agricultural conditions in Courland (1902) and was frequently employed on Russian imperial government committees. In 1906 he was elected member of the first Russian duma. After the first duma was dissolved by the imperial government, Cakste was one of those who signed the Viborg protest. The German invasion of Courland (July 1915) obliged him to leave Jelgava. He moved to Petrograd (Leningrad), where he was one of the founders of a central relief committee for war refugees. In 1916 he went to Stockholm to promote the cause of Latvia's independence and there published his book *Die Letten und ihre Latvija*. Cakste was elected chairman of the Latvian people's council in 1918 and was later head of the delegation sent to Paris and London to secure the recognition of the Latvian republic. He was president of the Latvian national council and, in 1920, of the Latvian constituent assembly. He also became professor of international law at the University of Riga. Elected president of Latvia by the first Latvian *saeima* (parliament) on Nov. 14, 1922, he was re-elected on Nov. 6, 1925, for a further period of three years, but died on March 14, 1927. (A. Sp.)

CALABAR BEAN, the seed of a leguminous plant, *Physostigma venenosum,* a native of tropical Africa. The plant is a climber and attains a height of about 50 ft. The seed pods, which contain two or three seeds or beans, are six or seven inches in length; and the beans are about the size of an ordinary horse bean but much thicker, with a deep chocolate-brown colour. Although highly poisonous, the bean has nothing in external aspect, taste or smell to distinguish it from any harmless leguminous seed, and disastrous effects have resulted from its being left in the way of children.

The bean usually contains less than 1% of alkaloids, of which several have been isolated, the most important being physostigmine or eserine. It occurs in small white crystals, turned red by exposure to light or air, slightly soluble in water, soluble in ether, chloroform and alcohol, and with a bitter taste. Medicinally, physostigmine is employed as the salicylate.

The pharmacological activity of physostigmine is due to its action in inhibiting the destruction of acetylcholine, permitting the latter to exert its characteristic effects in an intensified manner. According to the chemical theory of nerve transmission, acetylcholine is liberated at the nerve endings of all parasympathetic nerves and certain cholinergic sympathetic nerves, such as those supplying the sweat glands in human beings, at the ganglia of all autonomic nerves and also at the end plates of motor nerves to skeletal muscles. The effects of physostigmine at cholinergic nerve endings are antagonistic to those of atropine (*see* ATROPINE). Thus, the secretions of the salivary, mucous and sweat glands tend to be increased, the heart may be slowed and the blood pressure tends to fall; the pupil is constricted; the tone and motility of the gastrointestinal tract are increased and the bronchi are constricted. Because of its action at sympathetic ganglia, certain contradictory effects may be obtained such as increase in heart rate and blood pressure. The effect of physostigmine on skeletal muscle is observed with larger doses and is manifested by fibrillary twitchings.

In ophthalmology physostigmine is used in glaucoma to reduce the intraocular pressure and alternately with atropine to break up adhesions between the iris and the lens. It may be used to increase the motility of the gut or reduce abdominal distention. Physostigmine and, more especially, a synthetic substitute, neostigmine, have been used in the treatment of myasthenia gravis because they facilitate transmission of impulses at the myoneural junction by delaying the destruction of acetylcholine.

The calabar bean was formerly used by native tribes for "trial by ordeal." Gastrointestinal symptoms appear first and consist of violent peristalsis, nausea, vomiting, colic and diarrhea; there is restlessness and weakness with fibrillary twitchings of all voluntary muscles. The pupils are pinpoint, and salivation, sweating and lacrimation may be marked. There may be difficulty in breathing because of bronchiolar constriction. Death is due to respiratory paralysis. The administration of atropine will counteract all symptoms with the exception of the muscular twitchings. (F. L. A.)

CALABASH, the shell of a gourd or pumpkin made into a vessel for holding liquids; also a vessel of similar shape made of other materials. It is also the name of a tree, *Crescentia cujete* (family Bignoniaceae) of tropical America, and its gourdlike fruit is so hard that vessels made of the rind can be used over a fire many times. Tobacco pipes are made from the necks. The bottle gourd, *Lagenaria vulgaris,* is also called the calabash. Pictographic records were kept on dried calabashes by the Indians of the Matto Grosso. According to Sir James Frazer in *The Golden Bough,* sorcerers in primitive cultures in Hawaii were thought to be able to imprison souls of living persons in calabashes. *See* also GOURD.

CALABOZO, founded in 1695, one of the larger cities (pop. [1961] 15,739) and former capital of Guárico state, Venezuela, is on the Guárico River, 120 mi. SW of Caracas, on a piedmont plain in the zone between the mountains and the llanos. The town gained prominence in the 1950s as the headquarters for the Guárico River Project, south of the city, which is concerned with irrigation, flood control, and the cattle industry. Calabozo benefits from the agricultural growth of what has become a vast rice-growing region, and from the construction of modern transport facilities: *e.g.,* the highway to San Fernando (*q.v.*), the centre of the livestock-raising area to the south. *See* also GUÁRICO. (L. WE.)

CALABRIA, a region of southern Italy comprising the provinces of Catanzaro, Cosenza and Reggio di Calabria (*qq.v.*). Pop. (1961) 1,937,229. Area 15,080 sq.km. (5,822 sq.mi.). Sometimes referred to as "the toe of the Italian boot," Calabria is a peninsula of irregular shape, jutting out in a northeast-southwes direction from the main body of Italy, and separating the Tyrrhenian and Ionian seas. Most of the region is mountainous o hilly, the only extensive lowlands being those of the lower Crat valley near Sibari (which derived its name from ancient Sybaris), of the Marchesato near Crotone, of Sant' Eufemia and of Gioia Tauro. In the north Calabria is linked to the Lucanian Apennines (Appennino Lucano) by the massif of Monte Pollino (2,248 m. o 7,375 ft.); the Pollino is continued southward along the west coas by the coast range, which in turn is separated by the Crati rive from the extensive La Sila massif (highest point: Botte Donat 1,928 m., or 6,325 ft.). A narrow isthmus between the Gulf o Sant' Eufemia in the west and the Gulf of Squillace in the eas separates the northern from the southern part of the region; th uplands continue as the Calabrian Apennines (Appennino Calabrese) and culminate in the southernmost part as the massif o the Aspromonte (Mont-Alto 1,956 m., or 6,417 ft.).

The mainstay of Calabria's economy is farming, once chara terized by large landed estates and tiny peasant holdings. Unde the Italian land reform the majority of the former *latifundia* wer broken up after 1951 and new, small peasant holdings created, wit rural service centres, new houses and new roads. Formerly th agriculture of Calabria concentrated almost entirely on cerea and the raising of sheep and goats, with occasional work in th forests of the Sila uplands. New commercial crops, citrus fru (mostly on the west coast), figs and chestnuts, were introduce Hydroelectric power was developed during the 1920s and 193 in La Sila and is an important feature of the Calabrian econom supplying electric railways and the industrial centre of Crotone c the Ionian coast, which has chemical industries. There are tw trunk railways: the Rome-Naples-Reggio di Calabria line on th west coast (the direct line between Rome and Sicily), and th Ionian or Taranto-Reggio di Calabria line on the east coast. Th two lines are connected from Paola to Sibari (connection f Cosenza), and from Sant' Eufemia to Marina di Catanzaro; the are also local lines. The highways are well developed, with extensive bus services. A railway and car ferry links the ports of Reggio di Calabria and Villa San Giovanni with Messina in Sicily.

Calabria is one of the few areas of south Italy with a non-Italian minority: the Albanians who settled in the region during the 15th and 16th centuries under Turkish pressure, and who have retained their speech, the Greek Catholic rite in their churches and, on festival occasions, their colourful national costumes.

In classical times the region was a centre of Greek colonization; Crotona, Sybaris (*qq.v.*), Reggio (now Reggio di Calabria) were Greek cities of wide fame. After the Roman conquest the splendour of the Greek cities slowly gave way to a remote provincial existence, and eventually *Ager Bruttius* as it was then called passed to the Byzantines who applied the name Calabria (which was also the Roman name for the southeast extremity of the Italian peninsula, *see* CALABRIA [ANCIENT]). The Lombards controlled the region from Benevento and, later, from Salerno. After another period of Byzantine rule Calabria shared with the rest of southern Italy its Hohenstaufen, Angevin and Aragonian rulers; it became a stronghold of Italian republicanism until the *Risorgimento* (the movement for political unity), and part of Italy after Garibaldi's expedition in 1860. In World War II Reggio di Calabria, chief supply centre for Sicily, was heavily bombed by the Allies.

(G. KH.)

CALABRIA (ANCIENT), the name applied from the 3rd century B.C. to a district of ancient Italy in the southeastern extremity of the peninsula between the Adriatic and the Gulf of Tarentum ending in the Iapygian promontory (Salentina); the village on this promontory was called Leuca (Gr. *leukos* "white") from its white cliffs (mod. Santa Maria di Leuca). Calabria occupied the southern part of modern Apulia (Ital. Puglia), consisting of the provinces of Lecce, Brindisi and Taranto, though the latter extends farther westward than the ancient district (modern Calabria comprises the ancient territory of the Bruttii, the southwestern extremity of Italy).

The land forms a low terrace of limestone, the highest parts of which seldom reach 1,500 ft.; the cliffs, though not high, are steep, and it has no important rivers, but despite lack of water it was remarkably fertile. Strabo mentioned its pastures and trees, and reference was frequently made to its olives, wines and fruit trees. The wool of the ports of Tarentum (Taranto) and Brundisium (Brindisi) was famous and the former had considerable dyeworks. Traces of a prehistoric population are to be found all over Calabria, especially near Lecce, Gallipoli and Muro Leccese.

Between 272 and 266 B.C. six triumphs were recorded in the Roman *fasti* (calendar) over the Tarentini, Sallentini and Messapii, while the name Calabria does not occur; but after the foundation of a colony at Brundisium about 246 and the final subjection of Tarentum in 209, Calabria became the general name for the peninsula. According to Strabo (1st century A.D.) earlier Calabria had been extremely prosperous and had had 13 cities, but all except Tarentum and Brundisium had dwindled to villages. The Appian way, extended to Brundisium probably by 244 B.C., passed through Tarentum; the shorter route by Canusium (Canosa di Puglia), Barium (Bari) and Egnatia (near Fasano) was only made a main route by the emperor Trajan. When the emperor Augustus divided Italy into *regiones* he joined Calabria to Apulia and the territory of the Hirpini to form the second region. From the end of the 2nd century Calabria was associated for juridical purposes either with Apulia or with Lucania and the district of the Bruttii, while the emperor Diocletian placed it under one *corrector* (governor) with Apulia. When the Lombards seized Calabria about A.D. 668 its name became transferred to the southwestern peninsula of Italy.

See J. Whatmough, *The Foundations of Roman Italy* (1937); G. Palumbo, *Rivista di Scienze Preistoriche*, vol. x (1955).

CALAHORRA, a town of northern Spain, province of Logroño, is situated on the left bank of the Cidacos river near its confluence with the Ebro, and is 49 km. (30 mi.) E.S.E. of Logroño by road. Pop. (1950) 13,183 (mun.).

The cathedral, dating probably from the 5th century, was restored in 1485, with a façade dated 1680–1704 and much subsequent alteration. The Gothic church of San Andres is also notable. The Casa Santa, visited by thousands of pilgrims on Aug. 31, supposedly contains the bodies of the martyrs Emeterius and Celedonius. Calahorra is on the main railway from Bilbao to Saragossa and Barcelona. The town was famous for its four years' resistance to Pompey, 76–72 B.C. Augustus gave it Roman citizenship, and it later was called Calagurris Nassica to distinguish it from Calagurris Fibularensis nearby.

(M. B. F.)

CALAIS, a seaport on the Strait of Dover and industrial town of northern France in the *département* of Pas-de-Calais, is 274 km. (170 mi.) by road from Paris. Pop. (1954 census) 60,160. Area 2,937 sq.km. (11⅓ sq.mi.). The old town with the citadel of 1560 was virtually destroyed in World War II and is now a new quarter. It stands on an island bordered by the canal and harbour basins which separate it from the larger quarter of St.-Pierre to the south, which, also badly damaged, is still the industrial area. The principal thoroughfares are the Place d'Armes, Place Crévecoeur, Place Albert I, the Rue Royale, and Jacquard, Pasteur, Gambetta and La Fayette boulevards. The 13th-century Tour du Guet (watchtower) still stands in the old town; and the modern hôtel de ville (town hall) in St.-Pierre was built (1910–22) in Flemish Renaissance style.

Calais is the second most important passenger port in France, and the first for passenger traffic with England. It is linked by railway with Boulogne, Paris, Lille and Dunkirk, and by sea with Dover (the shortest crossing from England 21 mi.) and Folkestone. For passengers and automobiles there are several daily cross-channel sea services, and air services from Calais-Marck airport. There is a river transport link with Saint-Omer. The principal industry is lacemaking, including point lace and pillow lace, and tulles and embroideries are exported all over the world. Other exports are pit coal and sand. Imports include timber, cellulose pulp, iron ore and pyrites. Other manufactures include papier-mâché, Calais yarns, chemical products, biscuits and submarine cable.

Originally a fishing village, Calais was improved by Baldwin IV, Count of Flanders, in 997, and fortified in 1224 by Philip Hurepel Count of Boulogne. After the battle of Crécy it was besieged (1346) for nearly a year by Edward III of England, and reduced by famine. The famous episode of the six burghers of Calais, who surrendered themselves to save their town, is related to this siege and is commemorated by Auguste Rodin's monument. Calais remained English until 1558, when it was taken by François de Lorraine, 2nd duke of Guise. From this time the Calaisis, or territory of Calais, was known as the Pays Reconquis. It was occupied by Spain from 1596 to 1598, but returned to France by the treaty of Vervins. In 1805, 6,000 men of Napoleon's "army of England" were encamped there. It was often a German objective in World War I and in World War II was one of the main objectives of the German drive to the sea in May 1940, from which time it remained in German hands until its recapture by the Allies in Sept. 1944. It had then been, for about three months, a base for the robot bombs directed against England.

CALAIS AND ZETES, in Greek mythology, the winged twin sons of Boreas and Oreithyia. On their arrival with the Argonauts at Salmydessus in Thrace, they liberated their sister Cleopatra, who had been thrown into prison with her two sons by her husband, Phineus, the king of the country. According to another story, they delivered Phineus from the Harpies. They were slain by Heracles near the island of Tenos, in consequence of a quarrel with Tiphys, the pilot of the Argonauts, or because they refused to wait during the search for Hylas. Legend attributed the foundation of Cales in Campania to Calais.

CALAMIAN ISLANDS, an island group lying between Mindoro and Palawan, Republic of the Philippines. Politically a part of Palawan province, this group consists of Busuanga (344 sq.mi.), Culion (150 sq.mi.), Coron (27 sq.mi.) and many lesser isles and islets. Manganese was mined on Busuanga prior to Japanese occupation of the Philippines and again in the immediate postwar years. Culion is best known as the site of a leper colony. All the larger islands have some agriculture, principally subsistence cropping, and fishing is a significant activity. The principal settlement is Coron (pop. [1969 est.] 14,000) on Busuanga opposite the island of Coron. *See* also PALAWAN; CULION ISLAND. (AN. C.)

CALAMINE: *see* HEMIMORPHITE.

CALAMIS (fl. 470–450 B.C.), Athenian sculptor, made statues of Apollo the averter of ill, Hermes the rambearer, Aphrodite, and other deities, as well as part of a chariot group for Hiero, king of Syracuse. His works were praised by ancient critics for delicacy, simplicity, and orderliness. Copies of the Aphrodite or Sosandra have been identified, but evidence for his other works is inconclusive.

See Gisela M. A. Richter, *The Sculpture and Sculptors of the Greeks*, pp. 203–207 (1950). (C. C. V.)

CALAMY, EDMUND (1600–1666), English Presbyterian minister, a leader among the Presbyterians in England in the mid-17th century, was born in London in Feb. 1600 and educated at Merchant Taylors' School, London, and Pembroke Hall, Cambridge. After holding positions in the eastern counties, he became rector of St. Mary Aldermanbury, London, in 1639. In 1641 he was one of five writers who, over the nom de plume of Smectymnuus, made a noted attack on episcopacy and liturgy conceived as of divine right and inalterable; and in 1643 he was a member of the Westminster Assembly of Divines. When in 1646 parliament ordered Presbyterianism to be established in England, Calamy was one who served as moderator of the provincial assembly set up in London, and he contributed to various publications which it issued. He was prepared for discussion with Independents; and at the Restoration he accepted a chaplaincy to Charles II. He declined a bishopric, but was appointed to nominate those other than bishops to the Savoy conference of 1661. But a policy of comprehension proved impossible, and under the Act of Uniformity, he was ejected from his living, and in Dec. 1662 became the first Nonconformist to be imprisoned for disobeying the act. He died on Oct. 29, 1666. His son, grandson, and great grandson were all Nonconformist ministers of the same name and his grandson was the biographer of the ejected ministers. (G. F. N.)

CĂLĂRAŞI, a town of Rumania, is situated 104 km. (65 mi.) ESE of Bucharest on the left bank of the Borcea arm of the Danube, forming the Danube delta. It is the administrative centre of a district of the same name in the Bucharești region. Pop. (1966) 35,698. Călăraşi is a river port and trading centre. Its chief industry is food manufacturing, particularly fish processing and flour milling. The first documentary mention of the town occurred in 1593, during the reign of Michael the Brave.

CALAS, JEAN (1698–1762), the Huguenot cloth merchant of Toulouse whose judicial murder in 1762 became a *cause célèbre* in the history of toleration and first aroused Voltaire's passion for the reform of the French criminal code, was born in the village of Lacabarède, near Castres in Languedoc, on March 19, 1698. On Oct. 13, 1761, Calas' eldest son, Marc Antoine, was found by his family hanged in his father's shop. Local prejudice against the Huguenots, led by a panic psychology, accused the Calas family of having murdered Marc Antoine to prevent or punish his rumoured conversion to Roman Catholicism. Calas first attributed the crime to an unknown intruder, but later insisted that his son had committed suicide. He was tried by the *capitouls* (local magistrates) and finally condemned to death by the *parlement* of Toulouse, sitting as an appellate court, on March 9, 1762. Throughout his trial and subsequent torture Calas maintained his innocence. On March 10, 1762, he was publicly broken on the wheel, strangled, and then burned to ashes. His son was buried as a martyr to the Roman Catholic faith. Influential friends of the family in Geneva interested Voltaire in the case, and it was largely through his efforts that European opinion was mobilized and that Calas' innocence was vindicated in 1765. The family was indemnified and the sentence of the *parlement* was stricken from the record. Though the local magistrates had scrupulously observed most of the established procedure, much of the evidence that they admitted had been mere hearsay. The Calas case powerfully strengthened the argument for criminal law reform in France, though this did not come about till 1788.

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CALASIO, MARIO DI (1550–1620), Italian Minorite friar, was born in the Abruzzi region. Joining the Franciscans at an early age, he devoted himself to Oriental languages and became an authority on Hebrew. He was appointed by Pope Paul V to the chair of scripture at Ara Coeli at Rome, where he died on Feb. 1, 1620. He is known by his *Concordantiae sacrorum Bibliorum hebraicorum* (4 vol., 1621), on which he laboured for 40 years. All root words in the *Concordance* are treated in alphabetical order, and the entire Bible has been collated for every passage containing the word. Calasio also gives under each Hebrew word the literal Latin translation.

CALBAYOG, a city chartered in 1948 in the province of Samar Occidental on the island of Samar, Republic of the Philippines, on the northwest coast at the mouth of the Calbayog River, about 30 mi. NW of Catbalogan, the provincial capital. Its area includes much rural farmland, comprising three municipalities with three administrative centres, and a total of 83 *barrios* (loca districts). The estimated 1970 population was 109,100. The coastal plain is narrow, and rice production is insufficient for local needs. Calbayog is a regular port of call for interisland ship since it is less subject to storms than ports of the north coast. It is the leading exporter of Samar Island abacá (Manila hemp) an important exporter of copra, and the chief importer of ric and manufactures for northern Samar. (J. E. SR.)

CALCAR (KALKAR, KALCKER), **JAN STEPHAN VON** (*c* 1499–*c.* 1546), German painter, whose artistic personality is ob scure, was from *c.* 1536/37 in Venice, where he studied unde Titian, and in 1545 in Naples, where he died. Vasari praises hi portraits; both these and his drawings, according to Karel Va Mander, are virtually indistinguishable from Titian's. A mal portrait of 1540 (Louvre, Paris), attributed to him in a Frenc royal inventory of 1683, forms the basis of all modern attribution of paintings to Calcar.

His only certain works are the designs for three anatomica plates published for Andreas Vesalius (*q.v.;* 1538); the super illustrations of the latter's *De humani corporis fabrica* (1543) ar also generally ascribed to him. (D. KG.)

CALCEOLARIA, a genus of shrubs and herbs belonging t the figwort family (Scrophulariaceae; *q.v.*), containing about 50 species, chiefly natives of the South American Andes of Peru an Chile, and sometimes called slipperworts. The calceolaria of th florists has been developed into a decorative herbaceous plant wit large numbers of mostly red and yellow spotted, pouchlike inflate flowers. It is generally raised annually from the seed, which i sown about the end of June in a mixture of loam, leaf mol and sand. The shrubby calceolarias, sometimes used for beddin are propagated from cuttings planted in autumn in the cool gree house.

CALCHAQUI, a generic term for a subgroup of Diaguita speaking peoples who occupied a large territory in northweste Argentina in the region of the Santa María valley. Knowledge o these Indians comes from Spanish chronicles and archaeologica surveys. Their language affiliation remains uncertain.

The Calchaqui were described as warlike, and their stone fortif cations located at strategic places in their territory attest to thi observation. Most Calchaqui lived in unfortified settlement retreating to hilltop redoubts when under attack; but there wer also some fortified villages. Settlements were autonomous exce in wartime, when they united under the military alliance of i fluential chiefs. The Calchaqui adopted horses early in the coloni era and became effective cavalrymen who carried the attack t Spanish towns and destroyed houses and fields.

Archaeological remains and chronicle reports indicate that th Calchaqui lived in small, sedentary agricultural villages whe they farmed terraced fields, sometimes built irrigation canals, a also kept herds of llama. Their technological skill also extende to loom weaving llama-wool textiles, which were dyed; baske making; and a rather elaborate ceramic industry, as evidenced b pottery molded into anthropo- and zoomorphic shapes, and otherwise decorated and painted. Metallurgy was also known, work being done in silver, gold, copper and a copper-tin alloy called "Calchaqui bronze."

Religious beliefs involved shamanistic practices for the cure of illness felt to be caused by witchcraft. Shamans also appear to have held public fertility rites connected with agriculture, during which animal and sometimes human (enemy) sacrifice was made to the sun. Funeral ceremonies were elaborate and protracted, involving ceremonial wailing, flexed-burial of the deceased in a pit or special chamber and, in the case of infants, urn burial, apparently in special cemeteries.

See J. H. Steward (ed.), *Handbook of South American Indians*, Bureau of American Ethnology *Bulletin 143*, vol. ii, pp. 637–654, with bibliography (1947); also, J. H. Steward and L. C. Faron, *Native Peoples of South America* (1959). (L. C. Fa.)

CALCHAS, son of Thestor, the most famous soothsayer among the Greeks at the time of the Trojan war. He foretold the duration of the siege, demanded the sacrifice of Iphigeneia and the return of Chryseis; he suggested that Neoptolemus and Philoctetes should be fetched to Troy, and advised the construction of the wooden horse. It had been predicted that he should die when he met his superior in divination; and the prophecy was fulfilled in the person of Mopsus, whom Calchas met after the war, at Clarus, or at Siris in Italy.

Beaten in a trial of soothsaying, Calchas died of chagrin or committed suicide.

CALCIMINE: *see* DISTEMPER, WHITEWASH AND CALCIMINE.

CALCINATION. Solids, when heated to a high temperature for the purpose of removing volatile substances, for the purpose of oxidizing a portion of the mass, or to render them friable, are said to be calcined. Calcination, therefore, is sometimes considered a process of purification. A typical example is the manufacture of lime from limestone. In this process the limestone, usually admixed with coke or other fuel to maintain the high temperature but sometimes treated in rotary kilns heated by gas or powdered fuel, is brought to a temperature high enough to expel the carbon dioxide, producing the lime of commerce in a highly friable or easily powdered condition. Calcination in special cases may be carried on in furnaces designed to exclude air, for which an inert gas may be substituted.

CALCITE, a widely distributed rhombohedral mineral consisting of calcium carbonate and noted for the beautiful development and great variety of its crystals.

The name calcite is of comparatively recent origin, being first used in its present sense by W. K. Haidinger in 1845. However, the mineral had long been known by the name calcareous spar, and the transparent variety called Iceland spar had been much studied. The strong double refraction and perfect cleavage of Iceland spar were described in detail by Erasmus Bartholin in 1669 in his book *Experimenta crystalli islandici disdiaclastici*; a study of the same mineral led Christiaan Huygens to discover in 1678 the laws of double refraction. From an investigation of the cleavage and crystal forms of calcite, R. J. Haüy in 1781–1801 developed a theory of crystal structure which played an important part in the development of modern structural crystallography. In 1808 E. L. Malus discovered the polarization of light by Iceland spar.

Modes of Occurrence.—The modes of occurrence of calcite, $CaCO_3$, are exceedingly varied. It occurs as one of the most common sedimentary rocks, limestone, and as the metamorphic equivalent, marble. It is a common constituent of the shells of invertebrates. It frequently occurs as crystals in association with zeolites, lining the cavities of basaltic rocks, and is a common product of hydrothermal solutions, forming the gangue material in many ore deposits. $CaCO_3$ is appreciably soluble in ground water containing organic acids and dissolved carbon dioxide, obtained in passing through soils, and is redeposited when the CO_2 escapes. This solution mechanism is responsible for the frequency of limestone caverns and the wide distribution of stalactites and stalagmites in caves, massive banded deposits of travertine around springs, and spongy calcareous tufa in ordinary streams and springs. *Caliche* is a soil or porous rock zone in arid regions which has been enriched in $CaCO_3$ by the evaporation of ground water. Oölites are formed in the Sea of Azov and in the shallow waters of the Bahaman platform at places where upwelling waters lose CO_2 through warming, agitation and photosynthetic uptake by algae. Although often precipitated as aragonite, oölites subsequently invert to calcite.

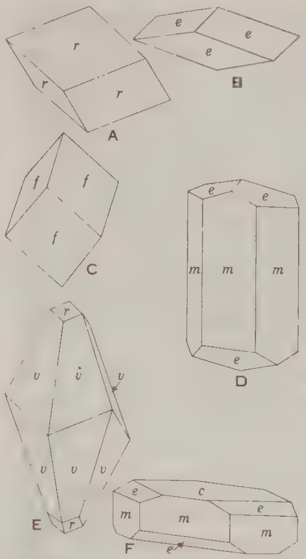


FIG. 1.—CALCITE CRYSTALS
(A) *r* is primitive (cleavage) rhombohedron
(B) *e* is flat rhombohedron
(C) *f* is acute rhombohedron
(D) combination of prism (*m*) with rhombohedron (*e*)
(E) combination of scalenohedron (*v*) with rhombohedron (*r*)
(F) combination of basal pinacoid (*c*) with prism (*m*) and rhombohedron (*e*)

Commercial Importance and Uses.—Calcite is the most important mineral constituent of limestones and marbles, which are of great commercial importance in the building, steel, chemical, glass and other industries (*see* LIMESTONE; MARBLE). Iceland spar, which was first produced as early as the 17th century from masses and enormous crystals in a large cavity in basalt on the east coast of Iceland, is used in polarizing prisms such as the Nicol and Ahrens prisms. These are used in polarizing microscopes to study the behaviour of crystallized substances, in polariscopes such as the saccharimeter used in the sugar industry, and in other optical instruments. These prisms reflect one component of the light to the side, leaving a single, completely polarized ray. Other methods of producing polarized light, either by reflection or absorption, do not give such complete polarization. Although the double refraction (see *Physical and Chemical Properties*, below) of some other minerals is much greater than that of Iceland spar (0.1723, while for cinnabar it is 0.347 and for calomel 0.683), the former materials cannot be obtained in large thick transparent pieces. (*See* also LIGHT: *Polarization and Electromagnetic Theory: Methods of Producing Polarization*; POLARIMETRY.)

Crystal Forms.—Crystals of calcite show a greater variety of forms than any other mineral. In his *Atlas der Kristallformen* (1912–23), V. Goldschmidt showed more than 2,500 drawings of calcite crystals. By the second half of the 20th century, 328 forms had been definitely established, with an additional 296 regarded as uncertain. In spite of this variety, there are four most frequently encountered types, namely: (1) prismatic, with various terminations; (2) scalenohedral, many times very complex, and when occurring in acute forms called dogtooth spar; (3) rhombohedral, varying from flat to very acute; and (4) tabular, with the basal face prominent, and sometimes occurring in almost paper-thin crystals. Clusters of parallel crystals are common. These may be nearly identical, or rhombohedral crystals may be perched on a scalenohedron (nailhead spar). Sometimes an earlier formed crystal will be completely enclosed by a later growth, giving a phantom crystal. Subparallel growths of platy crystals form an undulatory lamellar variety with a pearly lustre, called argentine. Calcite is also remarkable for the variety and perfection of its twinned crystals. (*See* CRYSTALLOGRAPHY.)

In addition to its perfect rhombohedral cleavage, calcite is characterized by a specific gravity of 2.71 and a hardness of 3 on Mohs' scale. It effervesces briskly with cold dilute acids, and is transparent and colourless when pure. Various colours may be imparted by other elements replacing the calcium, such as pink by manganese. Colour may also be due to admixed impurities such as red or brown from disseminated hematite or cuprite, and green from malachite or chlorite. Clear transparent crystals of calcite containing bright metallic flakes of copper are found in northern Michigan. A remarkable case of enclosed impurities is that of sand-calcite crystals. These consist of calcite with up to

64% of quartz sand, and are found at Fontainebleau near Paris and in the Bad Lands of South Dakota.

Physical and Chemical Properties.—Calcite is made up of calcium ions and carbonate ions in alternate planes perpendicular to the crystallographic *c*-axis to yield a structure which is a distorted equivalent of that of NaCl. This arrangement results in a marked anisotropism of chemical and physical properties including dielectric constant, thermal expansion, hardness, rate of solubility in acid, linear compressibility and refractive index. Thus, calcite is less resistant to scratching on a basal face than on a prism, and on the rhombohedral cleavage it is distinctly softer when scratched toward the apex than away from it. Optically, calcite is uniaxial negative, the index of refraction for the ordinary ray being 1.6585 and for the extraordinary ray 1.4862 (sodium light). The difference, 0.1723, between these two indexes is a measure of the strong birefringence or double refraction, which is sufficient so that an object viewed through a cleavage rhombohedron is seen double. W. L. Bragg was able in 1924 to calculate the refractive indexes of calcite from the atomic arrangement, one of the first such calculations to be made.

Calcite is polymorphous with aragonite, which is orthorhombic, with vaterite, which is hexagonal, and with several forms which apparently exist only under rather extreme experimental conditions. Calcite is the stable form at all temperatures and pressures encountered at or near the earth's surface.

The radius of the Ca^{2+} ion is markedly greater than those of Mn^{2+}, Fe^{2+} and Mg^{2+}, the cations in the three most common of the carbonates having the same crystal structure as calcite; *i.e.*, rhodochrosite, siderite and magnesite. Solid solutions between calcite and these minerals are therefore incomplete. Small amounts of zinc, lead, barium and strontium have also been found in calcite. Calcites from marbles contain up to 7½ mole per cent $MgCO_3$; when these materials exist in equilibrium with dolomite in the rock, the amount of $MgCO_3$ in solid solution may be used as a geologic thermometer. Manganese-rich ore bodies such as those of Franklin, N.J., and Långban, Swed., contain calcites with up to 40 mole per cent $MnCO_3$ in solid solution. The calcites making up the hard parts of some invertebrates contain as much as 18% $MgCO_3$. The content of both magnesium and strontium in such skeletal calcite varies with the kind of organism and with water temperature.

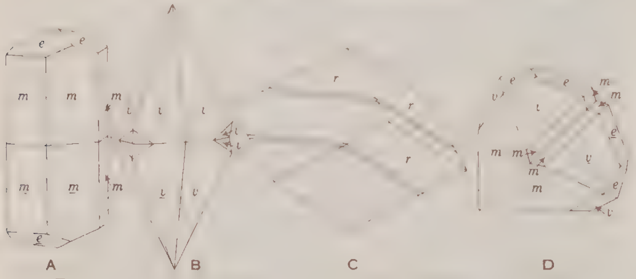


FIG. 2.—FOUR SPECIMENS OF TWINNED CRYSTALS OF CALCITE

(A) Twinned prismatic crystal, (B) twinned scalenohedron, (C) cleavage rhombohedron with twin-lamellae, (D) heart-shaped twin

The relative amounts of the O^{18} and O^{16} isotopes in shells consisting of calcium carbonate may be used to calculate the temperature of the water in which the organisms lived. The C^{14} isotope content of $CaCO_3$ less than about 40,000 years old may often be used to measure the age of the material, if the source of CO_2 incorporated in the carbonate can be inferred.

See also references under "Calcite" in the Index volume.

(D. L. G.)

CALCIUM, a metallic element, symbol Ca, was so named by Sir Humphry Davy because of its occurrence in chalk (*q.v.*).

Calcium does not occur in the free state, but compounds of the element are widely distributed. In the earth's crust calcium is the fifth most abundant element; it constitutes 3.63% of the igneous rocks and 3.22% of the entire crust of the earth. It is found as the sulfate in gypsum and related minerals.

The fluoride of calcium occurs as fluorite and (with calcium phosphate) as apatite. Many minerals, notably feldspars and zeolites, contain calcium silicates. Asbestos is composed of calcium magnesium silicate, $CaMg_3(SiO_3)_4$. Calcium phosphate is the principal inorganic constituent of bones; it also occurs as the mineral phosphorite, $Ca_3(PO_4)_2$. Calcium carbonate (calcite) occurs in limestone, chalk, marble, dolomite, eggshells, pearls, coral, stalactites, stalagmites and the shells of many marine creatures.

Production.—In 1808 Davy showed that lime was an oxide of the metal which he named calcium. Robert Bunsen electrolyzed calcium chloride, and A. Matthiessen obtained the metal by the electrolysis of a mixture of fused calcium and sodium chlorides While calcium was formerly produced by electrolysis of anhydrous calcium chloride, practically all commercial production is by the reduction of lime by aluminum in heated retorts under low pressures. Calcium distills out of the reaction mass and is collected in a cool section of the retort or in a condenser.

Uses.—Calcium is employed as an alloying agent for aluminum copper, lead, magnesium and other base metals (*see* also ALLOYS BEARING METALS). It is an important deoxidizer for chromium nickel, chromium-nickel-iron and related resistance high-temperature alloys, and for nickel, steel and tin bronzes. It is a getter o evacuating agent for high vacuums as in thermionic tubes, radi and television components. It has been employed as a reducin agent in the preparation of chromium, thorium, uranium, zirconiun and other metals from their oxides; as a dehydrating agent fo organic liquids; a desulfurizer for petroleum fractions; and a de composing agent for thiophenes and mercaptans. Calcium as 0.04% calcium lead is employed on telephone cables and in storag batteries (*see* BATTERY: *Stationary Batteries*).

Various compounds of calcium have numerous important use (see *Compounds*, below). (*See* also separate articles on calcium bearing minerals, as CALCITE; FLUORITE; ZEOLITE; etc.)

Physical and Chemical Properties.—Calcium is one of th alkaline-earth metals of Group II of the periodic table. It is silvery-white metal when freshly prepared, but it reacts readi with oxygen and nitrogen and tarnishes when exposed to the air t produce a gray and slightly yellow surface. There are six stab isotopes of the element; these, arranged in the order of abundanc have mass numbers of 40, 44, 42, 48, 43 and 46. Several artifici radioactive isotopes have also been prepared. The properties calcium are given in the accompanying table.

The arrangement of electrons in the levels and sublevels of th atom of calcium is: $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$.

The chemical properties of calcium are similar to those of stro tium and barium. In their compounds, these three elements ha a valence number of +2. They are also active reducing agents a their compounds have structures and properties commonly po sessed by compounds of active metallic elements. Calcium somewhat less readily oxidized to form ions than strontium a barium and is, therefore, a slightly less active metal.

Under ordinary conditions of temperature calcium reacts slow with the oxygen and nitrogen of the air to form a yellow lay composed of the oxide, hydroxide and nitride. This layer pr tects the metal from rapid oxidation. The element burns br liantly when in air or in pure oxygen to form the monoxide, Ca It reacts rapidly with warm water and more slowly with co water to produce a stream of bubbles of hydrogen.

Calcium reacts directly with most nonmetallic elements. high temperatures, it reacts with nitrogen to form the nitri Ca_3N_2, and with carbon to form the acetylide CaC_2, commercial but inaccurately called "calcium carbide." Upon reaction wi water CaC_2 gives acetylene C_2H_2. The true carbide Ca_2C, whi upon reaction with water would give hydrocarbonic acid H (Methane CH_4), is not stable at high temperatures and does n form. It reacts with the nitrogen of air in the electric furnace form calcium cyanamide (*see* CYANAMIDE, CALCIUM). At som what lower temperatures, it reacts with sulfur to form the sulfi CaS, and with phosphorus to form the phosphide, Ca_3P_2.

Compounds.—In general, the compounds of calcium resem those of strontium and barium but are, with a few exceptio somewhat more soluble in water.

Calcium hydride, CaH_2, sometimes called hydrolith, is obtai by heating the metal in a current of hydrogen. This compound is easily transported and on treatment with water yields hydrogen, which can be used in filling dirigibles. Calcium forms the monoxide, CaO, the peroxide, CaO_2, and possibly a tetroxide, CaO_4. The monoxide is commonly called lime (*q.v.*) or quicklime and the corresponding hydroxide, $Ca(OH)_2$, is sometimes called slaked lime.

The hydroxide is an inexpensive alkaline substance. It is not very soluble in water, and is generally used in the form of a suspension of the solid in water called milk of lime. Among its most important uses is the production of mortar or plaster which contains, in addition to calcium hydroxide, sand and water.

These materials set as they dry and as the hydroxide is slowly converted into calcium carbonate by the action of carbon dioxide in the atmosphere.

The peroxide is obtained by the addition of hydrogen peroxide to limewater; the resulting hydrate, $CaO_2.8H_2O$, loses water on being heated to 130° C. and forms the peroxide as a pale buff-coloured powder. It is used sometimes for bleaching and antiseptic purposes.

Physical Properties of Calcium

Atomic number	20
Atomic volume (c.c./gram atom)	25.9
Atomic weight	40.08
Boiling point	1,440° C. (2,625° F.)
Colour	White, approximating silver
Compressibility:	
30° C. (86° F.)	
o atm. pressure	5.885×10^{-6}
11,600 atm. pressure	5.300×10^{-6}
20° C. (68° F.)	
99–493 atm. pressure	5.8×10^{-6}
100–500 megabars/sq.cm.	5.7×10^{-6}
$\text{Compressibility} = -\frac{1}{\text{vol. (cu.cm.)}} \times \frac{\Delta\ \text{vol. (cu.cm.)}}{\Delta\ \text{pressure (atm.)}}$	
Crystal structure	Face centred cubic, $a = 5.56$ kX
Density (g./c.c.)	
20° C. (68° F.)	1.55 (0.056 lb./cu.in.)
450° C. (842° F.) α phase in extruded wire	1.48
480° C. (896° F.) β phase	1.52
Elastic limit (p.s.i.)	1,470
Electrical resistivity at 21° C. (70° F.) (microhm-cm.)	
rolled	4.24 to 4.50
annealed	4.04 to 4.11
Electrochemical equivalent (valence 2)	
mg./coulomb	0.20762
coulomb/mg.	4.81640
Electrolytic solution potential *v.* hydrogen (v.)	−2.76
Electron configuration	2-8-8-2
Erichsen value on 1/32-in. sheet	
rolled	3.55 to 3.6
annealed	11.1
Hardness number, cast slab	
Brinell (500-kg. load)	17
Rockwell (15-kg. load, 1/16-in. ball)	42 as rolled
Heat of combustion (cal./g.)	151.9
Isotopes (stable)	40, 42, 43, 44, 46, 48
Latent heat of vapourization at boiling point	
cal./gram atom	45,300
kilojoules/gram atom	399
Mass magnetic susceptibility (cg.)	$+1.10 \times 10^{-6}$
Melting point	850° C. (1,562° F.)
Minimum interatomic distance (kX)	3.93
Modulus of elasticity (p.s.i.)	$3 - 4 \times 10^{6}$
Specific gravity (g./c.c.)	1.55
Specific heat (cal./g.)	
−185°–20° C. (−301°–68° F.)	0.157
0°–100° C. (32°–212° F.)	0.149
Temperature coefficient of electrical resistivity per ° C., at 20° C. (68° F.)	0.00457
Tensile properties:	
Yield strength (p.s.i.)	
rolled	12,300
annealed	1,990
Ultimate strength (p.s.i.)	
rolled	16,700
annealed	6,960
Elongation in 1 in. (%)	
rolled	7
annealed	51
Reduction in area (%)	
rolled	35
annealed	58
Thermal conductivity	Same order as that of sodium and alkali metals
Thermal expansion, per ° C.	
linear, 0°–300° C. (32°–570° F.)	0.0000220
cubic, 0°–21° C. (32°–70° F.)	0.000717
Transformation temperature (cooling)	450° C. (840° F.)
Valence	2
Volume conductivity referred to standard copper (%)	48.7

Whereas calcium chloride, bromide and iodide are deliquescent, soluble substances, the fluoride is only slightly soluble in water. Calcium fluoride, CaF_2, occurs as fluorite and can be prepared as a white precipitate by mixing solutions of calcium chloride and sodium fluoride. The chloride, $CaCl_2$, occurs in many natural waters and is produced as a by-product in several manufacturing processes. The crystals may contain two, four or six molecules of water for each gram molecular weight of the chloride. The pure anhydrous chloride is obtained by heating the crystals above 200° C. in a current of hydrogen chloride. It melts at 772° C. It is used as a drying agent. The hexahydrate is used to produce freezing mixtures. Concentrated solutions find some use in laying dust on roads and elsewhere. Bleaching powder (*q.v.*) is now regarded as a mixture of the basic chloride, $CaCl_2.Ca(OH)_2(H_2O)$, and the basic hypochlorite, $Ca(OCl)_2.2Ca(OH)_2$. It is made by exposing thin layers of slaked lime to chlorine at 30°–40° C. (*See* ALKALI MANUFACTURE; BLEACHING.)

Calcium carbonate, or calcite, $CaCO_3$, occurs in all limestones and in other minerals (*see* above) and as bicarbonate, $Ca(HCO_3)_2$, in some naturally hard waters. The loss of carbon dioxide by the evaporating or heating of such waters results in the deposition of $CaCO_3$ and, hence, the hardness of water resulting from the presence in solution of calcium bicarbonate is called temporary. Precipitated chalk is prepared by mixing solutions of calcium chloride and a soluble carbonate.

Calcium nitride, Ca_3N_2, is produced by heating calcium in nitrogen; it is a grayish-yellow powder, which is readily decomposed by water with formation of ammonia.

Calcium nitrate, $Ca(NO_3)_2$, is a highly deliquescent salt; it is sometimes called lime saltpetre. The hydrate, $Ca(NO_3)_2.4H_2O$, has been produced in the flaming arc process for fixing atmospheric nitrogen. It is used as an artificial manure either directly or after conversion into ammonium nitrate.

Calcium phosphide, Ca_3P_2, is obtained by passing phosphorus vapour over strongly heated lime. It produces spontaneously inflammable hydrogen phosphide on reacting with water, and, therefore, is used in marine signal lights.

Normal calcium phosphate, $Ca_3(PO_4)_2$, is the principal inorganic constituent of bones and of bone ash (*see* PHOSPHORUS); it occurs as phosphorite, $Ca_3(PO_4)_2$, in Florida, Tennessee and certain western states of the U.S. and in northern Africa. It also occurs as apatite, $Ca_5F(PO_4)_3$, or $Ca_5Cl(PO_4)_3$, in Canada and elsewhere. The acid salt, $CaH_4(PO_4)_2$, is obtained by evaporating a solution of the normal salt in hydrochloric or nitric acid; it is very soluble and, with calcium sulfate, is a standard superphosphate fertilizer which is produced by treating mineral phosphates with sulfuric acid (*see* also FERTILIZERS AND MANURES).

Calcium phosphate is used in medicine; as a source of phosphorus; as polishing powder in tooth pastes (as calcium metaphosphate); in ceramics and porcelain manufacture; and in enameling.

Calcium sulfide, CaS, is produced by heating the sulfate with charcoal or by heating lime in a current of hydrogen sulfide. The hydrosulfide, $Ca(SH)_2.6H_2O$, is produced by saturating a cold suspension of lime with hydrogen sulfide. The di- and pentasulfides, CaS_2 and CaS_5, are formed when milk of lime is boiled with flowers of sulfur. The sulfides of calcium are used as a depilatory in the manufacture of leather; in medicine; and in luminous paints.

Calcium sulfate, $CaSO_4$, occurs as gypsum, alabaster, anhydrite, satin spar and selenite, and in water, in which it is one of the salts causing permanent hardness; *i.e.*, hardness not removed by boiling. The dihydrate, $CaSO_4.2H_2O$, is converted into a semihydrate, $CaSO_4.\frac{1}{2}H_2O$, on being heated to 120°–180° C.; this hydrate is called plaster of paris.

Analysis.—Most calcium compounds impart an orange-red colour to the flame of the Bunsen burner, more especially if they are moistened with hydrochloric acid. Spectroscopically, calcium exhibits two characteristic lines—Ca α, orange, λ 6,163; and Ca β, green, λ 4,229. Calcium ion is not precipitated by hydrogen sulfide either in acid or in ammoniacal solution, but is precipitated by ammonium carbonate in the presence of ammonium ion. It is quantitatively precipitated as calcium oxalate, a white solid, insoluble in acetic acid, either by ammonium oxalate or sodium oxalate. Calcium is usually separated in this form and subsequently dried and converted either to the oxide by heat or to the sulfate by sulfuric acid and weighed as such.

Calcium salts are not toxic; deficiency of calcium in the diet leads to diseases of the body resulting from the lack of material for bone formation.

See also references under "Calcium" in the Index.

Bibliography.—C. L. Mantell and Charles Hardy, *Calcium, Metallurgy and Technology* (1945); C. A. Hampel (ed.), *Rare Metals Handbook* (1954); G. L. Clark (ed.-in-chief), *Encyclopedia of Chemistry* (1957). (C. L. Ml.)

CALCULATING MACHINES: *see* Computer; Office Machines and Appliances: *Computing and Accounting Machines.*

CALCULUS (IN MEDICINE) is an abnormal concretion, composed ordinarily of mineral salts, occurring in any hollow organ of the body in which there is stagnation of the fluid contents together with an excess of some particular substance in solution. Calculi may also occur from the same cause in the ducts leading from glands.

The chief places where calculi (or stones) occur are the urinary system and the gall bladder.

Urinary Calculus Disease.—Urinary calculi have been known since ancient times. Descriptions have been found in ancient Sumerian literature and in the early writings of Egypt, while dissections of mummies more than 5,000 years old have revealed objects that doubtless were kidney calculi. Later, in the age of the Greeks, Hippocrates described the symptoms of kidney stones with remarkable accuracy. By A.D. 900 the Arabians had already devised an operation for the surgical removal of bladder stones, an operation similar to one sometimes still used.

In modern times, urinary calculus disease can be found in all lands, although its prevalence varies widely in the different regions. The disease is especially common in certain sections of India and China. Areas of high incidence in the western hemisphere are found in southern United States and the western coast of South America. In Europe several stone areas may be delimited, among them the Scandinavian countries and the region along the Dalmatian coast, where stones in children are particularly common. The cause for this striking variation in geographic incidence is obscure, though differences in diet and climate are frequently mentioned as possible factors.

Essentially, urinary stones are aggregates of crystals laid down layer upon layer in an organic matrix or framework. The crystalline component ordinarily comprises calcium and magnesium salts of phosphate or oxalate. More rarely the stone is composed of uric acid or the amino acid cystine. All these relatively insoluble materials are excreted in the urine. Under certain circumstances they tend to crystallize out of solution and produce stones.

However, a calculus is not simply a mere jumble of crystals, for the crystals are laid down in a highly organized pattern in conjunction with a matrix framework of noncrystalline organic material. Because the matrix provides a skeleton, stones often have a highly complex internal and external structure. The source of the matrix material is uncertain; it may be a product of irritation and inflammation of the membranes that line the urinary passages.

Urinary calculi may develop in any part of the urinary tract, but the commonest sites are the kidney and bladder. Kidney stones tend to mold themselves into the shape of the kidney cavity within which they develop. Occasionally a stone forms a complete cast of the interior of the kidney, being then called staghorn calculus, since the central body of the stone has extensions up into all the branches of the kidney cavity, somewhat resembling the branches of the horns of a stag. Smaller stones (or fragments of larger ones) tend to pass down from the kidney into the ureter, the tube that leads to the bladder. They often become lodged in the ureter and block the flow of urine, causing dilatation and swelling of the ureter above the block. A sudden complete obstruction of this type provokes extremely severe pain, called kidney colic, in the flank.

An incomplete block is very often asymptomatic, though gradual destruction of kidney substance may be in progress. Blood in the urine occurs in all instances where a stone is present, since the stone continually produces minute abrasions of the urinary membranes.

Bladder calculi are much commoner in males than in females because the female urethra, or bladder outlet, allows easy passage of incipient stones before they have time to reach significant size. The structure of the male urethra is such that a rudimentary stone, once formed, has a greater chance of remaining in the bladder, where it continues to grow until there is no possibility for spontaneous passage during urination. Partly for this reason stones in the bladder are particularly common as a complication of prostate enlargement. Bladder stones often assume enormous size, sometimes ten centimetres or more in diameter. They are usually round or ovoid, but many bizarre forms occur. A bladder stone may act like a ball valve at the outlet of the bladder, so that urination is difficult. The urinary stream becomes small in calibre and subject to frequent interruptions as the stone repeatedly falls against the bladder neck, obstructing the outlet of urine Severe spasms of pain usually accompany such episodes of obstruction.

Despite much investigation, the cause of stone disease defies complete understanding. In a few instances it is associated with a chemical disturbance of the body such as gout (which explains the occurrence of some uric acid stones) or overactivity of the parathyroid glands (explaining some calcium-type stones). In such conditions an increased amount of the stone-forming minerals appears in the urine, producing a state of excessive urinary saturation. However, the majority of stone sufferers manifest no such general metabolic disease. Many other contributing factors have been advanced as partial explanations for the formation of stones among which may be mentioned vitamin deficiency, dietary imbalance and reduced water intake.

Often the fundamental cause of stone disease seems to be i an antecedent abnormality of the structure of the urinary trac itself—abnormalities leading to imperfect drainage, stagnation an infection.

Many stones ultimately pass from the urinary tract spontaneously. Stones lodged in the ureter may sometimes be extracte by instruments introduced through the lower urinary passage while even large stones in the bladder may be crushed with speci instruments and the fragments extracted. Other stones, whereve found, may be removed surgically by open operation. So-calle stone solvents and stone-preventing medications have been ineffective, though a host of such treatments has been advocated over th centuries.

Biliary Calculi or Gallstones.—These, like urinary stones are composed of crystalline substances imbedded in a small amoun of protein material, the stone matrix. The chief crystalline components are cholesterol, bile pigments and insoluble calcium salt all substances that may be present in high concentration in th bile. Inflammation, stasis and stagnation predispose to precipit tion of these stone-forming materials, thus initiating the ston process.

The commonest site of gallstone formation is usually the ga bladder itself, though occasionally they may form in the bi ducts within the liver or in the common bile duct, which delive the bile into the intestines. A large number of stones may b present simultaneously, but more frequently a single large stor develops in the gall bladder.

The stones are hard bodies, with a smooth surface of varyin colour, white, yellow, green or even black, dependent upon th chemical composition. Gallstone formation is much common in women than in men.

Many gallstones give rise to no clinical symptoms, especial when located within the gall bladder. Sometimes they set up a inflammatory process in the gall bladder, producing acute chol cystitis with severe toxic symptoms and pain in the gall bladd region.

When a stone becomes lodged in the bile ducts, obstructi leads to increased pressures above the site of blockage, resul ing in the severe pain known as biliary colic. When the outfl of bile has been impeded for several days, jaundice superven because of the inability of the body to rid itself of the bile pi ments.

Gallstones sometimes pass into the intestines spontaneously, a he acute attack of pain is thereby relieved. More rarely, a large stone may ulcerate through the wall of the bile passages, provoking bile peritonitis, which may be fatal if untreated. In most instances, however, a blocking stone must be removed by surgical operation. Usually the gall bladder is removed at the same time in order to prevent further stone production. There is no known method for dissolving gallstones by means of oral medications.

Calculi in Other Organs.—Apart from the urinary and biliary systems, significant stone disease occasionally develops in the pancreatic, salivary and prostate glands. All these stones are composed principally of calcium phosphate. They occur within the gland ducts and may result in blockage of outflow of the normal gland secretions. Infection of the gland tissue then follows, often necessitating surgical intervention.

Stonelike bodies, called fecaliths, sometimes form in the intestinal canal. They are usually of minor importance since they are too small to produce obstruction, but an exception is the development of fecaliths in the vermiform appendix. Since the calibre of the appendix is relatively small, an appendicial fecalith may obstruct the appendix and precipitate an attack of acute appendicitis.

On X-ray examination the majority of older people are found to have rounded opaque bodies in the pelvic region. These stony objects, called phleboliths, are located in veins that have previously become obstructed for one reason or another. They are of negligible clinical significance. (C. W. V.)

CALCULUS, ABSOLUTE DIFFERENTIAL: *see* VECTOR ANALYSIS: *Calculus of Vectors; Field Theory.*

CALCULUS, BARYCENTRIC: *see* BARYCENTRIC CALCULUS.

CALCULUS, DIFFERENTIAL AND INTEGRAL. Calculus is generally defined as that branch of mathematics which is based on the concept of the limit (*q.v.*). This concept is used in other branches of mathematics. For example, it occurs in plane geometry in the calculation of the area of a circle when the area is considered to be the limit of the areas of regular inscribed polygons of $4n$ sides, as n increases without bound. In elementary algebra the concept is used when repeating decimals are introduced. The limit concept, however, plays a central role in the subject called calculus, while its use in plane geometry and elementary algebra is only incidental.

Two particular limits, the *derivative* and the *definite integral*, are the most fundamental ones in elementary calculus (to which this article is restricted). The area of study based on the former is called differential calculus while the latter forms the basis of the topic called integral calculus. These two subjects are very closely related, as will be shown subsequently.

DIFFERENTIAL CALCULUS

The Derivative.—If $f(x)$ is a real-valued function of a real variable and x_0 a real number, consider the difference quotient

$$\frac{f(x_0 + h) - f(x_0)}{h} \tag{1}$$

where h is any real number except zero. If this difference quotient approaches a number as h approaches zero, this number is called the *derivative of the function* $f(x)$ *at the point* x_0. For example, if $f(x) = x^2$ and $x_0 = 1$, the difference quotient is

$$\frac{f(1+h) - f(1)}{h} = \frac{(1+h)^2 - 1^2}{h} = \frac{2h + h^2}{h} = 2 + h$$

It is clear that as h approaches zero the difference quotient approaches the number 2. Thus, the function has derivative 2 at the point 1.

On the other hand, there exist "well-behaved" functions that fail to have a derivative at some given point. A simple example is the following: Let $f(x) = x$ if x is positive or zero and $f(x) = -x$ if x is negative (that is, $f(x) = |x|$, the absolute value of x), and choose x_0 to be 0. Then, if h is positive, the difference quotient is

$$\frac{f(0+h) - f(0)}{h} = \frac{h - 0}{h} = 1,$$

while if h is negative, the quotient is

$$\frac{f(0+h) - f(0)}{h} = \frac{-h - 0}{h} = -1$$

Thus $f(x)$ cannot have a derivative at $x_0 = 0$ because, arbitrarily close to 0, the difference quotient assumes the values 1 *and* -1, and this fact clearly excludes the possibility that this difference quotient approaches a single number as h approaches zero.

The derivative of $f(x)$ at x_0 (if it exists) is usually denoted by

$$f'(x_0) \text{ or by } \frac{df}{dx}(x_0)$$

Geometrical interpretation.—Perhaps the quickest way to obtain some insight into the concept of the derivative is to learn its geometrical interpretation. As an example, suppose that $f(x) = x^2/2$ and $x_0 = 1$, and examine the graph of this function near the point $P = [x_0, f(x_0)] = (1, \frac{1}{2})$. It is then easy to check that the difference quotient $\frac{f(x_0 + h) - f(x_0)}{h}$ is merely the ratio $\overline{QM}/\overline{PM}$ (*see* fig. 1). But, as is well known from analytic geometry, this ratio is the *slope* of the line passing through the two points P and Q; that is, it is the trigonometric tangent of the angle θ_h made by this line and the x-axis. Now, let L be the line tangent to the graph of $f(x)$ at the point P. It is intuitively clear that, as h approaches zero, the point Q moves along the graph of $f(x)$ toward the point P and the angle θ_h approaches the angle θ made by the line L and the x-axis. Consequently, the trigonometric tangent of θ_h approaches the trigonometric tangent of θ. The latter is the slope of the line L. On the other hand, by the definition of the derivative, this slope must also be the derivative of $f(x)$ at x_0.

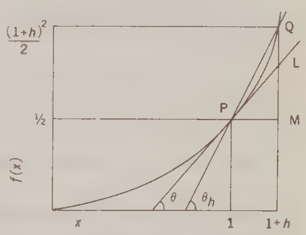


FIG. 1.—GEOMETRICAL INTERPRETATION OF DERIVATIVE CONCEPT

We see, therefore, that the derivative of $f(x)$ at x_0 is the slope of that line tangent to the graph of $f(x)$ which passes through the point $[x_0, f(x_0)]$.

This geometrical interpretation and the argument justifying it extend equally well to other functions, provided that their graphs are sufficiently smooth, *i.e.*, smooth enough to guarantee the existence of a unique tangent line passing through the point in question.

Conversely, if the graph of $f(x)$ fails to satisfy this condition at a point, then the derivative fails to exist. For example, it has already been shown that the function $f(x) = |x|$ fails to have a derivative at $x_0 = 0$. This is reflected geometrically by the fact that the graph of $f(x)$ has a "corner" at the point $[x_0, f(x_0)] = (0, 0)$ (*see* fig. 2).

Instantaneous Velocity.—An important physical interpretation of the derivative arises from the concept of instantaneous velocity. In fact, to arrive at a precise definition of the velocity of a moving particle at a given time, t, leads to exactly the same limiting process that occurred in the definition of the derivative, as will now be shown.

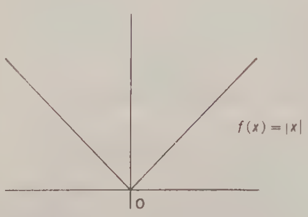


FIG. 2.—GRAPH OF F(X) = |X| SHOWING THAT F(X) HAS NO DERIVATIVE AT $X_0 = 0$

Suppose, for simplicity, that a particle is moving along a straight line and in a fixed direction. Its position as a function of time can then be represented in the following way. Choose a point on the line of motion of the particle. Then the particle's position at time t is completely determined by the distance, $f(t)$, between the particle and the chosen point, and no other dimension is needed to locate the particle.

Using this notation, the average velocity of the particle during an interval of time of length h, beginning at time t_0, is defined to be the ratio

$$\frac{f(t_0+h)-f(t_0)}{h} \qquad (2)$$

that is, the distance traveled during this interval of time divided by the length of this interval of time.

On the other hand, a little reflection will show that, whatever meaning is attached to the concept of the instantaneous velocity of the particle at time t_0, it should, first of all, be a number, and, second, the average velocities of the particle during small intervals of time starting at time t_0 should approximate this number. Comparison of the ratio (2) with the difference quotient (1) shows that these considerations make it obligatory to define this instantaneous velocity to be the derivative $f'(t_0)$.

An important example of this situation is given by a freely falling body. It is an experimentally established law that if a body is allowed to fall from rest it will traverse, in time t, a distance that is proportional to t^2 (provided the air does not offer resistance). This law can also be expressed by asserting that the distance traveled by the body is a function of time having the form $f(t) = ct^2$ (where the constant c depends on the units used in measuring distance and time). Thus the average velocity of the body during an interval of time of length h, beginning at time t_0, is

$$\frac{f(t_0+h)-f(t_0)}{h} = \frac{c(t_0+h)^2-ct_0^2}{h} = \frac{2ct_0h+ch^2}{h} = c(2t_0+h)$$

It is clear that the limiting value of this ratio, as h approaches zero, is $2ct_0$. Thus, it has been shown that the instantaneous velocity of the freely falling body at time t_0 is $2ct_0$, and also that $f'(t_0) = 2ct_0$.

Maxima and Minima.—It is now possible to discuss one of the more important applications of elementary differential calculus: the location of the maxima and minima of a function. Given a function $f(x)$, a real number $\bar{x}$ is said to be a relative maximum of the function if $f(\bar{x})$ is at least as large as all the values $f(x)$, where x ranges throughout an interval about $\bar{x}$. If, on the other hand, $f(\bar{x})$ does not exceed the values $f(x)$ when x ranges throughout an interval about $\bar{x}$, the number $\bar{x}$ is called a relative minimum of the function. In fig. 3 x_1 and x_3 represent minima while x_2 and x_4 represent maxima.

Suppose, now, that $f(x)$ has a derivative $f'(x)$ for all values of x satisfying $a < x < b$. Then, it is intuitively clear that when the tangent to the graph of $f(x)$ passes through a point $[\bar{x}, f(\bar{x})]$ corresponding to either a maximum or a minimum, and $\bar{x}$ is interior to the interval (a, b), this tangent must be horizontal; that is, the slope of the tangent must be zero (*see* fig. 3). The rigorous proof of this fact is not difficult. For, assuming x_0 is a maximum, it is seen that if h is positive and sufficiently small, the difference quotient (1) cannot be positive [because $f(x_0) \geqq f(x_0+h)$ if $x_0 + h$ is near enough to x_0]; similarly, for h negative, but of small absolute value, the difference quotient (1) cannot be negative (because in this case neither the numerator nor the denominator are positive). Thus, the number $f'(x_0)$ must be arbitrarily close to numbers that cannot be negative and to numbers that cannot be positive. The only number having this property, however, is zero. Thus, $f'(x_0) = 0$. Obvious changes in this argument will show that the result is equally valid for the case where x_0 is a minimum.

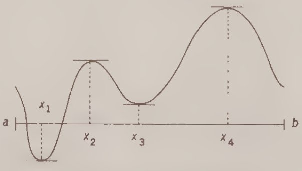


FIG. 3.—MAXIMA AND MINIMA OF A FUNCTION

It has just been shown that, if x is either a maximum or a minimum of $f(x)$, then $f'(x) = 0$. Simple examples show that the converse of this statement is not always true. The value of the positive result just obtained, however, lies in the fact that if it is desired to locate a maximum or a minimum it is only necessary to look at those numbers x for which $f'(x) = 0$. In general, this greatly simplifies the task.

Consider a simple, but illuminating, example. Suppose tha 100 ft. of fence is available in order to enclose a rectangular pasture. What dimensions should the pasture have in order to contain the maximum possible area? If x denotes one length of th rectangle, then $50 - x$ must be the other length. Thus, the are of the pasture is $(50 - x)x = 50x - x^2$. The problem, then, reduces to finding the largest value (hence, a maximum) of th function $f(x) = 50x - x^2$, $0 \leqq x \leqq 50$. Now

$$\frac{f(x+h)-f(x)}{h} = \frac{50h-2xh-h^2}{h} = 50-2x-h$$

therefore $f'(x) = 50 - 2x$. Thus, a maximum must satisfy th equation $f'(x) = 50 - 2x = 0$; therefore, $x = 25$. Hence, assuming the intuitively obvious fact that a maximal area is attained, the area is largest when $x = 25$; that is, when the rectan gle is a square of side 25 ft.

Differentiation Formulas; Computation of Derivatives—It has already been shown that if $f(x) = x^2$ then $f'(x) = 2$ This is just a special case of one of several formulas for differen tiation that are obtained in elementary calculus. That is, i follows readily from the definition of the derivative that if $n = 1$ 2, 3, . . . is any positive integer and $f(x) = x^n$, then $f'(x) = nx^{n-1}$ or, written more compactly,

$$(x^n)' = nx^{n-1} \qquad (3$$

In fact, by means of an appropriate limiting process, it can b shown that, for each real number n, the expression x^n, for pos tive x, has a natural definition as a real number (for example $n = \frac{1}{2}$ gives the familiar square root function: $x^{\frac{1}{2}} = \sqrt{x}$). For mula (3) extends to include *all* functions of the form $f(x) = x$

Many other well-known functions have simple expressions f their derivatives. For example, the trigonometric functions hav derivatives that are expressible in terms of other trigonometr functions. The most basic of these formulas are

$$(\sin x)' = \cos x \qquad ($$

$$(\cos x)' = -\sin x \qquad ($$

$$(\tan x)' = \sec^2 x \qquad ($$

$$(\cot x)' = -\csc^2 x \qquad ($$

In addition to such specific formulas, several general rules f differentiation are easily derived from the definition of the deriv tive. The four most basic of these rules will now be stated.

Suppose that $f(x)$ and $g(x)$ are two functions and a and b tw constants. Then, whenever $f'(x)$ and $g'(x)$ exist,

$$[af(x)+bg(x)]' = af'(x)+bg'(x) \qquad ($$

$$[f(x)g(x)]' = f(x)g'(x)+f'(x)g(x) \text{ (Leibniz's rule)} \qquad ($$

$$\left[\frac{f(x)}{g(x)}\right]' = \frac{f'(x)g(x)-f(x)g'(x)}{[g(x)]^2} \qquad (1$$

provided $g(x) \neq 0$.

The fourth basic rule, the *chain rule*, may be stated in the f lowing way. Suppose that, for each real number x for which $g($ is defined, the number $g(x)$ is such that $f[g(x)]$ is defined. T composite function $h(x) = f[g(x)]$ can then be formed. T chain rule asserts that, if both $g'(x)$ and $f'[g(x)]$ exist, then $h'($ exists and satisfies the equation

$$h'(x) = f'[g(x)] \cdot g'(x) \qquad (1$$

These four rules, together with formulas (3) through (7), pe mit the computation of the derivatives of a large class of fun tions. For example, the reader can check that (3) and (8) can used to obtain the derivative of the most general polynomi $p(x) = a_0 + a_1x + \cdots + a_kx^k$. In fact, $p'(x) = a_1 + 2a_2x$ $\cdots + ka_kx^{k-1}$.

If, in addition, rule (10) is used, a formula for the derivati f the most general rational function (*i.e.*, the quotient of two olynomials) can be obtained.

Use of all four of the above rules reveals that functions having airly complicated expressions have explicit formulas for their lerivatives. The reader can check, for example, that if

$$(x) = \frac{\sin(x^2 + 3x + 2)}{1 + x}, \text{ then}$$

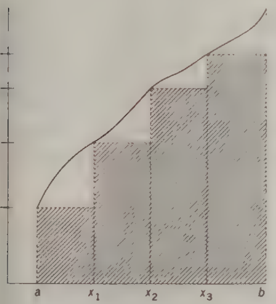
$$f'(x) = \frac{(1 + x)(2x + 3)\cos(x^2 + 3x + 2) - \sin(x^2 + 3x + 2)}{(1 + x)^2}$$

t was the development of formulas and rules such as (4) through 11), enabling mathematicians to calculate derivatives in this nanner, that motivated the use of the name *calculus* for this nathematical discipline.

INTEGRAL CALCULUS

The Definite Integral.—It was mentioned at the beginning of his article that another limit, the integral, plays a key role in he area of study called integral calculus. As in the case of the erivative, one of the best ways to begin the study of this concept ; to consider its geometrical aspect.

Let a and b be two real numbers and suppose that there is a unction $f(x)$ defined for all x satisfying $a \leqq x \leqq b$. For the sake of simplicity suppose, for the moment, that the values $f(x)$ are never negative. The basic problem of integral calculus can then be stated in the following way: What is the meaning (and numerical value) of the area of the region below the graph of $f(x)$ and above the interval (a, b) on the x-axis?



IG. 4.—REPRESENTATION OF AREA NDER CURVE AS EXPRESSED BY IN-QUALITY 12 (*See* TEXT)

Assume that it is known what is meant by "area" in case the region is a rectangle. Assume also that, if a region can be subdivided into a finite number of nonoverlapping rectangles, then its area is the sum of the reas of these rectangles. Having made these assumptions it is ot hard to give an answer to the above question.

First, subdivide the interval (a, b) into n subintervals by choosng consecutive points $a = x_0, x_1, x_2, \ldots, x_n = b$. In each of the ubintervals $I_i = (x_{i-1}, x_i)$ choose a point ζ_i $(i = 1, 2, \ldots, n)$ such hat the value $f(\zeta_i)$ is smallest among the values assumed by the unction in I_i (if such a point ζ_i exists). Then, the rectangle with ase I_i and height $f(\zeta_i)$ (*see* fig. 4, where $n = 4$ and $\zeta_i = x_{i-1}$) es below the graph of $f(x)$. Thus, it is reasonable to assert that he area in question should be a number exceeding the sum of the reas of the rectangles that have been constructed (that is, the rea of the shaded region in fig. 4). In other words, the inequality

$$A \geqq f(\zeta_1)(x_1 - x_0) + f(\zeta_2)(x_2 - x_1) + \ldots + f(\zeta_n)(x_n - x_{n-1}), \quad (12)$$

here A denotes the area below the graph of $f(x)$ and above the nterval (a, b), should be satisfied.

Next, make a similar construction, except that, instead of hoosing the point ζ_i in the subinterval I_i, choose a point μ_i (if exists) such that the value $f(\mu_i)$ is the largest among the values ssumed by the function in I_i (*see* fig. 5, where $\mu_i = x_i$ and again $= 4$). Then, clearly, there should be, in analogy to inequality 12), the inequality

$$A \leqq f(\mu_1)(x_1 - x_0) + f(\mu_2)(x_2 - x_1) + \ldots + f(\mu_n)(x_n - x_{n-1}) \quad (13)$$

the sum on the right being the area of the shaded region in fig. 5).

A sum of the type occurring in inequality (12), in which the mallest value of $f(x)$ in each subinterval I_i is used, is called a ower sum (with respect to the given subdivision); while a sum f the type occurring in inequality (13) is called an upper sum. hus, with this terminology, it can be stated that the area in uestion should be a number, A, less than or equal to any upper sum and greater than or equal to any lower sum. If the notion of area as used here is to have an unique meaning, however, there should exist only one number with this property. Thus, the following definition is forced upon us:

> Suppose that $f(x)$, defined for x satisfying the condition $a \leqq x \leqq b$, has the property that there exists exactly one number less than or equal to any upper sum and greater than or equal to any lower sum. Then this number is the area of the region below the graph of $f(x)$ and above the interval (a,b).

First of all, note that the restriction $f(x) \geqq 0$, which was made only in order to obtain a better grasp of the geometrical aspects of the construction, can be dropped without having to make any change in the above definition. Note, however, that this implies that regions below the x-axis and above the graph of a negative-valued function will have negative areas.

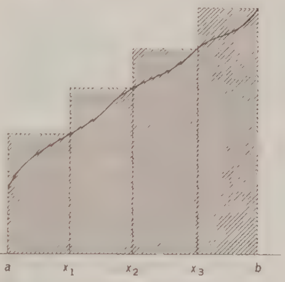


FIG. 5.—REPRESENTATION OF AREA UNDER CURVE AS EXPRESSED BY INEQUALITY 13 (*See* TEXT)

The area that has just been defined is usually called the *Riemann integral* (or the *definite integral*, for reasons that will be shown) of the function $f(x)$ over the interval (a, b). It is denoted symbolically by $\int_a^b f(x)dx$.

Integrable and Nonintegrable Functions.—It is natural, at this point, to attempt to determine what classes of functions have a Riemann integral. It is not hard to show that if $f(x)$ is *continuous* (roughly speaking, this means that whenever x_1 and x_2 are "close" then $f(x_1)$ and $f(x_2)$ are "close"), then it has an integral or, more briefly, is (Riemann) integrable. In fact, this restriction is not only sufficient but comes close to being a necessary condition for this type of integrability.

Two simple examples of functions that are not integrable are the following:

1. Suppose $a = 0$, $b = 1$. Let $f(x) = \frac{1}{x}$ for $0 < x \leqq 1$, and put $f(0) = 0$. Then, it can be seen that the upper sums of this function are not defined (for, in the first interval, I_1, of *any* subdivision, there is no number μ_1 such that the value $f(\mu_1)$ is the largest among the values assumed by the function in I_1).

2. Again, let $a = 0$, $b = 1$, and suppose $f(x) = 0$ if x is rational, while $f(x) = 1$ if x is irrational. Then, it is easy to check that each upper sum is 1, while each lower sum is 0. Thus, in this case there does not exist a *unique* number less than or equal to any upper sum but greater than or equal to any lower sum.

It is important to realize that the above definition of integrability is equivalent to the following one, which does not involve the concept of upper or lower sum. Subdivide the interval (a, b) as before and, again, form a sum of the type

$$f(\zeta_1)(x_1 - x_0) + f(\zeta_2)(x_2 - x_1) + \ldots + f(\zeta_n)(x_n - x_{n-1}) \quad (14)$$

except that the only restriction on ζ_i $(i = 1, 2, \cdots, n)$, is that it must belong to the interval I_i. If, as the subdivision is made finer (*i.e.*, when the length of each subinterval approaches zero), the sum (14) tends to a limit, then the function is integrable. This limit is $\int_a^b f(x)dx$. (*See* INTEGRATION AND MEASURE.)

FUNDAMENTAL THEOREM OF CALCULUS

The connection between the two basic concepts, the derivative and the integral, is perhaps the most important feature of calculus. This connection can be summarized roughly by saying that integration and differentiation are inverse operations; that is, if first one of these operations and then the other is applied to a function, the original function is obtained (this is analogous to the operation of addition, and then subtraction, with a given number).

In order to describe this situation more precisely, the concept of the *indefinite integral* must be introduced. Suppose that $f(x)$ is continuous (hence, integrable) in some interval I, and let a and y be two points of this interval. If the number a is fixed, then a function of y, $F(y)$, can be formed by letting

$$F(y) = \int_a^y f(x)\,dx$$

(if $y < a$, $F(y)$ is equal to $-\int_y^a f(x)\,dx$). The function $F(y)$ is called an indefinite integral of the function $f(x)$.

The connection between differentiation and integration can then be stated in the following way:

> The function $F(y)$ (*as defined above*) is differentiable and $F'(y) = f(y)$; furthermore, if $G(y)$ is any other differentiable function satisfying $G'(y) = f(y)$ for all y in I, the difference $F(y) - G(y)$ is constant.

This statement is known as the *fundamental theorem of calculus*.

A function such as $G(y)$, satisfying $G'(y) = f(y)$, is called an *antiderivative* of $f(y)$. Clearly, if a constant function is added to an antiderivative of $f(y)$, another antiderivative is obtained (because it is obvious that the derivative of a constant function is zero). The fundamental theorem of calculus can then be paraphrased by saying that the most general antiderivative of $f(y)$ can be obtained by adding a constant function to an indefinite integral of $f(y)$.

One of the immediate, and most important, consequences of the fundamental theorem of calculus is that the integrals of a large class of functions can be obtained merely by inverting the already developed formulas for differentiation. For example, in formula (4), sin x is an antiderivative of cos x. Thus, $F(y) = \int_0^y \cos x\,dx$ must differ from $\sin y$ by a constant; that is, $F(y) = \sin y + C$. The constant C is easily determined because it follows readily from the definition of the integral that $F(0) = 0$. Hence, $0 = F(0) = \sin 0 + C = C$. Therefore, it has been shown that

$$\sin y = \int_0^y \cos x\,dx \tag{15}$$

for all y.

The power of the fundamental theorem can be appreciated once it is realized that explicit formulas for integration, such as (15), are by no means easy to obtain by working directly from the definition of the integral. However, it should be noted that, unlike the case of differentiation, there are many functions that can be expressed by simple formulas but have no simple expression for their antiderivatives.

HISTORICAL DEVELOPMENT

The methods used by the Greeks for determining the area of a circle and the volumes of the cylinder, cone and sphere were similar to the modern methods of integration. It was not until the 17th century, however, that calculus began to develop. A number of special cases of integration were discovered by J. Kepler, B. Cavalieri, C. Huygens, G. Roberval, R. Descartes, P. De Fermat and others. A systematic account of the methods then in use was given, along with much that was original on his part, by B. Pascal in his *Lettres de Amos Dettonville sur quelques-unes de ses inventions en géométrie* (1659). The problem of finding the tangent lines to given curves was also solved in several special cases; however, mathematicians of the first half of the 17th century were not as proficient in finding derivatives as they were in performing integrations.

The reciprocal relation between differentiation and integration was first explicitly stated in I. Barrow's book *Lectiones opticae et geometricae* (1663–64), although this relation was noticed only in certain special cases and was not applied to obtain formulas for areas. The power and generality of this relation were discovered independently by Sir Isaac Newton (who was Barrow's pupil) and by G. Leibniz. The definite abandonment of the old tentative methods of integration in favour of the method in which this operation is regarded as the inverse of differentiation was primarily due to Newton. Both the precise formulation of simple rules for the process of differentiation in each special case and the introduction of the notation which was ultimately adopted were primarily the work of Leibniz (the notations $\frac{d}{dx}$ and $\int_a^b \ldots dx$ originated with him).

The 18th century saw a great development of the subject. L. Euler in 1734 and A. C. Clairaut in 1739 introduced the notion of partial differentiation of functions of more than one variable; this led to the extension of many of the ideas of calculus to such functions. The beginning of the theory of differential equations can also be traced to the same century.

The rigorous foundations of calculus, however, were not well understood by the mathematicians of the 17th and 18th centuries. Consequently, serious attacks were leveled against mathematicians of this period. Perhaps the most famous is the criticism by Bishop Berkeley contained in a tract entitled *The Analyst; or a Discourse Addressed to an Infidel Mathematician* (1734).

It was not until 1823, when A. L. Cauchy published his treatise *Résumé des leçons sur le calcul infinitesimal*, that we encounter the first presentation of the subject that meets modern standards of rigour. In addition to this establishment of the logica foundations of calculus and the introduction of the modern concept of function, the 19th century saw the development of most of the various topics constituting that branch of mathematics called analysis, of which calculus is the elementary foundation The theory of functions of a complex variable, trigonometri series and real variables are just a few of the topics that had thei beginning in that century.

This development carried into the 20th century with H. L. Lebesgue's discovery of a very natural and useful extension of the integral described in this article. This new method of integration gave rise to several new applications of analysis in other branches of mathematics and was instrumental in the initiation of severa new abstract topics in modern mathematics.

BIBLIOGRAPHY.—An excellent introduction to the subject can be found in R. Courant and H. Robbins, *What is Mathematics?* (1941). A comprehensive text is R. Courant's *Differential and Integral Calculus*, vol. i and ii (1936). A very readable account of the history of calculus can be found in O. Toeplitz's *The Development of the Infinitesima Calculus* (1936). (Gu. W.)

CALCULUS OF DIFFERENCES. Let $f(x)$ be a given function of the variable x. The differential calculus is concerned with the properties of

$$f'(x) = \frac{df(x)}{dx} = \lim_{\omega\to 0} \frac{f(x+\omega) - f(x)}{\omega}$$

which is a function of the single variable x (*see* CALCULUS, DIFFERENTIAL AND INTEGRAL). The calculus of differences, or finit calculus, on the other hand, is concerned with the properties of

$$\underset{\omega}{\Delta} f(x) = \frac{f(x+\omega) - f(x)}{\omega} = \frac{\Delta f(x)}{\omega}$$

which is a function of the two variables x and ω.

More generally, the finite calculus is concerned with the values of a function at a set of isolated points and with such propertie as may be derivable therefrom.

Suppose that the numbers $f(x_1), f(x_2), f(x_3), \cdots$, and an argument x different from $x_1, x_2, x_3, \cdots$, are given. Among the subjects of inquiry which present themselves are the following:

1. The determination of $f(x)$ from the given functional values This is the interpolation problem (*see* INTERPOLATION AND EXTRAPOLATION).
2. The determination of

$$f'(x) \text{ and } \int_a^b f(x)dx$$

These are the problems of numerical differentiation and int gration.

3. The determination of the properties of the functions $f($ defined by the equation

$$\frac{f(x+\omega) - f(x)}{\omega} = g(x)$$

where $g(x)$ is a given function. This constitutes the summati problem, which is analogous to the problem of integration in t integral calculus.

4. Consideration of more general relations between $f($ $f(x+\omega), \cdots, f(x+n\omega)$ leads to the study of differen equations analogous to the differential equations of the infinite mal calculus.

These several points will now be exemplified by means of sor simple illustrations.

Divided Differences.—Consider a function $f(x)$ of the variable whose values are given for $n + 1$ different *arguments* (or values f the variable) $x_0, x_1, x_2, \cdots, x_n$. The *divided difference* of $f(x)$ for he arguments x_0, x_1 is written $[x_0x_1]$ and is defined by

$$[x_0x_1] = \{f(x_0) - f(x_1)\}/(x_0 - x_1) =$$
$$\{f(x_1) - f(x_0)\}/(x_1 - x_0) = [x_1x_0] \qquad (1)$$

o that the divided difference $[x_0x_1]$ is symmetric in the argu-nents; that is, its value does not change with interchange of the rguments. In the same way $[x_1x_2] = \{f(x_1) - f(x_2)\}/(x_1 - x_2)$ defined, and so on for any pair of arguments.

Similarly, the divided differences of three, four and five argu-ents are defined by

$$[x_0x_1x_2] = \{[x_0x_1] - [x_1x_2]\}/(x_0 - x_2) \qquad (2)$$
$$[x_0x_1x_2x_3] = \{[x_0x_1x_2] - [x_1x_2x_3]\}/(x_0 - x_3) \qquad (3)$$
$$[x_0x_1x_2x_3x_4] = \{[x_0x_1x_2x_3] - [x_1x_2x_3x_4]\}/(x_0 - x_4) \qquad (4)$$

he process can be continued to define divided differences of any ositive integral order.

Table I shows the divided differences of $f(x) = x^3$ for certain rguments. The table illustrates that the third order divided ifferences of x^3 are constant and that the fourth order divided ifferences are zero. More generally, for any positive integral ower x^n the divided differences of order n are constant and those order $n + 1$ are zero. The same result must therefore hold for polynomial of degree n, *e.g.*, $3x^5 - 7x^2 + 2$.

TABLE I.—*Divided Differences of* $f(x) = x^3$

rgument	x	x^3	first order	second order	third order	fourth order
x_0	0	0				
			1			
x_1	1	1		4		
			13		1	
x_2	3	27		11		0
			79		1	
x_3	7	343		15		
			109			
x_4	5	125				

If in (1), (2), (3) and (4) x is substituted for x_0 and then, start-g with (4), $[xx_1x_2x_3]$, $[xx_1x_2]$ and $[xx_1]$ are successively elimi-ated, the following identity results:

$$f(x) = f(x_1) + (x - x_1)[x_1x_2] + (x - x_1)(x - x_2)[x_1x_2x_3] +$$
$$(x - x_1)(x - x_2)(x - x_3)[x_1x_2x_3x_4] + R_4(x) \qquad (5)$$

here $R_4(x) = (x - x_1)(x - x_2)(x - x_3)(x - x_4)[xx_1x_2x_3x_4]$. (6)

his is Sir Isaac Newton's *interpolation formula with divided dif-rences*, with the remainder term $R_4(x)$ in the case of four guments.

Because $R_4(x)$ vanishes when $x = x_1, x_2, x_3$, omission of the mainder term from (5) gives the *interpolation polynomial* of gree 3,

$$f(x_1) + (x - x_1)[x_1x_2] + (x - x_1)(x - x_2)[x_1x_2x_3] +$$
$$(x - x_1)(x - x_2)(x - x_3)[x_1x_2x_3x_4] \qquad (7)$$

hose value, as is easily verified, coincides with the value of $f(x)$ hen $x = x_1, x_2, x_3$.

In the case of the function $f(x) = x^3$, because $[xx_1x_2x_3x_4] = 0$, e remainder term vanishes and

$$^3 = 1 + (x - 1)\ 13 + (x - 1)(x - 3)\ 11 + (x - 1)(x - 3)(x - 7)$$

Thus, for example,

$$4^3 = 1 + 3 \times 13 + 3 \times 11 - 9 = 64$$

Similarly, for n arguments $x_1, x_2, \cdots, x_n$ it is found that

$$) = f(x_1) + \sum_{s=1}^{n-1} (x - x_1)(x - x_2)\cdots(x - x_s)[x_1x_2\cdots x_{s+1}] + R_n(x) \qquad (8)$$

$$R_n(x) = (x - x_1)(x - x_2)\cdots(x - x_n)[xx_1x_2\cdots x_n] \qquad (9)$$

y means of this general interpolation formula the evaluation of the function $f(x)$ whose value is known for the arguments $x_1, x_2, \cdots, x_n$ is reduced to the problem of evaluating the remainder term $R_n(x)$. Should this term be known or negligible, the value of $f(x)$ can be calculated from (8).

Starting from (1), it is easy to show by induction that

$$[x_0x_1\cdots x_n] = \frac{f(x_0)}{(x_0 - x_1)(x_0 - x_2)\cdots(x_0 - x_n)} + \frac{f(x_1)}{(x_1 - x_0)(x_1 - x_2)\cdots(x_1 - x_n)} + \cdots + \frac{f(x_n)}{(x_n - x_0)(x_n - x_1)\cdots(x_n - x_{n-1})} \qquad (10)$$

which proves that divided differences are symmetric functions of their arguments, *i.e.*, the value does not depend on the order, just as in (1) it was proved that $[x_0x_1] = [x_1x_0]$.

If in (10) x is substituted for x_0, it can be inferred that

$$f(x) = \sum_{s=1}^{n} \frac{f(x_s)}{x - x_s}\,\frac{\phi(x)}{\phi'(x_s)} + R_n(x) \qquad (11)$$
$$\text{where } \phi(x) = (x - x_1)(x - x_2)\cdots(x - x_n)$$

and where $R_n(x)$ is still given by (9). This is *Lagrange's interpolation formula*, which has the same remainder term as Newton's formula (8) and therefore has the same range of application and yields the same results. The distinction is that Newton's formula is used with a divided-difference table such as Table I, whereas Lagrange's formula employs the tabulated values directly.

Difference Operators.— It is usual to tabulate numerical values of a function, *e.g.*, sin x, log x, e^x, for arguments such as a, $a + \omega$, $a + 2\omega$, $a + 3\omega, \cdots$, in arithmetical progression. Here it is useful to introduce the difference operator Δ defined by

$$\Delta f(x) = f(x + \omega) - f(x) \qquad (12)$$

The operation can be repeated as often as desired to form second, third, fourth, $\cdots$, order differences:

$$\Delta^2 f(x) = \Delta\{\Delta f(x)\},\ \Delta^3 f(x) = \Delta\{\Delta^2 f(x)\} \qquad (13)$$

The successive differences of a tabulated function are easily formed from the definition (12) by simple subtraction. For example, *see* Table II, where again the fact is illustrated, that, like divided differences, the nth order differences of a positive integral power (and, thus, also those of a polynomial) of degree n are constant.

TABLE II.—*Successive Differences of* $f(x) = x^3$

x	x^3	Δ	Δ^2	Δ^3	Δ^4
0	0				
		1			
1	1		6		
		7		6	
2	8		12		0
		19		6	
3	27		18		
		37			
4	64				

Along with the operator Δ it is useful to consider the incremental or shift operator E defined by

$$E^\omega f(x) = f(x + \omega) = f(x) + \Delta f(x) \qquad (14)$$

Thus there is the symbolical equivalence of operators

$$E^\omega = 1 + \Delta \qquad (15)$$

leading to Gregory's theorem

$$f(x + n\omega) = E^{n\omega} f(x) = (1 + \Delta)^n f(x)$$
$$= f(x) + \binom{n}{1}\Delta f(x) + \binom{n}{2}\Delta^2 f(x) + \ldots + \binom{n}{n}\Delta^n f(x) \qquad (16)$$

which expresses $f(x + n\omega)$ in terms of differences of $f(x)$ and the binomial coefficients $\binom{n}{r}$.

Similarly,

$$\Delta^n f(x) = (E^\omega - 1)^n f(x) = f(x + n\omega) - \binom{n}{1} f(x + \overline{n - 1}\omega)$$
$$+ \binom{n}{2} f(x + n - 2\omega) + \ldots (-1)^n \binom{n}{n} f(x) \qquad (17)$$

If in (10) $x_0 + s\omega$ ($s = 1, 2, \cdots, n$) is substituted for x_s, formula (17) shows at once that

$$[x_0x_1 \ldots x_n] = \frac{1}{n!\,\omega}\Delta^n f(x_0) \qquad (18)$$

when the arguments $x_0, x_1, \cdots, x_n$ are in arithmetical progression.

Gregory's theorem can be applied to find the sum of a series, as can be seen by considering the differences shown in Table III.

TABLE III.—*Successive Differences*

Term	1st diff.	2nd diff.	3rd diff.
u_0			
	Δu_0		
u_1		$\Delta^2 u_0$	
	Δu_1		$\Delta^3 u_0$
u_2		$\Delta^2 u_1$	$\vdots$
	Δu_2	$\vdots$	$\Delta^3 u_{n-3}$
$\vdots$	$\vdots$	$\Delta^2 u_{n-2}$	
	Δu_{n-1}		
u_n			

Definition (12) gives

$$\Delta u_0 + \Delta u_1 + \ldots + \Delta u_{n-1} = (u_1 - u_0) + (u_2 - u_1) + \ldots + (u_n - u_{n-1})$$
$$= u_n - u_0 = \binom{n}{1}\Delta u_0 + \binom{n}{2}\Delta^2 u_0 + \ldots$$

from Gregory's theorem, and therefore a simple change of notation in which u_0 replaces Δu_0, and so on, gives

$$u_0 + u_1 + \ldots + u_{n-1} = \binom{n}{1}u_0 + \binom{n}{2}\Delta u_0 + \binom{n}{3}\Delta^2 u_0 + \ldots \qquad (19)$$

Thus, for example, use of Table II gives for the sum of the cubes of the first n integers

$$1^3 + 2^3 + 3^3 + \ldots + n^3 = \binom{n}{1} + 7\binom{n}{2} + 12\binom{n}{3} + 6\binom{n}{4} = [\tfrac{1}{2}n(n+1)]^2$$

which is the square of the sum of these integers.

Newton's Interpolation Formula.—In Newton's general interpolation formula with divided differences, (8), write

$$x_s = a + s\omega, \ (s = 1, 2, \ldots, n)$$

This gives Newton's interpolation formula

$$f(x) = f(a) + \frac{x-a}{\omega}\,\Delta f(a) + \frac{(x-a)(x-a-\omega)}{\omega^2 2!}\Delta^2 f(a) + \ldots$$
$$+ \frac{(x-a)(x-a-\omega)\ldots(x-a-\overline{n-2}\omega)}{\omega^{n-1}(n-1)!} + R_n(x) \qquad (20)$$

where it can be shown that for a differentiable function,

$$R_n(x) = \frac{(x-a)(x-a-\omega)\ldots(x-a-\overline{n-1}\omega)}{n!}f^{(n)}(\xi) \qquad (21)$$

where ξ lies somewhere in the interval bounded by the greatest and least values of x, a, $a + \overline{n-1}\omega$.

As a simple example, write $a = 1$, $x = 1.5$, $\omega = 1$. Then, using the values of Δ, Δ^2 and Δ^3 from Table II,

$$(1.5)^3 = 1 + .5 \times 7 + \frac{(.5)(-.5)}{2} \times 12 + \frac{(.5)(-.5)(-1.5)}{6} \times 6 = 3.375$$

for here, because the fourth difference vanishes, so does the remainder term.

From Newton's interpolation formula (8) a variety of special formulas can be obtained by similar steps, the best known being associated with the names of Gauss, Bessel and Stirling.

Reciprocal Differences.—Interpolation by means of divided differences is equivalent in the end to approximating the function to be interpolated by a polynomial. This works when, in the range of interpolation, the effect of the differences of some order becomes negligible. It would not work for a function like $1/x$ in a range which includes $x = 0$, where the function has a pole. Interpolation in the neighbourhood of a pole can be effectively performed by using, instead of a polynomial, a rational function, *i.e.*, a function of the form $P(x)/Q(x)$, where $P(x)$ and $Q(x)$ are polynomials.

To construct such a function *reciprocal differences*, defined a follows, are used. Let the values of the function $f(x)$ be given fo arguments $x_0, x_1, \cdots, x_n$. Then reciprocal differences ρ_1, ρ_2, ρ_3 o the first, second and third orders are defined by

$$\rho_1(x_0x_1) = \frac{x_0 - x_1}{f(x_0) - f(x_1)} = \frac{x_1 - x_0}{f(x_1) - f(x_0)} = \rho_1(x_1x_0) \qquad \text{(2}$$

$$\rho_2(x_0x_1x_2) = \frac{x_0 - x_2}{\rho_1(x_0x_1) - \rho_1(x_1x_2)} + f(x_1) \qquad \text{(2}$$

$$\rho_3(x_0x_1x_2x_3) = \frac{x_0 - x_3}{\rho_2(x_0x_1x_2) - \rho_2(x_1x_2x_3)} + \rho_1(x_1x_2) \qquad \text{(2}$$

and generally for the nth order,

$$\rho_n(x_0x_1 \ldots x_n) = \frac{x_0 - x_n}{\rho_{n-1}(x_0x_1 \ldots x_{n-1}) - \rho_{n-1}(x_1x_2 \ldots x_n)}$$
$$+ \rho_{n-2}(x_1 \ldots x_{n-1}) \qquad \text{(2}$$

It should be pointed out that the operation denoted by ρ_2 is n a simple repetition of that denoted by ρ_1. The operator does n obey the index law and is not distributive.

It can be proved that reciprocal differences of any order a symmetric functions of their arguments, as in (22), where it shown that $\rho_1(x_0x_1) = \rho_1(x_1x_0)$.

Reciprocal differences of the function $(1 + x^2)/(1 + x)$ a shown in Table IV. The table illustrates that the reciproc differences of some order (in this case the third) of a ration function are constant.

TABLE IV.—*Reciprocal Differences of $f(x) = (1 + x^2)/(1 + x)$*

x	$(1+x^2)/(1+x)$	ρ_1	ρ_2	ρ_3
0	1			
		∞		
1	1		1	
		3/2		1
2	5/3		—5	
		6/5		1
3	5/2		—20	
		10/9		
4	17/15			

In (22), (23) and (24) write x for x_0 and successively elimina $\rho_1(xx_1)$, $\rho_2(xx_1x_2)$. This gives the continued fraction

$$f(x) = f(x_1) + \frac{x - x_1}{\rho_1(x_1x_2) +}\ \frac{x - x_2}{\rho_2(x_1x_2x_3) - f(x_1) +}\ \frac{x - x_3}{\rho_3(xx_1x_2x_3) - \rho_1(x_1x_2)}$$

Thus in the case of $(1 + x^2)/(1 + x)$, the data from Table IV gi

$$\frac{1 + x^2}{1 + x} = 1 + \cfrac{x - 1}{\cfrac{3}{2} + \cfrac{x - 2}{-6 + \cfrac{x - 3}{-\frac{1}{2}}}}$$

The above continued fraction method can be generalized include reciprocal differences of any order. If the continu fraction is stopped at the nth order, the result is

$$f(x) = \frac{p_n(x)}{q_n(x)} + R_n(x)$$

where $p_n(x)$ and $q_n(x)$ are polynomials and $R_n(x)$ is the remainc term whose somewhat complicated structure can be expressed involve an nth derivative. When the remainder term is negli ble, a rational function approximation to $f(x)$ results from computation.

Numerical Differentiation.—Here again a symbolic opera method will be used. If D denotes the differentiation opera d/dx, Taylor's theorem gives

$$f(x + \omega) = f(x) + \omega Df(x) + \frac{\omega^2}{2!}D^2 f(x) + \ldots = e^{\omega D}f(x)$$

But $f(x + \omega) = E^\omega f(x) = (1 + \Delta)f(x)$ from (15). This gives operational equivalence $e^{\omega D} = 1 + \Delta$. Taking logarithms ase *e*) gives

$$\omega D = \ln(1+\Delta) = \Delta - \frac{1}{2}\Delta^2 + \frac{1}{3}\Delta^3 - \ldots$$

sing the logarithmic series expansion. Therefore

$$\omega f'(x) = \Delta f(x) - \frac{1}{2}\Delta^2 f(x) + \frac{1}{3}\Delta^3 f(x) - \ldots \tag{26}$$

nd if this series is stopped with the term

$$(-1)^{n-2}\Delta^{n-1}f(x)/(n-1),$$

ere will be a remainder term which can be proved to be proortional to $f^{(n)}(\xi)$, where ξ lies in the interval $(x, x+\omega)$. For xample, when $f(x) = x^3$, $f'(2)$, using the data of Table II, is

$$f'(2) = 19 - \frac{1}{2} \times 18 + \frac{1}{3} \times 6 = 12$$

nd this is exact, because fourth order differences vanish.

Numerical Integration.—To illustrate the principle of nuerical integration, start with the Lagrangian interpolation forula (11). Integration of $f(x)$ from a to b gives

$$\int_a^b f(x)dx = \sum_{s=1}^{n} h_s^{(n)} f(x_s) + R_n,\ R_n = \int_a^b \phi(x)[xx_1 \ldots x_n]dx \tag{27}$$

here

$$h_s^{(n)} = \int_a^b \frac{\phi(x)}{\phi'(x_s)} \frac{dx}{x - x_s}$$

hich depends only on the arguments $x_1, x_2, \cdots, x_n$ and not on x). From this basic result many integration formulas follow. or example, taking arguments $x_s = a + s\omega$, $s = 1, 2, \cdots, n$, here $\omega = (b-a)/(n-1)$ leads to Cotes' formula:

$$\int_a^b f(x)dx = (b-a)\sum_{s=1}^{n} H_s^{(n)} f[a + \overline{s-1}\omega] + R_n \tag{28}$$

$$H_s^{(n)} = (-1)^{n-s}\frac{n}{n-1}\binom{n-1}{s-1}\int_1^n \frac{1}{t-s}\binom{t-1}{n}dt \tag{29}$$

he *trapezoidal rule* results when $n = 2$:

$$\int_a^b f(x)dx = \frac{b-a}{2}\{f(a) + f(b)\} - \frac{(b-a)^3}{12}f''(\xi) \quad a < \xi < b$$

or $n = 3$, there is the well-known Simpson's rule:

$$\int_a^b f(x)dx = \frac{b-a}{6}\left\{f(a) + 4f\left(\frac{a+b}{2}\right) + f(b)\right\} - \frac{(b-a)^5}{2880}f^{(4)}(\xi)$$

Space does not permit a discussion of the many types of integation formulas, but the above shows their general dependence interpolation formulas. Such formulas have an important plication to the integration of differential equations.

The Summation Problem.—Consider the function

$$F(x|1) = \int_c^\infty g(t)dt - \sum_{s=0}^{\infty} g(x+s) \tag{30}$$

en

$$F(x+1|1) = \int_c^\infty g(t)dt - \sum_{s=0}^{\infty} g(x+1+s)$$

herefore $\Delta F(x|1) = g(x)$. The function $F(x|1)$ is therefore a lution of the difference equation

$$f(x+1) - f(x) = g(x) \tag{31}$$

d (following N. E. Nörlund) is called the *principal solution* of is equation, or alternatively the *sum of* $g(x)$ from c to x. When e integral and series do not converge, a definition along the me lines as (30) is available by a limiting process.

An important application is to the psi function $\Psi(x)$, defined as e sum of $1/x$ from 1 to x, so that

$$\Delta\Psi(x) = \frac{1}{x} \tag{32}$$

e psi function is therefore the analogue of $\ln x$, defined by $x = \int_1^x \frac{dx}{x}$. Summation of the logarithm $\ln x$ from 0 to x and representation of the result by $c + \ln\Gamma(x)$, where c is so chosen that $\ln\Gamma(1) = 0$, introduces the gamma function $\Gamma(x)$ which, from its definition, satisfies the equation

$$\ln\Gamma(x+1) - \ln\Gamma(x) = \ln x$$

so that

$$\Gamma(x+1) = x\Gamma(x) \tag{33}$$

Because $d\ln x/dx = 1/x$, the psi and gamma functions are related by

$$\Psi(x) = \frac{d}{dx}\ln\Gamma(x) = \frac{\Gamma'(x)}{\Gamma(x)} \tag{34}$$

Difference Equations.—Let u_x denote a function of x. A relation between $x, u_x, u_{x+1}, \cdots, u_{x+n}$ constitutes a difference equation of order n. By use of Gregory's theorem (16) any such relation can be replaced by one between $x, u_x, \Delta u_x, \cdots, \Delta^n u_x$. Thus, for example, the first order equations

$$(u_{x+1})^2 - 3u_x u_{x+1} + 2(u_x)^2 = 0,\ (\Delta u_x)^2 - u_x(\Delta u_x) = 0$$

are the same, and each has the solutions $u_x = c_x$, $u_x = c_x 2^x$, where c_x is an arbitrary periodic function such that $c_{x+1} = c_x$.

While some difference equations may have compact solutions like the above in terms of elementary functions, in general a difference equation must be regarded as defining a class of functions whose properties are to be inferred from the equation itself. When, however, the variable proceeds by equal steps from a given initial value of the function, difference equations lend themselves to machine computation. For this reason numerical problems are often approached via an approximating difference equation. This is the basis of so-called "relaxation" methods.

The following is a specific example which leads to a difference equation with constant coefficients.

A coin is spun n times. The probability of its showing head at the first spin is p', while at any subsequent spin the probability that the coin shows the same face as at the previous spin is p. What is the probability that the coin shows head at the nth spin?

Let u_n be the required probability. At the $(n-1)$th spin the coin has probability u_{n-1} of showing head, or probability $1 - u_{n-1}$ of not showing head. Therefore

$$u_n = pu_{n-1} + (1-p)(1-u_{n-1}) = (2p-1)u_{n-1} + 1 - p \tag{35}$$

First, solve the equation $u_n = (2p-1)u_{n-1}$ by writing $u_n = A\rho^n$ so that $\rho = (2p-1)$. Next, find a particular solution of (35) by putting (in this case) $u_n = c$, a constant, which gives $c = \frac{1}{2}$. The complete solution is therefore $u_n = \frac{1}{2} + A(2p-1)^n$. But $u_1 = p'$, therefore $A = (p' - \frac{1}{2})/(2p-1)$, so the required probability is

$$u_n = \tfrac{1}{2} + (p' - \tfrac{1}{2})(2p-1)^{n-1}$$

If $p' = \frac{1}{2}$, this is equal to $\frac{1}{2}$ for all values of n and p.

See L. M. Milne-Thomson, *The Calculus of Finite Differences* (1960).
(L. M. M.-T.)

CALCULUS OF VARIATIONS. When two points, A and B, are given in a plane, as shown in the accompanying figure, there is an infinity of arcs joining them. A simple problem of the calculus of variations is that of finding in this group of arcs (such as E and E′) one which has the shortest length, the solution of the problem being, of course, a straight line segment. But it may also be desired to find in the group of arcs joining A with B one down which a particle, started with a given initial velocity, will fall from A to B in the shortest time; or which one of these arcs, when rotated about the x-axis, will generate a surface of revolution of minimal area. These are typical problems of the calculus of variations of the so-called simplest type.

These problems illustrate the usual situation in the calculus of variations, in which mathematicians seek to find that arc from some given class for which some quantity, *the value of which depends on the entire arc* (its length, etc.), is a minimum or a maximum. The calculus of variations also deals with problems involving surfaces or functions of several variables. For example, if a circular wire is bent in any way, dipped in a soap solution, and then withdrawn, the soap film spanning the wire will assume the shape of the surface of least area bounded by the wire. The calculus of variations has been useful as a unifying principle in mechanics and as a guide for the determination of new laws of physics.

Albert Einstein's theory of general relativity, for example, utilizes the calculus of variations extensively. One of the most widely applicable variational statements of classical mechanics is known as Hamilton's principle; it states that the trajectories of many dynamical systems are the solutions of some variational problem involving an "energy integral."

Some of the problems of the calculus of variations were considered and partially solved by the ancient Greeks. The introduction of the calculus gave great impetus to the study and to the solution of variational problems. After a number of special problems had been solved, L. Euler in 1744 deduced the first general rule, now known as Euler's differential equation, for the characterization of the maximizing or minimizing arcs. Much of the terminology of the calculus of variations was introduced shortly thereafter by J. L. Lagrange.

Mathematical Formulation of Variational Problems.—All of the problems mentioned in the first paragraph reduce to the determination of that differentiable arc

$$y = y(x) \tag{1}$$

joining the two points (x_1, y_1) and (x_2, y_2) which minimizes an integral of the form

$$\int_{x_1}^{x_2} f[x,y(x),y'(x)]dx \qquad \left(y' = \frac{dy}{dx}\right) \tag{2}$$

among all such arcs. The length of the arc (1) and the area of the surface of revolution obtained by revolving it around the x axis are found from elementary calculus to be given respectively by the integrals

$$\int_{x_1}^{x_2} \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\,dx \text{ and } \int_{x_1}^{x_2} 2\pi y(x)\sqrt{1 + \left(\frac{dy}{dx}\right)^2}\,dx \tag{3}$$

In the case of the curve of steepest descent, the time required for a bead to descend along a wire in the shape of the arc (1) from the point (x_1, y_1) to the point (x_2, y_2) under the action of gravity is given by the integral

$$\int_{x_1}^{x_2} (\alpha - y)^{-\frac{1}{2}} \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\,dx \tag{4}$$

if friction is neglected; here

$$\alpha = y_1 + v_1^2/2g$$

where v_1 is the initial velocity of the bead and g is the acceleration of gravity. The function $f(x, y, p)$ occurring in (2) has the respective forms

$$\sqrt{1 + p^2}, \; 2\pi y\sqrt{1 + p^2}, \; \sqrt{1 + p^2}/\sqrt{\alpha - y} \tag{5}$$

in these examples, p being the third variable in f. The integrals arising from Hamilton's principle are of the type in (2), where x is replaced by the time t (this usually does not appear in the function f in such applications) and the single variables y and p are replaced by several variables $y_1, \ldots y_n$, and $p_1, \ldots, p_n$, the p_i standing for the derivatives dy_i/dt.

Euler's Equation.—Euler's differential equation for the determination of a minimizing arc is derived as follows: Suppose that $y = y\ (x)$ is a minimizing arc which passes through the two points, and assume that the second derivative y'' and the second partial derivatives of f are all continuous. If $\eta(x)$ is *any* differentiable function such that

$$\eta(x_1) = \eta(x_2) = 0 \tag{6}$$

then for any λ the arc

$$y = y(x) + \lambda\eta(x) \tag{7}$$

is another arc joining the two given points. Forming the integral (2) for this new arc gives a function

$$I(\lambda) = \int_{x_1}^{x_2} f[x,y(x) + \lambda\eta(x),y'(x) + \lambda\eta'(x)]dx \tag{8}$$

of λ which is differentiable and must have a minimum for $\lambda = 0$. From elementary calculus, it follows that

$$I'(0) = \int_{x_1}^{x_2} \left\{ \eta(x)f_y[x,y(x),y'(x)] + \eta'(x)f_p[x,y(x),y'(x)] \right\} dx = 0 \quad (9$$

The integral on the right in (9) is called the *first variation* of th integral (2); this corresponds roughly to the total differential a function of several variables, the function $\eta(x)$ correspondin to the set of differentials of the variables. Now, using the differentiability assumptions, the term involving $\eta'(x)$ in (9) may b eliminated by integrating by parts to obtain

$$\int_{x_1}^{x_2} \eta(x) \left\{ f_y - \frac{d}{dx}f_p \right\} dx = 0 \qquad (1$$

Because (10) holds for every function $\eta(x)$ allowed above, follows from a well-known theorem in analysis that

$$\frac{d}{dx}f_p = f_y \qquad (1$$

which is *Euler's differential equation*; it is understood that th values x, $y(x)$ and $y'(x)$ are to be inserted in the expressions fc f_p and f_y in (10) and (11).

If (11) is written out in more detail, the rules of differentiatio yield

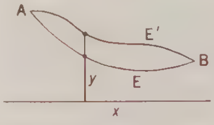
$$f_{pp}\frac{d^2y}{dx^2} + f_{py}\frac{dy}{dx} + f_{px} = f_y \qquad (1$$

which shows that Euler's equation is of the second order. Euler equation becomes singular if $f_{pp} = 0$. Hence *regular* variationa problems are those for which f_{pp} never vanishes; in that case is assumed that $f_{pp} > 0$, which makes minimum problems mo natural than maximum problems.

Some Questions Involving Arcs.—The analysis leading t Euler's equation applies just as well to a maximizing arc as to minimizing one. The first attempt to find a condition whic would single out a minimizing arc was to consider the *secon variation*, which is obtained, for any given $\eta(x)$, by finding $I''(0$ $I(\lambda)$ being defined by (8).

Clearly $I''(0) \geq 0$ for every $\eta(x)$ if $y(x)$ is a minimizin arc, but the condition that $I''(0) \geq 0$ for every $\eta(x)$ not sufficient to ensure that $y(x)$ is minimizing. Th attempt to find conditions which would ensure that a given a is a relative minimum led to many interesting discoveries an raised many new questions.

After Karl Weierstrass's famous example of a continuous fun tion which does not possess a derivative at any point (thereb showing that a function having a continuous first derivati need not have a continuous second deri ative), the question was raised as to wh a minimizing arc, or more generally a arc for which the first variation is ze for every η, should possess a conti uous second derivative, as required the derivation of Euler's equation. B the end of the 19th century, the proble of the existence of a minimizing arc ha been raised and the existence proved by D. Hilbert und certain hypotheses. L. Tonelli developed the so-called "dire methods" of the calculus of variations in order to simpli and amplify the results of Hilbert concerning the existen of minimizing arcs.



SIMPLE PROBLEM OF ARC LENGTH (*See* TEXT)

These results were applied to very general situations by t "metric geometry" methods of K. Menger and H. Buseman Most of the remaining important problems involving arcs we solved between 1910 and 1940 by such mathematicians O. Bolza, G. A. Bliss, E. J. McShane and others.

The fact that not every minimum problem has a solution seen by studying the following example:

$$I = \int_0^1 \left\{ 1 + [y'(x)]^2 \right\}^{-1} dx, \quad y(0) = 0, y(1) = 1$$

Clearly $0 < I < 1$ for every $y(x)$. Setting $y(x) = x^n$, $n = 1$, $\cdots$, shows that I may be made arbitrarily close to 1. By taki

$$y(x) = x + n \sin n\pi x, n = 1, 2, \ldots$$

t is seen that I may be made arbitrarily close to zero. However, here is no $y(x)$ for which $I = 0$ or 1.

Multiple-Integral Problems.—Meanwhile interest had developed in problems involving functions of two or more variables, nd the derivation of Euler's equation had been extended to ntegrals of the form

$$I = \iint_G f[x,y,z(x,y),z_x(x,y),z_y(x,y)]dxdy \quad (z_x = \partial z/\partial x, z_y = \partial z/\partial y) \quad (14)$$

Replacing z by $z + \lambda\zeta$, where $\zeta = 0$ on the boundary of the egion G, and proceeding as in (8), (9) and (10), results in the quation

$$\frac{\partial}{\partial x}(f_p) + \frac{\partial}{\partial y}(f_q) = f_z \quad (p = z_x, q = z_y) \quad (15)$$

which is Euler's equation for the integral (14).

Early in the 19th century C. F. Gauss and W. Thompson had bserved that Laplace's equation (which had already been recognized as having important applications) was the Euler equation or the integral

$$\tfrac{1}{2}\iint_G(z_x^2 + z_y^2)dxdy \quad (16)$$

s is easily seen by setting $f(x, y, z, p, q) = (p^2 + q^2)/2$ in (14) nd (15).

This fact is the formal basis for what is now known as *irichlet's principle* (after P. G. Lejeune Dirichlet), which states hat (subject to certain hypotheses) there is a unique function z which minimizes the integral (16) among all differentiable functions having given boundary values and that that unique function s the solution of Laplace's equation with those boundary values.

This principle has proved to be of great importance not only in otential theory and in the theory of partial differential equations, but also in the theory of functions of a complex variable nd in conformal mapping. The applications to these fields was egun by B. Riemann around 1850 and important advances have een made in them since 1935 by such mathematicians as R. Courant, L. Ahlfors, D. C. Spencer, M. M. Schiffer, P. R. Garaedian and others. Riemann simply assumed the principle but, f course, the objections which were raised concerning problems nvolving arcs applied to the Dirichlet principle with even greater orce; the first proof of the principle was given by D. Hilbert n 1900.

The almost simultaneous solutions by J. Douglas and T. Radó n 1930 of the problem of J. Plateau, *i.e.*, the proof of the existence f a minimal surface (surface of least area) bounded by a simple losed curve in space, aroused a renewed interest in variational roblems for surfaces. The Plateau problem was solved for suraces bounded by several curves and for more complicated suraces by Douglas, R. Courant and others. More general variational problems for surfaces were solved by Tonelli, McShane, C. B. Morrey, Jr., L. Cesari, A. G. Sigalov, and others between 930 and 1957 by extending the direct methods of Tonelli; these nvolve considering the surfaces as "points" in a "space" in hich limits are defined and using the general theorem in functional analysis that "a function which is lower-semicontinuous on compact set attains its minimum on that set." In order to pply this theorem it was found expedient to enlarge the classes f arcs or surfaces, etc., within which the minimum is sought. Unfortunately the enlarged classes usually contain surfaces which do not possess the properties of differentiability required in he derivation of Euler's equation.

In the case of the Plateau problem, the differentiability of the olutions follows from the Dirichlet principle. The differentiaility of the generalized solutions of certain other problems for urfaces was proved by C. B. Morrey, and some of his results ere extended in 1957 to problems in higher-dimensional spaces y E. De Giorgi and J. Nash.

An interesting attack on problems for surfaces has been made y L. C. Young, W. H. Fleming and others through their introuction of "generalized surfaces."

Morse's Theory of Critical Points.—If a function $f(P)$ is dened on an n-dimensional manifold (*see* MANIFOLDS), its behaviour ear a particular point may be studied by introducing co-ordiates, in which case f becomes just a function of n co-ordinates $x_1, \ldots, x_n$. A point (*i.e.*, set of numbers $x_1, \ldots, x_n$) is a *critical point* (*q.v.*) of f if all its partial derivatives are zero there. If $x_1, \ldots, x_n$) is such a point, then

$$f(x_1 + \eta_1, \ldots, x_n + \eta_n) - f(x_1, \ldots, x_n) = \tfrac{1}{2}\sum_{i,j=1}^{n} a_{ij}\eta_i\eta_j + R \quad (17)$$

where R consists of the higher order terms; here

$$a_{ij} = \partial^2 f/\partial x_i \partial x_j$$

evaluated at the point. It is known that linear combinations $\xi_1, \cdots, \xi_n$ of the η_i can be chosen so that the double sum becomes

$$-\xi_1^2 - \ldots - \xi_r^2 + \xi_{r+1}^2 + \ldots + \xi_s^2 \quad (18)$$

(where $r = 0$ if there are no negative terms, etc.). Moreover, the numbers r and s are independent of the coordinate system and the way the ξ_i are chosen as long as the form (18) is obtained. If $s = n$, the critical point is said to be nondegenerate, in which case r is called the *index*.

M. Morse first proved certain inequalities between the number of critical points of a given index of a (nondegenerate) function on a manifold and the so-called "Betti numbers" of the manifold. His greatest contribution was to generalize the notion of a nondegenerate critical point and his inequality results to situations where the functions and spaces were too general for differentiability to be defined. Morse applied his theory to spaces whose elements were arcs or closed curves on a manifold or surfaces in space. He was able to prove the existence of "unstable" minimal surfaces (*i.e.*, surfaces furnishing some critical value other than a minimum to the area) and to prove such theorems as that there exist at least three closed geodesics on a surface homeomorphic to a sphere. His theory has been applied to variational problems for arcs with great success; S. Smale and others have found a way to apply the Morse theory to multiple integral problems.

See also ANALYSIS, COMPLEX; TOPOLOGY, GENERAL.

BIBLIOGRAPHY.—For an introduction to the theory for problems involving arcs only, *see* G. A. Bliss, *Calculus of Variations* (1925) and *Lectures on the Calculus of Variations* (1946). For problems involving multiple integrals, *see* P. Funk, *Variationsrechnung und ihre Anwendung in Physik und Technik* (1962) and C. B. Morrey, Jr., *Multiple Integrals in the Calculus of Variations* (1966), in which other books are referred to. For expositions of Morse's theory of critical points, *see* M. Morse, *Calculus of Variations in the Large* (1934) and H. Seifert and W. Threlfall, *Variationsrechnung im Grossen* (*Theorie von Marston Morse*) (1938).

(C. B. M.)

CALCUTTA, the largest city of India, capital of West Bengal and one of the largest commercial and cultural centres of the east, is situated on the east bank of the Hooghly distributary of the Ganges, about 80 mi. from the head of the Bay of Bengal, and extends over a surface of 40 sq.mi.

Topography.—The city owes much of its size and importance to its command position on the westernmost distributary of the Ganges. The river there is wide and deep and navigable for seagoing vessels as far as the city. Hence Calcutta, like London, developed on a point of transshipment from water to land and from river to sea. With the Chitpur creek on the north, a vast salt marsh on the east and the Adi-Ganga river on the south, it was by far the most easily defensible site on the banks of the Hooghly. The wider setting of Calcutta perhaps contributed more than its local setting toward its rapid growth as the leading commercial hub of India. Not only the rich Ganges delta, but the entire Gangetic plains and the Assam valley on the north and the mineralized zones of Bihar, Orissa and Madhya Pradesh on the west constituted its great hinterland.

The mean height of Calcutta is about 20 ft. above sea level and the ground slopes gently from the riverbank toward the salt lake in the east. The surface is studded with broad and shallow depressions, which cause flooding during the monsoonal months of the year.

The weather remains hot from March to September when the mean monthly temperature ranges from 81° to 87° F. and the daily temperature may rise to 117°. With the high humidity, the weather becomes very oppressive. The only relief in hot weather is the southerly breeze which at the close of the day

MARIE J. MATTSON FROM BLACK STAR

JAIN TEMPLE OF BADRI DAS, CALCUTTA

blows regularly from the Hooghly estuary. Occasional thundersqualls or nor'westers in the evening also bring rain and lower the temperature. In the latter part of June the monsoon sets in and bursts of rain alternating with sporadic showers and rainless breaks continue for another three months. The normal monthly rainfall in monsoonal months ranges from 13 in. (July) to 10 in. (September). There is very little post-monsoonal rain except when occasional depressions come from the west. The weather remains pleasantly cool in the daytime from October to February and the evenings of December and January are sufficiently cold to make a fire agreeable.

Places of Interest.—Calcutta's chief glory is the maidan (plain or park), 1,283 ac. in area. Ft. William stands west of the maidan, facing the Hooghly. It is the shape of an irregular octagon and can accommodate about 10,000 men. The Victoria memorial, considered the finest building in Calcutta, stands southeast of the maidan adjoining the racecourse. It contains a picture gallery and a museum. To the east is St. Paul's cathedral, built in 1839–41 in "Indo-Gothic" style. In the northeast of the maidan stands the Ochterlony monument, the most conspicuous landmark in Calcutta. It is a beautiful column of Saracenic type, 165 ft. high. Curzon park, farther north, has lost much of its former beauty. Another beauty spot, Eden gardens, the extreme northwest of the maidan, contains the massive All India Radio building and the Ranji stadium. Government house, known as Raj Bhavan, close to Eden gardens, is the official residence of the governor of West Bengal. Farther west lie three imposing buildings, the legislative assembly, high court and town hall. The first has a beautiful copper-plated dome. The high court building, built in 1872 on the model of the Cloth hall at Ypres, Belg., has a massive 180-ft. tower. The town hall (1813) contains a fine collection of historical portraits. Facing the maidan for a length of about 2 mi. is Chowringhee, once a row of palatial residences but later given up almost entirely to hotels, shops, offices and museums. There stands the Indian museum with its fine archaeological, ethnographic and zoological collections.

Commercial and administrative Calcutta lies north of the Raj Bhavan around Dalhousie square. On the north stand Writers' buildings, which house the West Bengal secretariat. The 14-stor secretariat in Hastings street is the tallest building of Calcutt Almost all the big commercial houses are situated farther nort alongside the former Clive street, renamed Netaji Subhas roa In central Calcutta Nakhuda Masjid, the largest mosque in the cit Mahajati Sadan and Marble palace with its art collection deser special mention. North Calcutta has most of the educational i stitutions, including the University of Calcutta and Presidency co lege. Cossipore and Chitpur, the two northern suburbs, are t principal centres of jute pressing and cotton ginning. Cossipo also has ordnance factories. Another suburb on the east, Manick tala, has in its neighbourhood the famous Jain temple, name after Badri Das, enclosing one of the prettiest gardens of Calcutt The eastern parts of these two and adjoining suburbs have mo of the factories and mills. South of the maidan extend Kidderpor Alipore, Bhawanipur, Kalighat, Ballygunge and Tollygunge, fo merly suburbs but now within the city limits. The docks are Kidderpore. Alipore, with its open spaces and many histor buildings, includes the zoological and botanical gardens and m teorological observatory. Also in Alipore are Belvedere hous and Hastings house, the former housing the National library, t latter educational institutions for women. Bhawanipur is t most congested residential area in the south. Kalighat is not for its Kali temple, which stands on the Adi-Ganga, a silted-u channel of the Ganges.

Greater Calcutta includes areas outside the city limits. It almost a continuous built-up area astride the Hooghly with area of about 78 sq.mi. and an estimated population of abo 5,000,000 (1960).

Population.—In 1901 the population of Calcutta reached abo 1,000,000 and by 1951 there was a further increase of 1,500,00 Pop. (1961) 2,926,498. The area of the city during this peri increased by only 50%, resulting in considerable overcrowdin Cosmopolitan in character, Calcutta has within its confines perso speaking different languages. About two-thirds of the citizens a Bengalis, the remainder being Hindi-speaking people from nort India. The British are by far the largest European element. Mo than one-third of Calcutta's citizens are engaged in professio and other services and another third in commercial pursuits. I dustry absorbs one-fifth of the total population.

Education and Research.—Calcutta has two universities, t University of Calcutta and Jadavpur university. The Universit of Calcutta was founded in 1857 on the model of the Universit of London; it has its own postgraduate departments and al exercises control over about 145 affiliated colleges. The Unive sity of Jadavpur came into being in 1955 with the upgrading the former college of engineering and technology at Jadavpur, southern suburb of Calcutta.

Of the research institutes functioning in the city, the Roy Asiatic Society of Bengal founded in 1784 by Sir William Jone the Indian Association for the Cultivation of Science founded 1876 by Mahendra Lal Sircar and the Bose institute founded 1917 by Sir Jagadis Chandra Bose deserve special mention.

Municipal Administration.—The municipal government Calcutta is guided by the Calcutta Municipal act, 1951, amended 1953. The corporation consists of 80 elected councilors and o ex officio councilor who is the chairman of the Calcutta improv ment trust. The intake for the supply of filtered water for dome tic use is from the Hooghly at Palta, about 14 mi. above Calcutt To supplement the main water supply about 1,500 tube wells hav been sunk all over the city. The sewage from the city is carrie from the three main pumping stations to the Kulti river about 2 mi. E. Both gas and electricity are used for street lighting. The are eight municipal markets, the largest of which, named aft Sir Stuart Hogg, offers an immense variety of merchandise.

Commerce and Industry.—Commerce and industry are we organized in Calcutta. There are as many as eight chambers commerce in the city representing all sections of trade, commer and industry, of which the Bengal chamber of commerce is t largest. There are also more than 30 other Indian trade associ tions and at least 12 trade commissions organized by forei governments. The commercial prosperity of Calcutta resul mainly from its fine port on which rail, river and air traffic converge. The chief exports by sea are gunnies (jute sacking), hemp, tea, linseed, coal, pig iron, iron and manganese ores, mica, carpets, hides and skins. The principal items of import are salt, food grains, petroleum, iron and steel, machinery, cement, hardware and other consumer goods. The port of Calcutta, one of the busiest in the world, is under the control of the Calcutta port commissioners. Vessels of 16,000 tons, drawing 28 ft., go up the river to Calcutta. The passage is dangerous because of strong tides and bores and consequent changes in bed level, but it is kept safe for navigation by the vigilance of the port commissioners and the skill of the pilots. The main accommodations for ships are the Kidderpore docks, King George's dock, Calcutta jetties, Garden Reach jetties and petroleum wharves at Budge Budge. At the end of the second Indian five-year plan in 1961, the handling capacity of the port rose to 12,000,000 tons a year.

The port has its own railway system which provides the terminal for the Eastern and Southeastern railways for goods traffic to and from the port and deals with local goods traffic within the port area. Railway passengers to Calcutta have to terminate their journey on the outskirts of the city in Howrah (*q.v.*) and Sealdah stations. Calcutta has air links with practically all the important cities of the world. The Calcutta international airport is at Dum Dum.

Next to commerce, industry plays the most important part in the economy of the city. Within the city proper there is a very large concentration of printing and bookbinding establishments and on the outskirts are jute mills, jute presses, ordnance factories, chemical and glass works, match factories and rice mills. Not only these industrial concerns, but the tea gardens, coal mines and industrial concerns of West Bengal and the neighbouring states are managed, controlled and financed from Calcutta. (S. P. C.)

History.—The history of Calcutta for all practical purposes dates from Aug. 24, 1690, when it was founded by Job Charnock (*q.v.*) of the English East India company. In 1596 Calcutta had obtained a brief entry as a rent-paying village in the survey of Bengal executed by command of the emperor Akbar. In 1686 the English merchants at Hooghly retreated about 26 mi. down the river to Sutanati, a village now within the boundaries of Calcutta. They occupied Sutanati temporarily in Dec. 1686 and permanently on Aug. 24, 1690. The new settlement soon extended itself along the riverbank to the then village of Kalikata, and by degrees the cluster of hamlets grew into the present town.

In 1696 the English built the original Ft. William by permission of the nawab, and in 1698 they formally purchased the three villages of Sutanati, Kalikata and Govindpur from Prince Azim, son of the emperor Aurangzeb. The town grew up without any fixed plan and with little regard to sanitary arrangements.

The chief event in the history of Calcutta is the sack of the town and the capture of Ft. William in 1756 by Siraj-ud-Daula, nawab of Bengal. The majority of the English officials took ship and fled to the mouth of the Hooghly. The Europeans and non-Europeans who remained were compelled, after a short resistance, to surrender. The prisoners, numbering, according to the contemporary evidence, 146 persons (a modern estimate places the number as low as 64), were forced into the guardroom, a chamber measuring 18 ft. by 14 ft. 10 in. with only two small windows, where they were left for the night. It was June 20, the heat was intense, and the next morning only 23, or perhaps only 21, were taken out alive, among them J. Z. Holwell, who left an account of the awful sufferings endured in the "Black Hole." In Jan. 1757 an expedition dispatched from Madras, under Adm. Charles Watson and Col. Robert Clive, regained possession of the city.

After the battle of Plassey (June 23, 1757), Mir Jafar, the nominee of the English, was created nawab of Bengal, and by the treaty which raised him to this position he agreed to make restitution to the Calcutta merchants for their losses. By another clause in this treaty the East India company was permitted to establish a mint, the visible sign in India of territorial sovereignty, and the first coin, still bearing the name of the Delhi emperor, was issued on Aug. 19, 1757.

Modern Calcutta dates from 1757. The old fort was abandoned and its site devoted to the customhouse and other government offices. The new Ft. William was begun by Clive a short distance lower down the river. At this time also the maidan was formed.

Up to 1707, when Calcutta was first declared a presidency, it had been dependent upon the older English settlement at Madras. From 1707 to 1773 the presidencies were maintained on a footing of equality, but in the latter year an act of parliament was passed which provided that the presidency of Bengal should exercise a control over the other possessions of the company; that the chief of that presidency should be styled governor general; and that a supreme court of judicature should be established at Calcutta. In 1772 Warren Hastings had taken, under the immediate management of the company's servants, the general administration of Bengal.

The treasury was removed from Murshidabad to Calcutta which thus became the capital. In 1834 the governor general of Bengal was created governor general of India. It was not until 1854 that a separate head was appointed for Bengal. In 1912 the 1905 partition of Bengal was reversed and Calcutta was no longer the capital of India, the seat of government being transferred to Delhi (*q.v.*).

In 1926 Calcutta was the scene of communal rioting in which more than 200 shops were looted and 12 sacred buildings either desecrated or destroyed. Serious riots took place in 1930 as a result of Gandhi's call for mass disobedience to the salt laws, and also in 1946, 1947 and 1950; the riots from Aug. 16 to Aug. 20, 1946, were the worst in Calcutta's history. Japanese air raids in World War II inflicted heavy casualties among the dock workers. *See* also references under "Calcutta" in the Index. (C. C. D.)

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CALDARA, POLIDORO: *see* CARAVAGGIO, POLIDORO DA.

CALDAS, a department of Colombia, situated to the northwest of Bogotá. Area 2,812 sq.mi. (7,283 sq.km.); pop. (1964) 712,916. It was previously much larger, but in 1966 and 1967 two new departments, Quindío and Risaralda (*qq.v.*), were created from western and southern sections of Caldas. The terrain is varied, including sections both of the Cordillera Central of the Andes as well as the Cauca and Magdalena river valleys. Coffee is the chief product, but other agricultural items and industry were growing in importance in the late 1960s. Its capital, Manizales, with a 1964 population of 190,036, is the only significant industrial centre since the cities of Armenia and Pereira were lost when Risaralda and Quindío were created. Caldas was created initially in 1905 and was named for the scientist-martyr of the independence period, Francisco José de Caldas. Penetrated by conquistadores early in the 16th century, it was a part of the colonial province of Antioquia, Spain's leading gold production area. Gold production had become negligible in the 20th century, but mines of gold, silver, coal, sulfur, and zinc as well as other minerals were still producing. The department is served by railroads, highways, airlines, and an aerial cable between Manizales and Mariquita (department of Tolima). (T. E. N.)

CALDECOTT, RANDOLPH (1846–1886), English illustrator, painter and sculptor whose gently satirical drawings and book illustrations earned great popularity, was born at Chester on March 22, 1846. While a bank clerk at Whitchurch, Shropshire, and at Manchester, Caldecott began drawing for local magazines. Through George du Maurier he began contributing to the periodical *London Society* in 1871; the next year he settled in the capital and turned professional, ultimately drawing for *Punch* and *Graphic,* among other periodicals. He increased his skill by painting under Sir E. Poynter, by sketching and modeling in the studio of J. Dalou and by dissecting birds and animals. In 1872 he went with his lifelong friend Henry Blackburn to Germany. His drawings for Blackburn's book, *The Harz Mountains,* fix Caldecott's style in the tradition of Richard Doyle—moderate in distortion, affably satirical. He illustrated Washington Irving's *Sketch Book* (1875) and *Bracebridge Hall* (1876). These more sophisticated drawings were close to those of Du Maurier and W. P. Frith, though with an original sense of caricature, and they established Caldecott's reputation. His coloured picture books for children included W. Cowper's *John Gilpin* (1878), Oliver Goldsmith's *Elegy on a Mad Dog* (1879) and *The Great Panjandrum Himself* (1885). He also exhibited paintings at the Royal Academy, and made metal reliefs and terra cottas. He died at St. Augustine, Fla., on Feb. 12, 1886.

CALDER, ALEXANDER (1898–) U.S. sculptor, the originator of the mobile, was born in Philadelphia, Pa., on July 22, 1898, into an American family of artists. He was trained primarily as an engineer. In the 1920's, Calder created witty and playful sculptures such as his toylike circus, "The Hostess" (1926), and several portraits in which the sculpture consists of suggestively drawn shapes in wire. The familiar bulk and weight of the body is replaced with space. The viewer's imagination completes the sculpture. During long stays in Paris, Calder was inspired by Hans Arp, Picasso and Piet Mondrian, and by 1930, was working in more abstract forms. Calder's gift to sculpture was his development in 1932 of the mobile, sculpture that moved with the aid of air currents and its own delicate balance. While often lacking in specific reference, his mobiles and stationary metal sculpture recall movements, shapes and structures in nature. Calder's inventiveness produced a mercury fountain, stage sets, a water ballet and many fine architectural commissions.

See J. J. Sweeney, *Alexander Calder* (1951). (A. E. EL.)

CALDER, SIR ROBERT, 1ST BARONET (1745–1818), British admiral, who was court-martialed for failing to do his utmost to destroy a French fleet in 1805, although he fought in unfavourable conditions, was born at Elgin in Scotland on July 2, 1745. He entered the navy in 1756 and as a lieutenant participated in 1762 in the capture of the Spanish ship "Hermione," homeward bound from Lima with a cargo of cash and bullion valued at more than £540,000 and probably the richest prize ever taken. He was captain of the fleet under Sir John Jervis at the battle of Cape St. Vincent in Feb. 1797, for which he was knighted (1798). In 1801 as a rear admiral he unsuccessfully chased Admiral Ganteaume's force which escaped from Brest for Egypt. In 1804 he joined the fleet blockading Brest under Admiral Cornwallis. In Feb. 1805 he was detached to watch El Ferrol in Spain in order to intercept Admiral Villeneuve on his return from the West Indies. This he failed to do on July 22, though he captured two Spanish ships when the combined fleet pressed past him in thick weather to reach Vigo. Aware of his inferiority in numbers, Calder sailed north to rejoin Cornwallis, but was sent south again on Aug. 16, an action which Napoleon described as "remarkably stupid" because Cornwallis thus divided his force, but it was approved by the admiralty and by that date Villeneuve had already turned south to Cadiz. On Aug. 30 Calder joined Vice-Admiral Collingwood off that port. Since much indignation was expressed at home over his action in July, Calder demanded a court-martial which was held in December. At this he was severely reprimanded for failing to renew action, but was acquitted on all other charges. This ended his career at sea. He died at Holt, Hampshire, on Aug. 31, 1818.

See J. Corbett, *Campaign of Trafalgar* (1910); "Biographical Memoir of Sir Robert Calder, Bart.," *Naval Chronicle*, vol. xviii. (1807). (C. C. L.)

CALDER, an ancient district of Midlothian, Scot. It comprises West Calder parish (pop. [1961] 6,873), the district centre, and East Calder district (pop. [1961] 6,727), consisting of Kirknewton parish and Mid Calder parish. Calder stretches from 10 to 25 mi. S.W. from Edinburgh and, with the exception of Pumpherston, lies along the south banks of the Almond and Breich rivers, rising from them into barren moorlands. Oil is the principal industry, established in the mid-19th century to produce paraffin. From oil shale mined around West Calder crude oil is extracted at Addiewell; refining, the extraction of by-products and brickmaking from spent shale take place at Pumpherston. Coal is mined in West Calder. At Mid Calder is a small paper mill. Sandstone, limestone and fire clay are quarried near West Calder.

Mid Calder has an ancient church where John Spottiswoode, the Scottish reformer, was minister. At Calder house John Knox first administered Holy Communion according to the Protestant rite; Frédéric Chopin stayed there in 1848. There are several tumuli ruined castles and a Roman camp in the district. (J. McB.)

CALDERÓN, RODRIGO (1570?–1621), conde de Oliva and marqués de Siete Iglesias, Spanish royal favourite, who enjoyed considerable authority during the ascendancy of the duque de Lerma in the reign of Philip III, was born at Antwerp, the son of an army officer. On the accession (1598) of Philip III, Calderón attached himself to the king's favourite and chief minister, Lerma by whom he was employed as a secretary. Intelligent and capable he soon distinguished himself and was repeatedly honoured by the king. There seems little doubt that Calderón exploited his influence for private gain and he became the main target for the anti-Lerma opposition, headed by the queen, Margarita, for whose death in 1611 he was unjustifiably alleged by his enemies to have been responsible. But the position of Calderón, who was awarded his marquessate on returning from a special mission (1612–14) to Flanders, remained strong until Lerma's fall in Oct. 1618. He was then arrested, tortured and implicated in the murder of a certain Francisco Xuara. After spending more than two years in prison he was about to be released when Philip III died. This proved fatal for Calderón; for the conde de Olivares, the chief minister of the new king, Philip IV, wishing to disassociate his governmen from the previous regime, determined upon Calderón's execution which took place in Madrid on Oct. 21, 1621. The Spanish saying *Tener más orgullo que don Rodrigo en la horca* ("To be haughtie than Don Rodrigo on the scaffold") derived from his behaviour on this occasion. (J. RE.)

CALDERÓN DE LA BARCA, PEDRO (1600–1681 Spanish dramatist and poet, who succeeded Lope de Vega as th greatest Spanish dramatist of his age, was born at Madrid o Jan. 17, 1600. His father, a fairly well-to-do government officia who died in 1615, was a man of harsh and dictatorial temper, and strained family relations must have had a profound effect on the youthful Calderón, for several of his plays show a preoccupation with the psychological and moral effects of unnatural family life in that they present anarchical behaviour directly traced t the abuse of paternal authority through unloving severity, injustice or tyranny.

Destined for the church, Calderón matriculated at the University of Alcalá in 1614, transferring a year later to Salamanc where he continued his studies in arts, law and probably theolog until 1619 or 1620. Abandoning an ecclesiastical career, he entered the service of the constable of Castile and in 1623 began to write plays for the royal palace, rapidly becoming the leading member of the small group of dramatic poets whom Philip IV gathered around him. In 1636 the king made him a Knight of the Military Order of St. James. Calderón's popularity was not confined to the court, for these early plays were also acclaimed in the public theatres, and on the death of Lope de Vega (1635 Calderón became the master of the Spanish stage. On the outbreak of the Catalan rebellion he enlisted in 1640 in a cavalry company of knights of the military orders and served with distinction until 1642 when he was invalided from the army. In 1645 he entered, probably as secretary, the service of the duke of Alba A few years later an illegitimate son was born to him; nothing is known about the mother and the idea that sorrow at her death led him to revert to his intention of joining the priesthood i pure surmise. He was ordained in 1651 and announced his intention of writing no more for the stage. This he kept as regards the public theatres, but at the king's command he continued to write regularly for the court theatre. He also wrote each year the two Corpus Christi plays for Madrid. Appointed a prebendary o Toledo cathedral he took up residence in 1653. The fine meditativ religious poem *Psalle et sile* is a product of this period. Receivin permission to hold his prebend without residence he returned t Madrid in 1657 and was appointed honorary chaplain to the kin in 1666. He died in Madrid on May 25, 1681.

The court patronage which Calderón enjoyed uninterruptedl constitutes the most important single influence in the development of his art. The court drama grew out of the popular drama and at first there was no distinction in themes and style between the two, but the construction of a special theatre in the new palace of the Buen Retiro, completed in 1633, made possible spectacular productions beyond the resources of the public stage. The court plays became a distinctive baroque genre combining drama with dancing, music and the visual arts, and departing from contemporary life into the world of classical mythology and ancient history. Calderón, as court dramatist, is thus associated with the rise of opera in Spain. In 1648 he wrote *El jardín de Falerina,* the first of his *zarzuelas,* plays in two acts with alternating spoken and sung dialogue. In 1660 he wrote his first opera, the one-act *La púrpura de la rosa,* with the whole dialogue set to music. This was folowed by *Celos aun del aire matan* (1662), an opera in three acts with music by Juan Hidalgo. Following Italian tradition the music was subordinate to the poetry; all Calderón's musical plays are poetic dramas in their own right.

Calderón's drama must be placed within the context of the court theatre, with its conscious development of an unrealistic and stylized art-form. Though for two centuries after his death his pre-eminence remained unchallenged, the realistic canons of criticism prevailing at the end of the 19th century produced a reaction in favour of the more lifelike drama of Lope de Vega. Calderón appeared mannered and conventional: the structure of his plots artificially contrived, his characters stiff and unconvincing, his verse often affected and rhetorical. Although he used technical devices and stylistic mannerisms that by constant repetition became conventional, Calderón remained sufficiently detached to make his characters, on occasion, poke fun at his own conventions. This detachment indicates a conception of art as a formal medium whose artifice is so contrived as to compress the externals of human life the better to express its essentials, and the justification for his formalism lies in the extent to which its self-consistency succeeds in lifting the surface of experience to disclose the permanent and universal.

In this direction Calderón developed the dramatic traditions he inherited. From the start he manifested his technical skill by subordinating the characters and incidents of his plots to the development of a dominant idea. As his art matured his plots became more complex, and the action more constricted and compact. The creation of complex dramatic patterns in which the artistic effect resides in the totality of the design through the inseparability of the parts is Calderón's greatest achievement as a craftsman. *El pintor de su deshonra* and *La cisma de Ingalaterra* are masterly examples of this technique, in which poetic imagery, characters and action are subtly interconnected by dominant ymbols that elucidate the significance of the theme. While rhetorical devices, typical of the Spanish baroque style, remained a eature of his diction, his verse developed away from excessive ornamentation toward a taut style compressed and controlled by penetrating mind.

The difficulties that Calderón's art presents to the modern eader have tended to obscure the originality of his themes. Accepting the conventions of the comedy of intrigue, of which *La lama duende* (1629) is a neat and lively example, he used them for a fundamentally serious purpose. In *Casa con dos puertas, mala es de guardar* (1629) the intrigues of secret courtship and disguises re so presented that the convention of seclusion of women on which they are based is shown to create social disorder by breedng enmity and endangering love and friendship. *No siempre lo peor es cierto* and *No hay cosa como callar* (1639) mark the peak f this development; although the conventions of comedy remain, he overtones are tragic: both plays are implicit criticisms of the ccepted code of honour, the former being a plea for frankness nd trust between men and women, the latter upholding silence nd forgiveness as more dignified and noble than scandal and revenge. Calderón's critical attitude to the rigid assumptions f the code of honour is evident also in his tragedies. In the amous *El alcalde de Zalamea* the secrecy and vengeance demanded y the code are rejected: the dishonoured father makes his disonour public because justice is a social act and punishment lies with the law, not the individual. This play also presents a powerful contrast between the aristocracy and the people: the degeneration of the aristocratic ideal is exposed, wealth is associated with manual labour and honour is shown to be the prerogative of moral integrity irrespective of class. Yet this profound humanity of Calderón has been denied in connection with *El médico de su honra* (1635). The critics who allege that Calderón approves of the murder of an innocent wife, because honour demands it, overlook the fact that the horror we feel at this deed is precisely what Calderón has made us feel. This moving play presents objectively the grimness of a world ruled by the code of honour.

Calderón's tragic view of life is, however, wider than his preoccupation with the social code of honour. A keynote is his deep-seated realization that a man can be responsible, through his own wrongdoing, for the wrongdoing of another. This can be connected with Calderón's own family experience. In *La devoción de la cruz* and *Las tres justicias en una* the heart of the tragedy lies in the fact that the greatest sinner is also the most sinned against, in that others, before he was born, had begun to dig his grave. To this group should be added *El pintor de su deshonra,* the plot of which is so contrived that each of the major characters, through actions in themselves reprehensible, forges a link in the chain that leads to the tragic conclusion. The human predicament, as seen by Calderón, lies in the fact that each man is separated from all other men, yet is in intimate solidarity with them, caught in circumstances that are the collective responsibility of all, whose ramifications he cannot see because he is the prisoner of his own limited vision. Connected with this is another keynote of Calderón's drama, that of "confusion," the difficulty of seeing clearly and choosing correctly in the maze of possibilities that life offers. *La vida es sueño* (1635) exemplifies this in the splendidly presented symbol of life as a dream. The material and social advantages that life can bestow are like a dream because they are transient. By seeing nothing beyond them man can blunder into disaster; the only guiding thread is renunciation of personal advantage for the good of others.

The fully developed court plays are best represented by *La hija del aire* (1653). This play in two parts, which dramatizes the legend of Queen Semiramis, has many claims to be considered Calderón's masterpiece. Highly stylized, it succeeds in conveying a strong impression of violence. It presents, with considerable complexity, the contrast between passion and reason. Passion, self-seeking, grasping power and devouring everything in the urge to domination, breeds disorder and leads to destruction; reason, sacrificing self-interest to justice and loyalty, produces order. This basic contrast underlies the themes of the plays of Calderón's last period, its various aspects being expanded in a number of interesting variations, many directly concerned with the positive values of civilization. Though none has the intensity of *La hija del aire,* most exemplify a thoughtful, dignified and restrained art. Mythological themes, treated more or less allegorically, predominate, as in *Eco y Narciso* (1661), *La estatua de Prometeo* (1669) and *Fieras afemina amor* (1669).

Calderón's vision of the human world in his secular plays is one of confusion and discord due to the inevitable clash of values in the natural order—honour in conflict with love, ambition with loyalty, peace with justice, and so on. The values underlying his thought in these plays are based on natural reason: prudence and social co-operation through unselfishness, trust and love. His religious plays round off his view of life by confronting natural values with supernatural ones. The most characteristic group, following the tradition established outside Spain by the Jesuit drama, are stories of conversion and martyrdom taken usually from the saints of the early church. One of the most beautiful is *El príncipe constante* (1629), which dramatizes the martyrdom of Prince Ferdinand of Portugal; by worldly standards this is a story of defeat and disaster, but worldly failure is changed into spiritual triumph by the saint's self-sacrificing loyalty to his faith; by contrast the human values of the other characters are shown to be morally inadequate. *El mágico prodigioso* (1637; later revised and expanded) is a more complex religious play; *Los dos amantes del cielo* and *El Josef de las mujeres* are the most subtle and difficult. The basic human experience upon which, in this type of drama, Calderón relies for rational support of religious faith is decay and death and the consequent incapacity of the world to fulfil its promise of happiness. This promise is centred in such natural values as beauty, love, wealth and power which, though true values if pursued with prudence, cannot satisfy the mind's aspiration for truth or the heart's longing for happiness. Only the apprehension of an infinite Good can assuage the restlessness of men. This religious philosophy is given its most moving expression, in terms of Christian dogma, in the *autos sacramentales*. Seventy-six of these allegorical plays, written for open-air performance on the feast of Corpus Christi, are extant. In them Calderón brought the tradition of the medieval moralities to a high degree of artistic perfection. The range of his scriptural, patristic and scholastic learning, together with the assurance of his technique and poetic diction enable him to endow the abstract concepts of dogmatic and moral theology with convincing dramatic life. At their weakest the *autos* tend to depend for their effect upon the ingenuity of their allegories, but at their best they are imbued with profound moral and spiritual insight, and with a poetic feeling varying from tenderness to forcefulness. *La cena de Baltasar* and *El gran teatro del mundo* are fine examples of the early style; the greater complexity of his middle period is represented by *No hay más fortuna que Dios* and *Lo que va del hombre a Dios*. But his highest achievement in this type of drama is to be found among those *autos* of his old age that dramatize the dogmas of the Fall and the Redemption, notably *La viña del Señor* (1674), *La nave del mercader* (1674), *El nuevo hospicio de Pobres* (1675), *El día mayor de los días* (1678) and *El pastor fido* (1678). Here is found the most moving expression of that compassionate understanding of human waywardness that characterizes all Calderón's work, presented through Christ's compassion for human suffering and sorrow and through the timeless reenactment of Calvary in the regeneration of the individual sinner.

To have found a dramatic form that conveys the doctrines of the Christian faith gives Calderón a special place in literature. But his greatness is not confined to this; the depth and consistency of his thought, his supremely intelligent craftsmanship and artistic integrity, his psychological insight and the rationality and humanity of his moral standards make him one of the major figures of European drama.

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CALDERWOOD, DAVID (1575–1650), Scottish Presbyterian minister and historian of the Church of Scotland. About 1604 he became minister of Crailing, near Jedburgh, Roxburghshire. In 1617, while James was in Scotland, a remonstrance, which had been drawn up by the Presbyterian clergy, was placed in Calderwood's hands. He was summoned to St. Andrews and examined before the king, but neither threats nor promises could make him deliver up the roll of signatures to the remonstrance. The privy council ordered him to be banished from the kingdom for refusing to acknowledge the sentence of the high commission. On Aug. 27, 1619, he sailed for Holland. During his residence in Holland he published his *Altare Damascenum* (1623) attacking episcopacy. Calderwood appears to have returned to Scotland in 1624, and he was soon afterward appointed minister of Pencaitland, East Lothian. He spent his last years writing his *History of the Kirk of Scotland*, the only published edition of which was made in digest form by the Wodrow society (1842–49). He die at Jedburgh on Oct. 29, 1650.

CALDWELL, ERSKINE (1903–), U.S. author whos novel *Tobacco Road* added the southern poor-white to world li erature and made its title a name for poverty, degeneracy and se comedy. He was born in Coweta county, Ga., on Dec. 17, 190 Because of his father's frequent moves as a home missionary c the Associate Reformed Presbyterian Church, Caldwell's schoolin was irregular. He attended Erskine college, Due West, S.C., an the University of Virginia, Charlottesville, but did not graduat From his numerous and fantastic jobs as listed in *Call It Exper ence* (1951) and other autobiographical statements, he not onl gained an extraordinarily broad experience of life in the U.S. bu also developed an active social conscience. His text for *Yo Have Seen Their Faces*, in collaboration with Margaret Bourke White (1937), and such stories as "Candy-Man Beecham" sti arouse indignation against injustice.

Caldwell was a prolific writer whose fiction had very large sale but his reputation rests on three novels—*Tobacco Road* (1932 *God's Little Acre* (1933) and *Trouble in July* (1940). After 194 Caldwell produced nothing that equaled these three novels, bu there was no question as to his great narrative gift or his perfec ear for southern country speech. Both these gifts were first ex hibited fully in his collected stories, *Jackpot* (1940), but his mas tery of the story has not been properly appreciated. (S. McI.)

CALDY (Ynys Bŷr), an island in Carmarthen bay, Pembroke shire, Wales, lies 2¼ mi. S. of Tenby. It is 1½ mi. long fro east to west and at its widest nearly 1 mi. across, with abou 9 mi. of coast line. Excavations have produced Neolithic remain and Roman pottery of the 1st century A.D. It is known that Yny Bŷr was inhabited in the 6th century by monks and the herm Pyro who was succeeded as abbot by Samson, later archbishop Dol and now Caldy's patron saint. In the 12th century Cald became a cell of the Benedictine monastery of St. Dogmael Pembrokeshire, and the remains of those buildings are part of th old Priory church (St. Illtyd's) which contains a stone doubly in scribed with Ogham characters (*see* Ogham Writing) and Latin After the dissolution of the monasteries Caldy changed hand many times until in 1906 it was bought by the Reformed Order o Anglican Benedictines who built the present monastery and origi nal abbey church. In 1928, 15 years after becoming Roma Catholics, they moved to Prinknash near Gloucester, having sol the island to Reformed Cistercians (Trappists) from Chimay i Belgium. These monks cultivate the island and grow herbs fro which they make perfumes. Caldy has a small village, and a light house (1828) at its southernmost point.

CALEB, in the Old Testament, one of the spies sent b Moses from Kadesh in south Palestine to spy out the land o Canaan. Only Caleb and Joshua advised the Hebrews to procee immediately to take the land; for his courage he was rewarde with the promise that he and his descendants should possess i (Num. xiii–xiv). Subsequently Caleb settled in Hebron (Kiriath arba) after driving out the three sons of Anak; he gave his daugh ter Achsah to Othniel, his brother, who took nearby Debir (Jos xv, 13–19; *cf.* Josh. xiv, 6–15; Judg. i, 10–20). In the time o David, a Calebite named Nabal, the husband of Abigail, lived a Maon, south of Hebron (I Sam. xxv).

The stories of Caleb probably represent the movements of clan that invaded Palestine from the south, settled in the regio of Hebron and southward, and eventually became absorbed in th tribe of Judah. He is called "the son of Jephunneh the Kenizzite in Num. xxxii, 12; Josh. xiv, 14, and his brother Othniel is called "son of Kenaz" (Josh. xv, 17; Judg. iii, 9), the latter being counte as a descendant of Esau (Edom) in Gen. xxxvi, 11. This may mea that the clan was loosely related to the large group known a Edomites living south and southeast of Palestine, but it was no antagonistic to the Hebrews. That this clan was eventually ab sorbed into the tribe of Judah is indicated by the fact that Cale is described as being from the tribe of Judah in Num. xiii, 6 xxxiv, 19, and that Judah in the later tradition was considered t have given Hebron to Caleb (Judg. i, 10, 20). In the genealogie of I Chron. ii, Caleb is apparently a descendant of Judah. Sinc ıe word "Caleb" means dog, some scholars believe the dog was riginally the totem of the clan. *See* also JUDAH; JERAHMEEL.

(J. P. HY.)

CALEDONIA, the Roman name of north Britain. There ·ere (1) a district Caledonia, of which the southern border as nderstood by Tacitus lay beyond (*i.e.,* to the north of) the isthmus etween the Clyde and Forth rivers, (2) a Caledonian forest possibly in Perthshire) and (3) a tribe of Caledones or Calidones, ssigned by the 2nd-century geographer Ptolemy to Glenmore in nverness-shire. The Romans first occupied Caledonia in the rst sense under Agricola in A.D. 82, penetrating deeply and fighting ıe decisive battle of the war, according to Tacitus on the slopes f the Mons Graupius. Agricolan temporary camps of an army n the move have now been identified as far north as the Pass of range (Banffshire), where the Mons Graupius may well have een. Permanent occupation centred upon the legionary fortress f Inchtuthil (near the village of Dunkeld in Perthshire near ıe union of the Tay and Isla rivers), and is represented by large orts for auxiliary troops in Perth at Callander, Dealginross near omrie, Fendoch in Glenalmond, Cardean near Meigle, and in ngus, at Stracathro near Edzell, all blocking the highland passes; lso at Ardoch, Strageath on the Earn river and Bertha on the Tay iver (all in Perthshire). Inchtuthil, however, was evacuated bout A.D. 90 and with it all sites north of the Earn, all Scotland eing abandoned during the first half of Trajan's principate. inally Hadrian fixed the frontier to the south of the Cheviot hills. bout A.D. 142, when the district up to the Firth of Forth was gain annexed, a rampart with forts along it, the wall of Antoninus ius, was drawn from sea to sea (*see* BRITAIN: *Roman Britain;* NTONINUS PIUS). At the same time the north road as far as the ay at Bertha and Carpow was reoccupied in an attempt to gain olitical control of Strathmore (the large valley in central Scotland xtending through the counties of Perth, Angus and Kincardine-hire). But the conquest was stubbornly resisted, and after at ast two risings the land north of the Cheviot hills was lost not arlier than A.D. 180–185. In A.D. 209 the emperor Septimius everus carried out an extensive punitive expedition against the orthern tribes who had overrun Hadrian's wall in A.D. 197, and similar incursion in A.D. 296 evoked a comparable campaign y Constantius I. The occupation was military and produced ttle civilizing effect. Details of native conditions are beginning ɔ be revealed by excavation. The "crannogs," or lake dwellings, nd the underground stone houses, locally called "weems," in hich Roman objects of trade have been found, belong to this age. tolemy gives a list of tribes and place names, but no certainty as been reached about ethnological problems, though the non-ndo-European character of the Pictish language is now generally greed.

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(I. A. RD.)

CALEDONIAN CANAL, a waterway connecting the east nd west coasts of Scotland. In 1773 James Watt was employed y the government to make a survey for such a canal, which was onstructed by Thomas Telford and opened in 1822. From the orthern entrance on Beauly firth to the southern, near Ft. Wil-am, the total length is about 60 mi., that of the artificial portion eing about 22 mi. The number of locks is 28, and their lift is in eneral about 8 ft., but some of them are for regulating purposes nly. The canal is now little used because of its small size and ıe increased power and range of steam fishing vessels. *See* VATER TRANSPORT, INLAND.

CALENDAR, a word derived from the Latin *kalendae* (cal-nds), literally, the day on which the accounts are due. It now efers to an accounting, usually for civil purposes, of days and ther divisions of time. The calendar now used for civil purposes ıroughout the world is called the Gregorian calendar, after Pope regory XIII, who introduced it in the 16th century. Chronology (*q.v.*), the science of reckoning time by regular divisions or periods, is closely related to calendar development. The present article discusses the important calendar systems in use from prehistoric to modern times in different regions of the world, and is outlined as follows:

I. Primitive Calendar Systems
    1. Days, Hours, Weeks and Months
    2. Seasons
    3. The Year
        Solar Year
        Lunar Year
    4. Time Determination by Stars and Moon
    5. Solstices and Equinoxes
    6. Intercalation and Extracalation
    7. Early Methods of Time Reckoning
II. Western Calendar
    1. Roman Republican Calendar
    2. Julian Calendar
        Easter and the Ecclesiastical Calendar
        Dionysian or Great Paschal Period
        Cycle of Indiction
        Julian Period
    3. Gregorian Calendar
        Epacts
        Adoption and Adjustments
        Calendar Reform
    4. Perpetual Calendars
III. Chinese Calendar
IV. Egyptian Calendar
V. Hindu Calendar
    1. Nakshatra System and Other Early Systems
    2. Classical Calendar Forms
VI. Babylonian and Assyrian Calendars
    1. Babylonian Calendar
    2. Assyrian Calendar
VII. Jewish Calendar
    1. Months and Important Days
    2. Origin
VIII. Greek Calendar
    1. Days and "Thirds"
    2. Months
    3. The Year
    4. The Athenian Prytany Calendar
IX. Muslim Calendar
X. Middle American Calendars
    1. Maya Calendar
    2. Mexican Calendar

I. PRIMITIVE CALENDAR SYSTEMS

Early man required a calendar primarily for religious observance although, of course, when he settled in agricultural communities he came to need a civil calendar as well. Unlike modern man, who uses artificial time intervals, often of a very sophisticated kind, primitive man utilized the cycle of recurring natural phenomena familiar to him in his everyday life. The most obvious and most precise of these were the alternation of night and day and the phases of the moon. The phases of the moon were considered important because their full cycle coincides with the menstrual period of women, which was deemed of great significance by many primitive tribes and was usually accompanied by various taboos; the phases of the moon are also significant for the hunter. Other less precise but naturally recurring phenomena were also made use of for calendar purposes; *e.g.,* the sprouting of leaves, the habits of animals (especially the birth of their young), the coming of the rains or of the dry season, or the periodic flooding of rivers. In general, however, these less precise phenomena can best be described as a "discontinuous" form of time reckoning, because their cyclic return is markedly irregular. Longer periods of time for which lunations were considered inconveniently short were often marked off in the form of the number of harvests, the number of snows or the total of some other easily noted occurrence; thus, a child who has lived through ten harvests or ten snows is ten years old. Methods such as these formed the foundation of the more elaborate calendars of later civilizations.

As might be expected, primitive man was both intrigued by and in awe of the various celestial phenomena that were displayed before him in the clear night skies. He recognized the stars, long before he invented written records, by grouping them into patterns which could be identified either with familiar animals or with the gods, goddesses, heroes, heroines and creatures of mythology (*see* CONSTELLATION). Thus the pattern of the stars was recognizable in a way which allowed, in due course, of a synthesis between the predominant constellations and the natural phenomena such as the sprouting of leaves and the advent of dry and wet seasons. This grouping of stars into constellations not only allowed patterns to be recognized but also enabled particular stars to be referred to without difficulty. It was then possible to trace the path of the moon and, more particularly, that of the sun, through the sky. Because primitive man rose with the dawn and, generally speaking, went to bed at sundown, he naturally watched those constellations visible just before sunrise or just after sunset. More particularly he noted those which were on the eastern horizon at sunrise and on the western horizon at sunset and which were therefore about to rise or set at these times. By observing that a given group would rise each day about four minutes earlier than the day before, he could work out the constellation in which the sun was situated by watching the risings of those stars that appeared just before sunrise. Those stars about to set just after sunset gave, as it were, the other side of the field of stars in which the sun lies. These heliacal risings and settings of stars (*i.e.*, risings and settings that coincide with the rising and setting of the sun) thus allowed the position of the sun among the stars to be derived. This evidence of the sun's position is not, of course, direct because the very appearance of the sun in the sky renders the stars invisible; but by using the phenomenon of heliacal risings and settings and by so tracing the sun's apparent circling of the heavens it is possible to obtain a calendrical year. Seasonal activities in nature—the ripening of plants, the birth of certain young animals, the coming of the rains—were correlated with the changing position of the sun among the stars. Moreover, natural phenomena were also associated with the height to which the sun rose above the horizon at midday; thus those times at which the sun reached its greatest altitudes, and in consequence would be above the horizon for the longest period, would be at midsummer. Primitive civilizations used the shadows cast by trees or by a stick placed vertically in the ground (a gnomon) to measure the maximum altitudes reached by the sun. In such a way they could discern the seasons by means of what are, in fact, astronomical measurements.

The moon's phases follow the cycle new moon to new moon (*see* MOON). Technically, new moon occurs when the moon lies directly between the earth and the sun and, in consequence, cannot be seen. While it is clear that the full cycle of the moon's phases was used by primitive man in his lunar reckoning it is equally clear that his lunar cycle must have had an easily observable commencement. It is likely, therefore, to have begun when the moon first appeared in the evening sky as a thin crescent—indeed, this crescent is still often referred to as "new moon." The cycle of the moon's phases gives a first approximation to the month (it takes $29\frac{1}{2}$ days) so that it was a natural interval for primitive man to use for this reason as well as for those mentioned above. (Modern months are, of course, arbitrary periods of numbers of whole days.) The use of a true seasonal year based on the sun's position among the stars as distinct from a year based purely on seasonal changes in nature, which are subject to fluctuation, was obviously a later development. Thus it is seen that primitive man began his calendar by utilizing the more obvious natural phenomena. As he progressed, so his calendar was increasingly based on astronomical observations.

1. Days, Hours, Weeks and Months.—The day is to some extent a natural division of time. However, its subdivision into a number of equal intervals of, for instance, 24 hours, is a late development and although of great convenience is purely artificial. In the most primitive societies the day was recognized merely as an alternation between light and darkness and in many languages there is no word meaning day—which is perhaps not surprising since the concept of a day as a period of 24 hours involves a marrying together of the periods of light and darkness into one unit. The expressions "light and darkness" were sometimes used but, in general, primitive man counted days as so many dawns, suns, nights or sleeps. The ancient Teutons used terms derived from counting in nights, viz., sennight (a week) and fortnight (two weeks). Divisions of the light period were at first based upon the daytime effects of sunlight, namely, daybreak, sunrise, noon, afternoon, twilight, sunset and so on; upon the compass position of the sun, sometimes in relation to natural and local surface features (the peoples of the far north particularly noted where the sun lay in relation to mountain peaks at various times of day); and also upon the occurrence of daily events such as the crowing of cocks the yoking or unyoking of oxen and the siesta. There were many variations in reckoning the commencement of the day. Dawn was used by some and in Israel the day began at evening. The present method of reckoning from midnight is a late innovation and it is of interest to note that astronomers, for convenience in observing use a day beginning at noon which allows them to keep the same date throughout night observations.

The artificial division of the day into hours became necessary for commercial reasons as trade became more than just a simple system of barter. When the concept of hours was first used these intervals were unequal in duration; this was because people had the idea of an equal number of hours per natural division of the day; *i.e.*, the time between dawn and dusk consisted of just so many hours. Therefore, as this period would be longer in summe than in winter, the summer daylight hours would be of longer duration than their winter counterparts. As far as night was concerned, time indication was best obtained by observing the passage of the stars across the sky. However, with the advent of mechanical clocks, hours of equal duration became more convenient and have since been adopted in all civilized countries.

The week is an entirely artificial division of time and canno really be correlated with any astronomical or natural phenomena except insofar as it is a closed cycle of days. Again it is in trade that an explanation of the beginning of this concept is to be found It occurred among those primitive peoples advanced enough to undertake regular trading and appeared first as the interval between market days. This market week varied in length accordin to the area in which trading occurred. For example, among some west African tribes the interval was four days; in central America it was five days; the ancient Assyrians used a six-day interval while the ancient Romans had a *nundinae* or eight-day period an the Incas a ten-day interval. It has been suggested that the seven day week of the Israelites may have been derived from the marke week, but it must be remembered that their seventh day differe from that of other peoples in that it was not only set aside fo religious observance but was also accompanied by taboos agains trading and certain other activities. If, then, this suggested derivation is correct, it would seem clear that some change in outloo occurred when Israel took over this concept. It was, however a habit of certain other ancient peoples, especially in Africa, t set apart one day each week for religious observance.

The seven-day week which is now universally used may hav been derived from the mystical significance attached to the numbe seven. Support for this view may perhaps be derived from th use of the names of gods and goddesses for each of the seve days. The Romans and the Saxons used such a nomenclature which has been carried on to modern times as Table I shows.

The month is, as has been said, a calendrical period derive from the lunation. As the earliest adopted of the longer calenda periods, it had a significance in religious observance. The Jewis calendar was a lunar one and a lunar calendar is still used in th Christian church and by Islam, while monthly (lunar) reckonin is, of course, the method universally used for calculating pregnancy. A total of 12 lunations amounts to 354 days and i roughly, a year. A period of 12 lunations was therefore used b some primitive peoples to make their year, while others used on

TABLE I.—*Days of the Week*

Latin name	French name	Saxon name	English name
Dies Solis	Dimanche	Sun's day	Sunday
Dies Lunae	Lundi	Moon's day	Monday
Dies Martis	Mardi	Tiw's day	Tuesday
Dies Mercurii	Mercredi	Woden's day	Wednesday
Dies Jovis	Jeudi	Thor's day	Thursday
Dies Veneris	Vendredi	Frigg's day	Friday
Dies Saturni	Samedi	Seterne's day	Saturday

f 13 months; the former period was too short by 11¼ days nd the latter too long by 18¾ days, and thus the solar year nd calendar could not be correlated exactly with a lunar-based alendar. Various arrangements were adopted by early civilizaions, but only gradually did a solution along the lines of the resent system become accepted. The fact that the month is still sed is merely a recognition of its utility as a conveniently brief alendar division.

2. Seasons.—In all except tropical countries the seasons are airly well-defined, but even in tropical lands there are alternating ainy or dry periods. It was the seasons of the more temperate ountries which led to the use of a solar calendar as distinct from lunar one, the reason for this change being the need to have a alendar which was closely tied to the agricultural year of sowing nd reaping. Such an agricultural calendar might not, of course, e one of an actual year's duration because it depended upon the atural phenomena chosen to represent seasons and on their requency. For example, in the tropics the dry and rainy seasons vere chosen, and because there are two dry and two rainy periods er solar year the primitive "year" of peoples in tropical lands, vhich comprised one dry and one rainy period, was of only six nonths' duration. In temperate climates the seasons can be orrelated with agricultural changes, but again this does not necesarily mean that a solar year is chosen; the Teutonic peoples recogized only winter, spring and summer—three seasons—and their hoice did not, therefore, result in a true year. Moreover, the easons are not of equal duration and they undergo minor variaions from year to year. In consequence they are not, per se, articularly suitable for calendar periods; those chosen depended ntirely upon local climate. However, as more elaborate civilizaions developed and trade between peoples increased, the need or an agricultural calendar in which the seasons of one people ould be correlated firmly with the seasons of another became itally necessary. Gradually, then, because seasonal changes are irectly dependent upon the position of the earth in its annual rbit around the sun, a solar calendar was adopted over those omparatively large areas of the world where nations traded with ne another.

In primitive times seasonal changes were often correlated with egular changes in the habits of animals. Thus in Greece the cry f migrating cranes was an indication that it was time to sow or o reap, and the climbing of plants by snails signified that plowing n the vineyards should cease. Changes in plant life were also bserved for this purpose, suitable conditions for sea navigation eing indicated by the sprouting of fig trees. Indications of this ind have been used from the earliest times and have not been mited to settled agricultural communities only. Farmers still ake use of such indications, and rightly, for calendar dates are rtificial and a late spring or late autumn, without particular ignificance for the townsman or for the factory worker, has a reat importance for the farmer. Nowadays the seasons are only eneral indications of the time of year.

3. The Year.—The year, as now understood, is a concept of omparatively late development in mankind's history. In primiive times it grew from the need to have a calendar period longer han the month. Such a period became essential to early peoples hen they wished to compare the age of one man with that of ther men. The lunation is too short to be convenient for such a easurement and is wholly inadequate for reckoning the life span f groups of people. The method of counting by generations was volved comparatively early, as was also the habit of calculating ears not by numbers but by reference to some notable event. hus a plague, a famine, a war, a migration, an unusually large arvest, etc., would form significant points from which counting ould commence or recommence. This method was widely used, r example, in early Arabia, in Babylonia and as far away as orth America among the Indian tribes. Later, the beginning f the reign of a new monarch or chief was used as the starting oint for counting while, where the ruler was changed annually, he years were named for him—in Rome for the consul and in reece for the archon.

The requirement of a long calendar period meant that some cycle of repeated phenomena had to be chosen, and the most primitive long calendar periods appear to have been those based on a cycle of seasons or, more precisely, on an association of natural phenomena of such a kind that phenomena within it would recur in the same order. Such a grouping need not necessarily coincide with a true year. A calendar period which contained one monsoon and one dry period and which had a "year" of six months has already been mentioned. That the true year is a later conception is shown clearly in this instance, because the two monsoon periods are in fact different, one monsoon blowing from the southwest and one from the northeast, and to compound a calendar period containing both the southwestern and the northeastern monsoon required a degree of sophistication which would not be expected to occur early. Another example of an early grouping of phenomena to give a calendar period longer than the month may be seen in the vegetation year, which lasted for ten months, the gap between one such period and the next being passed over. Again, a true year required a more sophisticated approach and meant that the use of concrete phenomena was supplanted in favour of an astronomical computation. Thus it is plain that the concept of a year needs to be based upon astronomical observation.

Solar Year.—It is now known that the true year is that period of time in which the earth performs one revolution in its orbit around the sun. This period is found by noting the apparent passage of the sun through the constellations; *i.e.*, one journey of the sun along its apparent path—the ecliptic (*see* TIME MEASUREMENT). The year thus computed, called the "tropical years," contains 365 days 5 hr. 48 min. 46 sec. of mean solar time, *i.e.*, 11 min. 14 sec. less than 365¼ days. While mean solar time is an artificial subdivision of the day, the fact that the orbital period of the earth is not a whole number of days is real enough; thus for a calendar period to be formulated for the year, it is necessary to have a 365-day period and then to make some arrangement to take account of the fractional quarter day. The most convenient method of doing this is to wait for it to accumulate to a whole day. If the fraction is left out of consideration, the 365-day year will, over the centuries, come to begin at different seasons and the year as a calendar period will thus be made useless. It is, however, necessary to use some period, even though it be other than the true astronomical year. Such a period is the civil year, which has three basic requirements to fulfill. It must contain the full series of the seasons; it must always begin at the same season; and the lunar calendar should, as far as possible, be incorporated in it. Therefore such months as are used for it must be of equal length, or as nearly so as can be arranged.

Once the concept of a year had been achieved, various attempts were made to meet these three requirements. Observations of the heliacal risings and settings of certain stars made it possible to select a time, geared to the sun's position on the ecliptic, for the beginning of the year. In this way the beginning of the year could, apparently, be kept at a fixed time from both equinox and solstice (see *Solstices and Equinoxes*, below). However, this fixture could not be exact, because the seasons are determined both by the earth's position in its orbit and by the inclination of its axis to the plane of this orbit. The seasons therefore gradually get "out of step," because although the angle of inclination of the earth's axis remains static, its direction in space is continually altering (*see* PRECESSION OF THE EQUINOXES). This precession of the axis is observable, over many years, as an apparent motion of the ecliptic against the background of the stars; in consequence, if the commencement of the year is taken from observed heliacal risings and settings of particular stars, the year will get out of alignment with the sun's true position in the sky and thus with the seasons. For the year to keep in correspondence with the seasons it must correspond with the equinoxes, for precession alters the time at which these occur and an additional correction to the number of days in the year is required—in other words, use of the fractional quarter mentioned above is not sufficiently accurate. The early civilizations which adopted the year did not, of course, realize this. The very small correction necessary was for a long time unobservable, and the phenomenon of precession remained undiscovered until *c.* 130 B.C. As a result, the Egyptians, who commenced their year with the heliacal rising of the star Sirius, found, after centuries, that instead of continuing to coincide with the flooding of the Nile, this rising occurred at an increasingly later time. With the discovery of precession a new precision in the calendar reckoning of the year was possible. Just as the quarter day was accounted for by the addition (intercalation) of a whole day every four years, so the effect of precession could be taken into account by postponing the intercalation of a day by one year whenever the precessional factor amounted to, *e.g.*, a quarter day.

Because the lunar cycle cannot be exactly reconciled with the year, if it is decided to make the month at least as long as a lunation, then either the months must contain unequal numbers of days—as in all modern calendars—or days left over after equal-number months must be unallotted and intercalated each year. The latter approach has, after due experience, given way to the former in which the months, although not equal in length, are very nearly so.

Lunar Year.—A period of 12 lunar months constitutes a lunar year. If a lunar month is counted as $29\frac{1}{2}$ days, the lunar year contains 354 days. It is thus $11\frac{1}{4}$ days shorter than the solar year and a cycle of lunar years will, therefore, become progressively more and more out of step with the seasons. After 34 lunar years the difference between the lunar calendar and the solar calendar reaches a minimum, but it is still significant. For these reasons a lunar year is of no real use for calendar purposes; its use as a collection of lunations only may be of help to primitive peoples whose time reckoning is based on the lunar month.

The incompatibility of the lunar and solar years was one of the problems which had to be faced by early civilizations. The lunar calendar had great religious significance while the solar calendar had a prime importance from the seasonal or agricultural point of view, and it was early desired to marry together the two systems. This could be accomplished only by extending the lunar year of 12 lunar months, either by adding a number of monthless days at the end of the year or by taking an artificial value for each month and by so doing destroy the nature of the month as a truly lunar period. In either event the dates of those religious festivals determined by lunations must change from year to year.

4. Time Determination by Stars and Moon.—The problem of indication of time within the year cannot easily be solved by reference to seasonal changes for the simple reason that the length of particular seasons is not constant from year to year. Some other means of time measurement must be found, and the stars, particularly their heliacal risings and settings, provide a ready and accurate one. Such a system requires familiarity with the constellations and with the brighter stars, and most primitive peoples had some form of star recognition. The Indians of South America, the Polynesians and Melanesians, for example, as well as other primitive civilizations, knew the stars well. Homer and Hesiod refer to the various constellations and bright stars and, as do other classical authors, indicate time by referring to the rising and setting of certain stars. For example, they state that vines should be pruned before Arcturus is seen to rise in the evening, and that autumn storms are to be expected, and autumn sowing should be undertaken, when the Pleiades are seen to set before dawn. Even now, certain primitive peoples count the time of year by the Pleiades. Some South American Indians use the Pleiades to indicate the passage of a solar year and, indeed, have the same word for both Pleiades and year. The Egyptians used the heliacal risings and settings of Sirius for the same purpose. Intervals of time during the night may also be determined by the stars; this was done before the advent of accurate clocks and it is still considered necessary to teach military recruits to tell the time in this way.

The course of the moon in the sky and the cycle of its phases provide a natural division of periods of time intermediate between the year and the day. These periods are short enough to be remembered easily and the phases can be noted at a glance; therefore, the month constitutes a natural, definite and limited unit of time. Moreover, the phases follow one another with a gap of only a few days (new moon) when no moon is visible, so that they present an almost continuous sequence from waxing to waning; this doubtless suggested to early man the idea of continuous tim reckoning. The lunation was often divided into two periods, corresponding to the waxing and the waning of the moon, while som peoples even divided it into four, the extra divisions being made a the first and last quarters. The moon's phases were of great importance for religious observance, and at both new moon (*i.e.*, th first thin crescent) and full moon, festivals were often held.

5. Solstices and Equinoxes.—The solstices and equinoxes are of course, dependent upon the apparent position of the sun. A solstice the sun reaches that position on the ecliptic where it i at its furthest north or south from the celestial equator and "stand still" before moving again toward it. At equinox the sun is at on of the two points where the ecliptic intersects the celestial equato so that day and night are then of equal length. The sun's position are important because they indicate the seasons. At summe solstice the sun appears at noon at its maximum highest altitud above the horizon, while at winter solstice it reaches only its min mum highest altitude. The solstices may be observed either b noting the length of the shadow cast by a gnomon or by using fixed observing point and noting the sun's position in relation t local landmarks. The latter course was practised by, for example the Indians of Arizona and the Eskimos, while the gnomon wa used in middle eastern countries and in Greece. The observation of the equinoxes is more difficult and requires at least som means of measuring the relative duration of daylight and darknes Certain of the more advanced primitive peoples, such as th Eskimos, the northern Scandinavians and the Polynesians, mac such observations.

6. Intercalation and Extracalation.—Intercalation is th insertion of an additional day or days in a calendar in order t bring it into line with the solar year. For a lunar year of 12 lunations, the total number of days that must be added is $365\frac{1}{4} -$ $(12 \times 29\frac{1}{2})$, or $11\frac{1}{4}$ days. Extracalation is the marrying togethe of a lunar year of 13 lunations with the solar year by subtracti days; in this case the number of days subtracted from the lun year is $(13 \times 29\frac{1}{2}) - 365\frac{1}{4}$, or $18\frac{1}{4}$. In the 12-lunation year th lunations will precede the seasons earlier and earlier if the proce of intercalation is not used, while in the 13-lunation year th months will arrive later and later than the appropriate seaso unless extracalation is carried out. The question facing those wh compile a calendar is to decide when intercalation or extracalatio is to be done. If the series of months is named for and is intende to fit into a seasonal pattern, then the purpose of the procedure to keep these months in their proper positions.

The earliest method of carrying it out involved the repetition removal of an entire lunation, so that the change occurred at mo only every three years. Very often in the 12-lunation year th lunation which coincided with the harvest was repeated, its fir appearance in that year being referred to as "lost" or "forgotten In the 13-lunation year that lunation was omitted which had b come so out of step that it usurped the position originally held b the lunation which followed.

From the practice of intercalation there arose the lunisol year, which had alternately 12 and 13 months, but this soon becar out of step with the seasons because of the seven-day err ($- 11\frac{1}{4} + 18\frac{1}{4}$ days) every two years. A more exact method synchronization was to name some or all of the months (lunation after appearances of stars or constellations coinciding with th true solar year. Such, for example, was the practice of the India of northwest America and the peoples of Polynesia. In Bab lonia, before the middle of the 3rd millennium B.C., a series of months was used and one particular month was singled out as th to be intercalated.

The intercalation was, in primitive civilizations, an empiric procedure and occurred when the seasons and their appropria months became noticeably and sufficiently out of step. The d cision to intercalate or not was taken by the priests, for they we concerned with the religious observances tied to the calenda Empirical intercalation continued into Greek times, but in the 7 century B.C. the Greeks introduced a cycle of intercalation know as the octaeteris and in this way began the scientific regulation the calendar. The solar year is a naturally recurring cyc henomenon and, in a sense, has no natural beginning. The commencement of a lunisolar year was, however, often tied to the gricultural year, but even this could lead to wide variations.

7. Early Methods of Time Reckoning.—Any calendar sysem involves the recording of the days, lunations or years which ave passed. Early peoples did this by means of some kind of lly. But as the calendar system became more sophisticated (for xample, in the computation of a lunisolar year), the methods of ckoning became more elaborate, and it seems likely that the acus was used. The reckoning was in the hands of the priests, and ey saw to it that the religious festivals which, in the most primive societies, had been regulated purely by lunar phenomena or y the beginning and ending of seasonal activities like sowing and aping, were celebrated regularly. Thus the priesthood, through e accumulated knowledge and experience of many generations, quired considerable information on calendar matters. Usually is information was jealously guarded. There has been much rearch on the methods of calculation used in Babylonian times, d it is clear that by the 2nd millenium B.C. a considerably deeloped system of arithmetical calculation existed. Recording was rried out in cuneiform script on clay tablets which were later aked for permanence. It is the work of those early peoples who rst tackled the questions relating to the correlation of lunar henomena, the seasons and the cyclic appearances of stars and nstellations, which furnished the basic material and methods of tack for the development of the modern system of time reckoning d the more sophisticated type of calendar.

II. WESTERN CALENDAR

1. Roman Republican Calendar.—The calendar of the Roan republic was similar in style to the Greek calendar. It was, owever, more primitive than the latter and appears to have been erived from an earlier Roman calendar which was lunar. This arlier calendar contained ten lunations which ran from March to ecember and had a two-lunation gap in the winter. The informaon available about the Roman republican calendar is derived from e fragmentary pre-Julian calendar of the city of Antium, extant bout 70 B.C., as well as from various later literary references. The publican calendar contained 12 months—seven equal in length a lunation, four with two additional days each and one with one ay less. Thus the total length of the calendar year was 355 days, r $10\frac{1}{4}$ days less than the solar year. The months were named as llows, the figures in parentheses giving the number of days in ach: Martius (31), Aprilis (29), Maius (31), Iunius (29), Quintis (31), Sextilis (29), September (29), October (31), November 29), December (29), Ianuarius (29) and Februarius (28).

The earlier calendar was traditionally attributed to Numa ompilius, the second king of Rome (*c.* 716–673 B.C.), and it was so believed that Ianuarius and Februarius were the months which ere added in order to bring the calendar up to its full quota of 12 onths. Certainly the leaving of a gap of 60 days, as such a tenonth year would entail, is not unknown in many early civilizaons. It has also been suggested that the 12-month form of the lendar was due to the Etruscans of Tuscany, and in support of is theory it is claimed that the name of the fourth month, Iunius, a derivation from *Iunonius,* which is connected with the Etruscan rm of the name of the goddess *Uno* (Juno).

March remained the first month of the year for a long period, t the name *Ianuarius* has been taken by some scholars to indite that the Etruscans, whose dynasty was expelled early in the urth century B.C., had commenced the year in January, since is title referred to the festival of the god of gates or god of "first eginnings." The beginning of the year on Jan. 1 instead of March became officially recognized in 153 B.C. But, in the popular mind e year was thought to end on Feb. 23 (the *Terminalia*), for it as after this that intercalation was made. An intercalary month *ensis intercalaris*), which occurred once or twice every four ears, was followed by the remaining five days of February.

The operation of the calendar was under the jurisdiction of the ntifices or priests. Every month they watched for the new oon and proclaimed its appearance; after the dedication of the apitol in 509 B.C. the proclamation of the new moon was made from there, as was the announcement of the appropriate *nonae* or "nones," *i.e.,* the ninth day of the month before the *idus* or ides, the backward reckoning from the ides being inclusive. The ides fell in mid-month, this being the time of the full moon. They occurred on the 15th day in Martius, Maius, Quintilis and October and on the 13th day of the other months. In consequence there were either seven or five days from the beginning of the month to the nones—seven in the months Martius, Maius, Quintilis and October and five in the remainder. The first day of the month, the day of proclamation of the new moon and of the nones, was known as the *kalendae* or callings. The second day was known as the *postridie kalendas,* and this day, the *nonae* and the *idus* were believed to be unlucky, the *postridie kalendas* especially so. The *nonae* were sometimes festival days, while on the *kalendae* sacrifices were offered to Juno, the spouse of Jupiter, and to Janus, the god of beginnings; the *idus* was held sacred to Jupiter.

The Roman republican calendar made use of *nundinae; i.e.,* ninth days or market days, which resulted in the use of an eight-day interval or "week" between *nundinae.* These weeks were independent of the months. They had no individual names and were unconnected with any religious festivals; they were, indeed, merely intervals between one market day and the next. Some days of astrological significance are to be found in some later calendars of the republic; such days were known as "Egyptian" (*dies Aegyptiaci*), but they had nothing to do with any Roman religious cult. On the other hand, some of the months had religious associations with the god Mars, and the festival of purification (*februa*) occurred in Februarius. Festivals were most often held on odd-numbered days and, if a festival lasted for more than one day, there were gaps of either one or three days in between; for example, the festival *Lučaria,* which lasted two days, was held on Quintilis 19 and 21 and the *Carmentalia* on Ianuarius 11 and 15.

Inscriptions given on the calendar (many of which have survived) showed for each day a sign to indicate its civil standing. Some of these were: F for *fas* (lawful), indicating those days available for legal business; N for *nefas,* indicating days not so available; C for *comitialis* (relating to the *comitia* or assembly), indicating days on which a meeting of the assembly could occur; and NP (perhaps *nefas feriae publicae,*) denoting public feast days on which sacrifice was offered. Such permissions were sometimes divided during a day; thus a day could be *nefas* in the morning and evening and *fas* in the afternoon.

Elaborate and ingenious though the republican calendar was, it became hopelessly confused by the end of the republic both because of failures on the part of the priests and because of political maneuvers. The calendar was interfered with so as, for example, to reduce or extend the term of office of a particular magistrate. It therefore needed revision, and this was undertaken by Julius Caesar in the first century B.C.

2. Julian Calendar.—The Julian calendar, the basis of the civil calendar now used throughout the world, was derived from the Roman republican calendar as reformed by Julius Caesar. By 46 B.C. the republican calendar had become so seriously out of step with the seasons that the calendar equinox had become separated from the astronomical equinox by three months. As a result, the seasons were no longer in proper relationship with the calendar months; winter was carried back into the autumn months and autumn into summer. Caesar, advised by the Alexandrian astronomer Sosigenes, began his reformation in 46 B.C. by intercalating not only the usual 23 days but also an additional 67 days between the months November and December, thus making that year 445 days in length. By this action the civil and astronomical years were brought into line and the stage was set for a new calendar which would avoid the errors of the old.

For his new calendar to have any degree of permanency, Caesar realized that so gross a discrepancy between the astronomical and civil calendars must be prevented from occurring again. Dictatorial action was necessary and, upon the advice of Sosigenes, the lunar calendar was abolished and it was decreed that regulation should be on the basis of a solar calendar. Sosigenes also suggested, from astronomical evidence, that the length of the year should be $365\frac{1}{4}$ days. But such a length was not practical inasmuch as an odd quarter day could not be fitted into a civil reckoning. It was therefore decided that there should be a four-year cycle in which the first three years each had 365 days and the fourth year 366 days. The new calendar was first adopted in 45 B.C., over 700 years after the date on which Rome is believed to have been founded, and the year was taken to begin on Jan. 1.

There has been a tradition that in his reformation of the calendar Julius Caesar so ordered matters that the odd-numbered months, *i.e.*, January, March, May, July, September and November, each had 31 days; April, June, August, October and December 30 days; and February 29, or 30 days every fourth year. However, there seems to be no evidence, either ancient or modern, to support this view, and indeed the grammarian Ambrosius Theodosius Macrobius (4th–5th century A.D.) in his *Saturnalia* flatly contradicts it. In 44 B.C. the month Quintilis was renamed July as a memorial to Julius Caesar's reform.

The emperor Augustus is reputed to have made in 7 B.C. adjustments to the Julian calendar rendered necessary by a mishandling of the intercalations in the 38 years since its adoption; it is said that he lengthened the month Sextilis and had it renamed Augustus in his own honour. However, research during the 19th century led most scholars to the conclusion that much was attributed to Augustus without warrant, and that certainly the lengthening of the month Sextilis and its renaming as August should not be credited to him. Macrobius gives evidence which indicates that Sextilis was renamed by the consuls Asinius Gallus and Marcius Censorinus. The idea of renaming months after emperors appears to have continued, for Macrobius and others say that Caligula changed the name of September to Germanicus in memory of his father and that Domitian decreed that October should be called after himself. These last two decrees seem to have been abolished after the deaths of these emperors, however, for the surviving names of the months are those of the original Roman republican calendar with, of course, the changes of Quintilis and Sextilis to July and August respectively.

The additional day which Julius Caesar had decreed should be inserted every fourth year was intercalated in February, the shortest month, between the 23rd and 24th days, and thus occurred after the sixth day preceding the calends (first day) of March. This intercalation resulted in any fixed festival which occurred after February falling on the next weekday but one to the day on which it fell in those three years when intercalation was not made. Thus the intercalation caused Feb. 23 to occur twice in the intercalary year; the intercalated day was therefore known as the *bissexto kalendas* and the year in which the intercalation occurred as a bissextile year. (The modern term "leap year" appears to have been derived from the Old Norse *hlaupar*, although the term "bissextile" is still used occasionally.)

The Julian calendar assumed the length of the year to be equal to 365.25 days, whereas the tropical year (the apparent passage of the sun from one solstice to the same solstice again, or from equinox to equinox) is nearly 365.2422 days. The calendar year was therefore 0.0078 days, or a little under 11 min. 14 sec. too long. This small fractional error does not, of course, become significant until a long time has passed and amounts only to a little over a day after 130 years. Thus it is clear that the Julian calendar was a satisfactory means of so arranging the civil dating that the seasons occurred at the same time each year; and only after centuries did it become so markedly out of step with the seasons that an attempt to provide a still more refined method of calendar reckoning had to be considered, with intercalation more exactly regulated over a period longer than the Julian four-year cycle.

Easter and the Ecclesiastical Calendar.—The Julian calendar brought order into the computation of dates and, being in principle a solar calendar, was successful in correlating the civil and astronomical years over a long period, thus keeping the seasons and the months in step. However, it could act only as a guide for the regulation of the dates of religious festivals in the Christian Church because the chief of these were founded on events dated by the Jewish lunar calendar. The Christian Church had therefore to find a method of reckoning these festivals and of synchronizing the observance of each by Christians throughout the world; this necessitated the construction of a combined lunisolar calendar Those festivals based on Jewish reckoning were movable, *i.e.* they were held on a different date each year in consequence of thei dependence on the phases of the moon; while those established by later ecclesiastical decree, *e.g.*, commemorations of saints, coul be immovable, *i.e.*, on the same date each year, through being reckoned by the solar calendar and not by the lunar.

The earliest question to be decided was the date of Easter, whic is the most important of the church's festivals and from which th dates of all other "movable" feasts are determined. There arose by the 2nd century A.D., disputes among Christians concerning th date on which it was proper to celebrate Easter. Because th crucifixion occurred before the Jewish Passover, Easter was computed according to the Jews' mode of determining this festiva The Passover was ordained to be celebrated on the 14th day o the first month of the new year; *i.e.*, of the lunar month whos 14th day falls on or next follows the vernal equinox. Howeve because the civil calendar was of solar origin and because Sunda was the main day for Christian congregational worship, it becan generally agreed that the Sunday next following the date of th old Jewish Passover should be the date set aside for Easter. Ther were, however, those who wished to take a more literal view and t observe the exact Jewish date and so celebrate Easter on the 14t day of the lunar month; *i.e.*, on the day usually conceded to be th time of full moon. These literalists, or Quartodecimans, as the were called, were a minority and were regarded as heretics. I A.D. 325 the ecumenical Council of Nicaea ordained that Easte day should thenceforth be celebrated on the Sunday immediatel following either that full moon which occurs on the day of th vernal equinox or, if there is no full moon on that day, then o the Sunday following that full moon which occurs next after th day of the vernal equinox. In order to prevent the festival fro coinciding either with the Jewish Passover or with the celebratio of the Quartodecimans, special provision was made, should the fu moon actually occur on a Sunday, to defer the celebration of East until the next Sunday.

It was now necessary to make sure that every congregation he the festival on the same date in the solar calendar. Because th time of Easter depended upon the occurrence of astronomic phenomena—*i.e.*, full moon and vernal equinox—tied to the tropical year, the problem to be solved was that of marrying togeth the civil week, the lunation and the astronomical (solar) calenda Because of the nature of the case the rules for doing this cou not be simple, and the determination of Easter is complicated. Th rules constitute what is known as the ecclesiastical calendar.

The first thing to do is to correlate the civil and the astronomic calendars. The problem is, therefore, to devise a means where the day of the week corresponding to a given day in any year c be found. The total number of days in the week is 7; the tot number of whole days in the year is 365. Because 365 is not exactly divisible by 7, two successive years cannot begin on the san day of the week. Thus, if one year begins on a Sunday, the ne year will begin on a Monday or, if it is a leap year, on a Tuesda Now if some system is arranged so that the day of the week wi which any particular year commences can be ascertained, th the dates on which the days of the week will fall throughout th year can be determined. For the ecclesiastical calendar, therefore, it was decided to allot one of the letters from A through to the first seven dates of the year. The particular letter is determined by the date on which the first Sunday of the year fall If Sunday falls on Jan. 1 the Sunday or dominical letter is A, it falls on Jan. 2 the dominical letter is B, if on Jan. 3 the dominic letter is C, and so on. Since the date of the first Sunday of ar one year falls one day earlier than on the previous year, th dominical letters run backward from G to A.

Every Sunday during that particular year will be represented this same letter. The dominical letter thus indicates how all t weekdays are placed with respect to the dates throughout t year.

In the Julian calendar the dominical letters recur in the sar order every 28 years; this forms a comparatively short cycle whi is computed by multiplying the number of years in a comple ulian cycle (*i.e.,* four, because every fourth year is a leap year nd can be considered to complete a cycle) by the number of days f the week, because these cover the complete series of the domincal letters. The date of this invention is unknown but it would ppear not to have been earlier than the Council of Nicaea. he 28-year cycle was known as the cycle of the sun or the olar cycle, and after a complete round the same dominical etters referred to the same civil calendar dates as at the commencement of the cycle. Thus a table of dominical letters could e drawn up and, provided that the tabulation covered a period of 8 years, the dominical letter for any year could readily be found. he cycle was taken to have commenced nine years before the hristian era, making the year A.D. 1 the tenth year of the first olar cycle, and the following rule to determine the position of any ear in the cycle was formulated: Add 9 to the date and divide he sum by 28; the quotient is the number of cycles elapsed and he remainder is the year of the cycle. Should there be no remainder, then the year concerned is the final year of a cycle.

Once the position of a year in the solar cycle has been determined, its dominical letter can be ascertained provided that the lominical letter of the first year of the Christian era is known. his began on a Saturday and, in consequence, the first Sunday ell on Jan. 2, giving the dominical letter B. In A.D. 2 the first unday was on Jan. 1 (one day earlier) and the dominical letter or this year was therefore A. In A.D. 3 Sunday again moved backward by one day bringing it to Dec. 31 of A.D. 2. The first Sunday in A.D. 3 consequently fell on Jan. 7, giving the dominical etter G for this year. In A.D. 4 it fell again one day earlier, that s, on Jan. 6, and the dominical letter was F. But A.D. 4 was a eap year and this means that the first Sunday for A.D. 5 arrived wo days earlier, *i.e.,* on Jan. 4. Hence A.D. 4 has two dominical etters, F and E, and A.D. 5 is given the dominical letter D. It will e clear that the dominical letter for A.D. 6 must be C, that for .D. 7 is B, and for A.D. 8 which is another leap year, the dominical etters are A and G.

Next, for determining Easter, the lunar nature of the festival ad to be taken into account. The framers of the ecclesiastical alendar took lunations to consist alternately of 29 and 30 days (making up a lunar year of 354 days) and adopted a lunar cycle n this basis. This cycle was equal to 19 Julian years; *i.e.,* it mounted to $19 \times 365\frac{1}{4}$ or $6{,}939\frac{3}{4}$ days. Now 6×19 lunations of 9 days each amounts to $6 \times 19 \times 29$ or 3,306 days, and 6×19 nations of 30 days each amounts to 3,420 days; together these otal 6,726 days. In 19 Julian years there are five leap years (unless the fourth year of the 19-year cycle is itself a leap year, in hich case there are only four); in consequence, the total number f days in the lunar cycle would be either $6{,}726 + 5 = 6{,}731$ days r $6{,}726 + 4 = 6{,}730$ days. Six intercalary months of 30 days ach (a total of 180 days) as well as one intercalary month of 29 ays were added during the cycle to make it coincide as closely as ossible in length with 19 tropical years. Thus the total number f days in a lunar cycle amounts either to $180 + 29 + 6{,}731 =$,940 or to $180 + 29 + 6{,}730 = 6{,}939$. The average length of the unar cycle is, therefore, $\frac{1}{4}(3 \times 6{,}940 + 6{,}939) = 6{,}939\frac{3}{4}$ days, nd thus it exactly equals 19 Julian years.

By means of this lunar cycle the dates of new moon could be ndicated in the civil calendar, for the cycle virtually places these henomena on the same days of the month, and thus the phase of he moon on any given day in one year of the cycle will be the same n the equivalent year of the next cycle. In consequence a table howing the phases of the moon for 19 years will serve for any year rovided that the number in the cycle of that year is known. This ycle is sometimes known as the Metonic cycle (see *Greek Calendar,* below). A year's number is called its golden number, perhaps because it was marked with that colour in ancient calendars, r because of its importance for the determination of Easter.

The golden numbers were introduced about the year 530, but ere arranged as they would have been if they had been adopted at he time of the Council of Nicaea. The cycle was taken to begin n a year when new moon fell on Jan. 25. This date for new moon ccurred in the year preceding the commencement of the Christian ra, and so to find the golden number for any year the rule is: Add 1 to the date and divide the sum by 19; the quotient is the number of lunar cycles elapsed and the remainder is the golden number. When the remainder is zero, that year is the last of a cycle. However, the true motions of the sun and the moon are not completely regular and, thus, while a complete lunar cycle is very nearly correct, errors in it often become significant during its progress, and the actual new moon may be two calendar days from its theoretical position as calculated by the cycle.

Dionysian or Great Paschal Period.—The solar cycle brings back the days of the month to the same day of the week, and the lunar cycle restores the new moons to the same day of the month; therefore the cycle $28 \times 19 = 532$ years includes all the variations involving the new moons and the dominical letters, and is consequently a period after which the new moons again occur on the same day of the month and the same day of the week. This "grand cycle" was first employed by the astronomer Victorius of Aquitaine, who had been appointed by Pope Hilarius about 465 to revise and correct the church calendar, and the cycle was therefore known as the Victorian period. However, its use for determining Easter by the 6th century Scythian monk Dionysius Exiguus led to the more usual appellation Dionysian period or Great Paschal period.

Cycle of Indiction.—The Roman emperor Diocletian (reigned A.D. 284–305) instituted a census for taxation purposes and ordered that it be taken every 15 years. This 15-year period later became known as the cycle of indiction. It had no astronomical significance, and as it was primarily a fiscal period, its date of commencement could be varied if necessary. Gradually its use became more widespread and it was sometimes utilized for other than financial purposes. During the middle ages the cycle was taken as commencing on Jan. 1. It was used in the 11th century and later as a form of dating for charters and public deeds, the year of indiction being given as well as the year of the Christian era. Taking Jan. 1 as the commencement of each year in the cycle and reckoning backward from the year 313, it is found that the first year of the Christian era would have been the fourth year of a cycle of indiction; in consequence, the rule for finding the position in this cycle of any year may be expressed as follows: Add 3 to the date, divide the sum by 15, and the remainder is the year of indiction. When the remainder is zero, that year is the 15th or last of a cycle.

Julian Period.—Obviously a calendar showing months and days is convenient from the civil point of view, but it is not a suitable means for counting back long periods of time in order to find out how many days have elapsed since the occurrence of some astronomical phenomenon or civil event. This problem was tackled in 1582 by the Italian Protestant scholar Joseph Scaliger (1540–1609). He realized that during a period made up of the product of the solar cycle, lunar cycle and cycle of indiction, *i.e.,* $28 \times 19 \times 15$ or 7,980 years, no two years can be expressed by the same number in all three cycles. He therefore proposed the use of this very long period for chronological purposes, and named it the Julian period in honour of his father. Scaliger fixed its commencement arbitrarily at Jan. 1, 4713 B.C., thinking that this would be early enough to include all historical events and all precisely observed and recorded astronomical phenomena. The great value of the Julian period is that each day is consecutively numbered from Jan. 1, 4713 B.C.; thus the interval between any previous event and the present can be precisely ascertained. By international agreement among astronomers, now the primary users of the system, each Julian day is taken as commencing at noon; thus observations made at night can be referred to by one calendar date.

3. Gregorian Calendar.—Although the Julian method of intercalation was not only convenient but also provided a calendar whose length closely approximated the tropical year, its deficiency showed up in due course, so that further reform became imperative. Its basic defect was that, in taking a period of $365\frac{1}{4}$ days as the length of the tropical year, it overestimated this length by a little less than 11 min. 14 sec. or, more exactly, by 0.0078 days. Thus, although the error amounted only to one whole day in 128 years, it was constantly increasing and over a long time became troublesome. By A.D. 730 it resulted in the vernal equinox having advanced by three days from its position in the calendar at the time of the Council of Nicaea, and this was noted by the English historian Bede of the monastery of Jarrow. By the 13th century the discrepancy had increased to just over seven days; attention was drawn to this fact by the Paris professor Johannes de Sacrobosco (John of Holywood, *fl.* 1230) in his *De Anni Ratione*, as well as by Roger Bacon, who wrote a treatise, *De Reformatione Calendarii*, suggesting that a change should be made. This treatise was not published but was transmitted to the pope. No action was taken and it was not until the 15th century that there was a revival of criticism of the calendar; the discrepancy between the true vernal equinox and its calendar date of March 21 by then amounted to nine days. In 1472 Pope Sixtus IV invited the astronomer Johann Müller (Regiomontanus) to come to Rome to superintend the necessary changes in the Julian calendar, but Regiomontanus was assassinated in 1476 and no reformation took place. In the 16th century, after further criticisms the Vatican again made an effort to reform matters, and this time it was successful. Pope Gregory XIII approached the governments of the principal states of the Holy Roman empire, and all agreed to accept his alterations. He then promulgated a new calendar known as the Gregorian or new style calendar in a brief issued in March 1582.

Gregory was advised in his reformation by the Neapolitan astronomer and physician Aloysius Lilius or Luigi Lilio Ghiraldi. But Lilius died in 1576, before the reformation was fully completed, and Gregory then sought the assistance of the German Jesuit and mathematician Christopher Clavius (1537–1612), who verified all the calculations and developed the rules. Clavius published his *Romanii Calendarii a Gregorio XIII P.M. restituti Explicatio* in 1603.

The first thing to do in preparing a new calendar was to take account of the fact that the tropical year amounts to 365.2422 and not 365.25 days. This difference amounts to three days in 128 × 3 or 384 years, *i.e.*, to approximately 3 days in 400 years; and it was this approximation which Gregory adopted. To take account of this difference Gregory ordered that no century year should be counted as a leap year unless it was exactly divisible by 400. By the time this reformation took place the displacement of the beginning of the year had increased to ten days, so Gregory directed that the day following the feast of St. Francis, *i.e.*, Oct. 5, should be reckoned as Oct. 15. In consequence the next vernal equinox fell correctly on March 21 instead of on March 11. The difference between the Gregorian calendar (new style) and the Julian calendar (usually referred to after this reformation as old style) remained ten days until the year 1700, after which it amounted to 10 + 1, or 11 days, because the year 1700 was a leap year in the old style but not in the new. These procedures of changing the intercalation of leap years and dropping 10 days were simple enough, but problems arose concerning the change required in the lunar cycle.

Epacts.—It was Lilius who tackled this problem of changing the lunar cycle. It amounted to 6,939.75 days, whereas the true period, for 235 lunations, should have been 235 × 29.530588 or 6,939.68818 days. Because a lunar cycle covers 19 Julian years, the difference of 0.06182 days amounts to one whole day in a little over 307 years and so, after this period, the new moons occur one day earlier than indicated by the golden numbers. For the reform it was decided, therefore, to reject the golden numbers and adopt the "epact." (This term was derived from the Greek *epakte* and meant, originally, an intercalation, but was later used to signify the age of the moon at the beginning of the year.) Now the difference between the calendar year and the lunar year is 365 − 354, or 11 days; and therefore if a new moon falls, for example, on Jan. 1 in one year, it will be 11 days old on Jan. 1 of the next year and 22 days old on Jan. 1 of the year after that. The epact of the second year is then said to be 11 and that of the third year, 22. However, Lilius gave every third year of the lunar cycle an intercalary month of 30 days; therefore in the fourth year the age of the moon on Jan. 1 would be not 33 days but only 3. It might, therefore, appear that to find the epact of any particular year, 11 should be added to the epact of the previous year and, when the sum exceeds 30, deduct 30. However, the problem of leap years and the above-mentioned inaccuracy of the lunar cycle have to be taken into account.

The omission of a leap year every century except when the date was exactly divisible by 400 meant that the omission of the intercalary day would result in the astronomical new moon occurring one day *later* in every month following such an omission. Thus the age of the moon would be one day *less* at the end of every such month. Therefore it was necessary that the epact should be diminished by unity, and so the epacts 11, 22, 3, 14, etc., would become 10, 21, 2, 13, etc. On the other hand, the lunar cycle was not exact; as mentioned above, the error amounted to one day in a little over 307 years, the astronomical new moon arriving one calendar day earlier. This required an increase of the epact by unity so that epacts 11, 22, 3, 14, etc., became 12, 23, 4, 15 etc. What was subtracted in order to bring matters into line through more accurate intercalation had largely to be added on again to allow for errors in the lunar cycle, and it was therefore decided that any change in the epact which might be required should be held in abeyance until the commencement of the appropriate century. Corrections of the epact for errors in the lunar cycle were to be made only at the end of 300 years, and in the Gregorian calendar this correction was assumed, for convenience to amount to one day in 312½ years or eight days in 2,500 years Thus changes of epact were made at the end of seven successive 300-year periods and once at the end of a 400-year period. From the way in which the epacts were disposed at the time of the reformation of the calendar, it was found that the most correct result was to be obtained by assuming one of the 2,500-year period to terminate with the year 1800. Reckoning from the time o the Gregorian reform, the correction to the epact for intercalation occurs in the years 1700, 1800, 1900, 2100, 2200, 2300, 2500, etc and that for the lunar cycle in 1800, 2100, 2400, 2700, 3000, 3300 3600, etc. In the former instances the epact is diminished b unity; in the latter it is augmented by unity. When the change coincide, as they do in the years 1800 and 2100, for example, n change in epact is made.

In the light of the above, epact numbers can be so calculate as to minimize calendar errors. Because the purpose of the epac is to indicate the age of the moon at the beginning of a year, it i clear that, in the course of time, the epact will have values rangin from 1 to 30 inclusive to correspond with the days in a full luna month. To compute the epact the last date of the last lunation o the previous year is taken; this shows the date of the last new moo in the year and thus the age of the moon on the last day of the year is found. The moon's age in days is the epact of the nex year. For example, if the last lunation ends on Dec. 2, then th last new moon falls on Dec. 3, and so the age of the moon o Dec. 31 is 31 − 2, or 29 days. The epact of the year following therefore 29. Similarly, if the last lunation of the year had occurred on Dec. 3, the epact of the year following would have bee 28. This computation will only be altered if the new year to whic the epact applies is 1700, 1800, 1900, 2100, etc. If it is 1700 th epact is 29 − 1 or 28 because of intercalation; if it is 1800 th epact is 29 − 1 + 1 = 29 owing to intercalation and the correctio for the lunar cycle. In 1900 intercalation makes the epact 2 again; in 2100 the double correction will leave 29 once again unaltered.

The principal use of the epact is in determining Easter, th date of which is regulated by the moon's age as given by it, wit the vernal equinox taken as occurring on March 21. Even th Gregorian calendar is not exact and the vernal equinox can be much as two days early, so that a full moon may occur after th true equinox but still before the calendar equinox (March 21 however, it is the calendar equinox which is the regulating facto Thus the ingenious but complicated system invented by Lili meant that the date of Easter could be determined without refe ence to astronomical observation solely by the correct use of tab lated values. Moreover, the epacts were so arranged that the was no chance for the paschal full moon to coincide with th Jewish Passover.

Introduction of the Gregorian calendar also involved a chan in the dominical letters because of the omission of an intercala day every 100 years; this change makes it possible to use the d minical cycle throughout a century.

Adoption and Adjustments.—The Gregorian calendar was adopted in various Italian states, in Portugal, in Spain and in France in the same year (1582) as in Rome. The Roman Catholic states of Germany followed suit in 1583. So also at this period, for a short time, did the Protestant state of Sweden under its romanizing king, John III.

Other Protestant countries clung consistently to the Julian calendar for another 100 years. In 1700, however, the imperial diet of Regensburg decreed the Gregorian calendar for the Protestant states of Germany. Nevertheless the golden numbers and epacts for determining Easter and the movable feasts were not adopted; instead, the paschal moon was determined by astronomical calculation from Johannes Kepler's "Rudolphine" tables, which he had dedicated to the emperor Rudolph II in 1627. In 1774, however, the Prussian king Frederick II ordered this method to be abandoned.

Protestant Denmark adopted the Gregorian calendar at about the same time as the German Protestants. Sweden readopted it in 1753, but Russia did not alter until the advent of the Soviet government (1917).

Great Britain, too, took a long time to make the change. In 1751, however, a Calendar (New Style) act was passed and the Gregorian calendar was thenceforth ordered to be used for all legal and public business. By that time the difference between the Julian and Gregorian calendars amounted to 11 days and it was, therefore, further enacted that the day following Sept. 2, 1752, should be termed Sept. 14. Many people did not understand the nature of the change and were under the misapprehension that they were being cheated in some way: riots ensued with the slogan "give us back our eleven days."

At the same time that the calendar was adjusted, the date of the commencement of the new year was also changed. Hitherto the year had begun on March 25, but by the act of 1751 this was changed to Jan. 1—an enactment which had been carried out in Scotland as early as 1600. (It is important to remember this when dealing with legal deeds executed in Scotland between 1600 and 1751.) For the determination of Easter the rule laid down by the Council of Nicaea was adopted, but the epacts and golden numbers were fixed by the full moon instead of by the new moon. In the Church of England calendar, in those years when the course of the epacts is changed in the Gregorian calendar, the golden numbers are moved to refer to different days. A new arrangement of the table is, of course, made at the years 1800, 1900, 2100, etc. By means of this scheme, Easter is celebrated on the same date as that computed by the Gregorian calendar but, because the Church of England calendar changes from century to century, it is essentially of the same general form as the old Roman calendar.

The Orthodox church in Greece has adopted the Gregorian calendar with a 900-year cycle, but computes the date of Easter by means of the moon's actual movements rather than the simplified assumptions of the ecclesiastical calendar, basing its calculations on the meridian of Jerusalem.

Later, a slight change was made in the Gregorian calendar to bring it still more closely into line with the tropical year. The Gregorian calendar is still in error by one day in 3,323 years and, in consequence, a further rule of intercalation has been adopted that makes the years 4000, 8000, etc., common years, *i.e.*, years without an intercalated day. The calendar is now, therefore, correct to within one day in 20,000 years.

Calendar Reform.—A number of proposals designed to give greater regularity to the Gregorian calendar have been suggested. One proposed calendar, called the International Fixed calendar, would divide the year into 13 months of exactly four weeks each. The present month names would be retained (although some have suggested the use of Roman numerals instead), and the extra month, called Sol, would fall between June and July. The day following Dec. 28, *i.e.*, the 365th day (366th day in leap year), would bear no designation of month or weekday. In leap years, the intercalary day would be the day following June 28, and it also would bear no designation of month or weekday. Every month would begin on Sunday and end on Saturday. A serious disadvantage of the 13-month year from a business standpoint is that it is not readily divisible into quarters.

Another proposal involves the so-called World calendar, which would divide the year into four 91-day quarters of three months each. In each quarter the first month would have 31 days and the last two months would have 30 days each. The day following Dec. 30 would bear no designation of month or weekday, nor would the intercalary day following June 30 in leap years. The twelve month names would be the same as at present, and January 1 would fall on Sunday, as would April 1, July 1 and October 1. In the International Fixed calendar, the dates of holidays would be fixed and annual production of new calendars would no longer be necessary. Critics of the World calendar have pointed out that each month would extend over parts of five weeks, and that each month in a given quarter would begin on a different day of the week.

4. Perpetual Calendars.—So-called "perpetual calendars" give the date and the day of the week either throughout the future or for hundreds of years. Such calendars may be of the chart or of the mechanical type.

The chart calendar covers long periods. In the late 18th century some chart calendars were published, an example being the *Secular Diary* of D. Barstow, which covered all dates from 1601 to 1900 inclusive. More elaborate kinds were produced in the 19th century, such as that published in Edinburgh in 1868 by John Gardiner. Called *A Perpetual Almanack and Calendar for the Investigation of Dates*, it was printed on stiff paper and had a kind of slide-rule calculator as an integral part. By its use the days of the week in both old and new styles could be found for all past and future dates.

Mechanical types of perpetual calendar vary in complexity. Probably the simplest kind is the desk calendar, where the date, the month and sometimes also the day of the week are changed by hand. A certain amount of automatic control is found in the calendar wrist watch, in which a date wheel rotates once every 24 hours; but manual correction has to be made from time to time because of the variable number of days in a month. In some wrist and pocket watches a month wheel, performing one-twelfth of a rotation during each revolution of the date wheel and displaying the name of the month in abbreviated form, is incorporated as well; a few models have a wheel rotating once every 29 days so that the phases of the moon may be displayed. This feature is also to be found in certain old clocks having long cases.

Perpetual calendars of considerable complexity have been fitted to clocks. A French mechanism consisted of an automatic device to take account of the unequal lengths of the months and also of the February leap-year day. Similar mechanisms have on rare occasions been incorporated into pocket watches. (Cn. A. R.)

III. CHINESE CALENDAR

It is well known that the ancient Chinese reckoned their days, months and years by a sexagenary cycle formed from the combination of 10 celestial stems and 12 terrestrial branches. Each double name in the cycle consists of a stem name (in roman) and a branch name (in italics). In order to complete the cycle of 60 the 10 stem names are repeated six times alongside the 12 branch names, which are repeated five times. (*See* Table II.)

Some of these cyclical names were supposed to have originated as far back as the 27th century B.C.; however, books recording these dates were mostly written between the 6th and 4th centuries B.C. and were based on sources of the 11th century B.C. and later. It is thus difficult to say exactly at what time the sexagenary cycle was invented. The inscribed oracle bones excavated in Honan

TABLE II.—*Stem Names and Branch Names in Chinese Calendar*

1. Chia-*tzu*	11. Chia-*hsü*	. . .
2. I-*ch'ou*	12. I-*hai*	. . .
3. Ping-*yin*	13. Ping-*tzu*	. . .
4. Ting-*mao*	14. Ting-*ch'ou*	. . .
5. Wu-*ch'en*	15. Wu-*yin*	. . .
6. Chi-*szu*	16. Chi-*mao*	56. Chi-*wei*
7. Keng-*wu*	17. Keng-*ch'en*	57. Keng-*shen*
8. Hsin-*wei*	. . .	58. Hsin-*yu*
9. Jen-*shen*	. . .	59. Jen *hsü*
10. Kuei-*yu*	. . .	60. Kuei-*hai*

from the mausoleums of the Shang dynasty (*c.* 1766–*c.* 1122 B.C.) have revealed that the ancestors of the founder of this dynasty, during the preceding two centuries, were designated with characters taken from the stem and branch names, and that in the Shang calendar the 60 names in the cycle were borne by each 60 consecutive days. This 60-day period was divided into six *hsün*, each of ten days. Because the first day of each *hsün* contains in its double name the stem name "Chia," the six *hsün* were referred to as the "six Chia." Throughout all ages the 60-day cycle has been an essential part of the lunar calendar used in China and in those neighbouring countries, such as Japan, Korea and Vietnam, which have inherited Chinese culture.

Application of the cyclical names to months and years does not occur on the inscribed Shang bones or on the inscribed bronze vessels of the Chou dynasty (*c.* 1122–256 B.C.), but books of the later Chou period occasionally give the cyclical names with the number of lunar months or with years of a king's reign. Books on history and astronomy written from the 5th to the 3rd centuries B.C. (*e.g.*, *Tso Chuan*, *Shih's Classic of Astronomy*) indicate that a cycle of 12 years, known as *Chi*, was used since the 7th century B.C. In this cycle each year was designated by a special name, which was related to the constellation through whose zodiacal sign the year star (*Sui-hsing*, or Jupiter) passed. The names of the 12 years were arranged according to the order of the 12 terrestrial branches, beginning with the third branch (*Yin*) and ending with the first two branches (*Tzu* and *Ch'ou*), as shown in Table III.

TABLE III.—*Twelve-Year Cycle Based on Jupiter's Positions*

Designation of year	Branch order	Position of year star	
1. She-t'i-ke	3. Yin	Hsing-chi	(Capricornus)
2. Shan-o	4. Mao	Hsüan-hsiao	(Aquarius)
3. Chih-hsü	5. Ch'en	Ch'ü-tzu	(Pisces)
4. Ta-huang-lo	6. Szu	Chiang-lü	(Aries)
5. Tun-tsang	7. Wu	Ta-liang	(Taurus)
6. Hsieh-hsia	8. Wei	Shih-ch'eng	(Gemini)
7. T'un-t'an	9. Shen	Chün-shou	(Cancer)
8. Tso-o	10. Yu	Chun-huo	(Leo)
9. Yen-mao	11. Hsü	Chun-wei	(Virgo)
10. Ta-yüan-hsien	12. Hai	Shou-hsing	(Libra)
11. K'un-tun	1. Tzu	Ta-huo	(Scorpio)
12. Ch'ih-fen-jo	2. Ch'ou	Hsi-mo	(Sagittarius)

But since Jupiter takes approximately 11.86 years to complete its course in the zodiacal belt, there were certain solar years when Jupiter's positions did not coincide with the predicted zodiacal signs into which it was expected to enter. When after a number of years Jupiter was observed to have advanced to a position corresponding to its next year's zodiacal sign, it was described as having "leaped over one constellation" (*ch'ao-ch'en*).

The Chinese civil year normally consists of 12 lunations of alternately 30 days for a "big month" and 29 days for a "small month." But, unlike the Muslim lunar year, it has always been adjusted to the length of the solar year. This is best illustrated by (1) its insertion of one intercalary month in a period of three civil years, or of two intercalary months in a period of five years or of seven in a period of 19; and (2) its division of the solar year into 24 equal portions, using the equinoxes and solstices as four fixed points. Each portion is called a ***chieh*** (node) and has 15.218 days. The 24 *chieh* have between them two generic names: the first, third, fifth, etc., are called *chieh-ch'i* (node-portions); the second, fourth, sixth, etc., are called *chung-ch'i* (centre-portions). Because the celestial sphere is divided into 360°, the first *chieh* of the year, *li-ch'un* (advent of spring), is a *chieh-ch'i* on which the sun reaches 315° (*i.e.*, Feb. 5); the fourth *chieh* of the year, *ch'un-fen* (vernal equinox), is a *chung-ch'i* on which the sun reaches 0° (*i.e.*, March 22); the winter solstice is the day on which the sun reaches 270°; etc. In this way the four seasons of the solar year are neatly divided, each covering six *chieh* of which three are *chieh-ch'i* and the alternative ones are *chung-ch'i*. Since the interval between two *chung-ch'i* lasts for 30.436 days, *i.e.*, longer than the synodic period of the moon, it must happen that in some lunar months the sun does not enter a new sign, or that a *chung-ch'i* does not occur in a certain lunation. Such a lunar month is designated "intercalary" (*jun*), and it is called by the ordinal number of its predecessor with *jun* added as a prefix. The 24 *chieh* have been regarded by the Chinese peasants as a strict timetable for their farm work.

The Chinese day is divided equally into 12 periods (*shih*, or double hour) named after the 12 branches (*Tzu, Ch'ou, Yin, Mao*, etc.). The first period, *Tzu*, begins at midnight and lasts for two hours. The last period, *Hai*, ends at midnight. In ancient times, when the water clock was used, the whole day was divided into 100 *k'e*. On the summer solstice the day consisted of 60 *k'e*, the night of 40; on the winter solstice these numbers were reversed. With the advent of the western clock in the 18th century the *k'e* came to mean "a quarter of an hour." The night was divided into five watches, each lasting for two hours. The first watch, at 8 P.M. clock time, coincided with the ancient curfew.

(WU S.-C.)

IV. EGYPTIAN CALENDAR

The Egyptians appear to have begun with a lunar calendar There is no definite proof of this, but the writing of the word "month" with the moon symbol, the importance of the monthly and half-monthly festivals in later times and the adoption of th month as a unit in the later calendar place it beyond doubt.

At a very early date, the Egyptians had begun to observe the heliacal rising of the star Sirius or Sothis, a conspicuous objec in the Egyptian sky. The Egyptians noted that this rising corresponded very closely with the rise of the Nile, on which the agricultural welfare of the country depended. Small wonder then that they chose this for the first day of the year, and took th period between two such observed risings to form a unit of tim which was convenient not only as being much longer than the old month, but as including a complete cycle of the seasons.

The next step was to subdivide the new unit, and here use wa made both of the old months and of the changing seasons. Twelve nominal months of 30 days each gave 360 days, and the missing 5 days were added on at the end under the name of "days additiona to the year." The months were grouped into three sets of four the first four forming the inundation season, the second four th winter or sowing time and the third four the summer or harvest

The constructors of this calendar either overlooked or ignore the fact that every four years, as observation must have shown Sothis rose a day later, *i.e.*, after a lapse of 366 and not 365 day the reason being, as is now known, that the star year, which i virtually identical with the solar year, measures about 365¼ days. This error meant that their calendar got out of gear with the sola year, and consequently with the seasons, to the extent of on day every four years. The error became greater and greater unt eventually, after 1,460 (365 × 4) solar years, known as a Sothi period, the calendrical New Year's day had worked right around the seasons and come back to its correct place again. The Egyptians were not unaware of this error, but it was not until quit late times that they sought to correct it by the insertion of a extra day every four years (leap year), and even then the attemp failed.

The Latin writer Censorinus (fl. 3rd century A.D.) states in hi *De Die Natali* that the first day of the Egyptian calendar yea coincided with the rising of Sothis in A.D. 139, and it must therefore have done the same thing 1,460 solar years earlier and before *i.e.*, in 1321 B.C., 2781 B.C., 4241 B.C., 5701 B.C., etc. Quite possibl it was at one of these times that the calendar was introduced The religious texts inscribed in the pyramids of the 5th an 6th dynasties show that the calendar with its five extra days wa then already in existence. Egyptologists consequently date th introduction of the calendar to 4241 B.C. or to 2781 B.C., accordin to whether they believe the pyramids to be earlier or later tha the latter date. A still higher date, *e.g.*, 5701 B.C., is hardly likely

The Egyptians used no unit of time longer than a year. Consequently they had no dating by eras in the modern sense. In ver early times each year was named after some important event in it *e.g.*, "The year of the first smiting of the east," and was at th same time connected with the reigning king. Later, under th 5th and 6th dynasties, the biennial cattle census was used for tim reckoning, and the years of a king's reign were numbered alternately as "The year of the first (second, third, etc.) census" an

"The year after the first (second, third, etc.) census." Still later the years of the reign were numbered straightforwardly (1, 2, 3, etc.).

In early Egyptian documents the months bear no special names, being written merely as the first, second, third or fourth month of such and such a season. In the Persian period, however (6th century B.C.), there began to appear month names drawn from festivals which took place during the month; these names may of course have been used in speech earlier, even though they were apparently never written. Considerable uncertainty surrounds the origin of some of them, and the question is complicated by the fact that at some date in or before the Ramesside age all of the names seem to have been shifted one month back in the year.

The week of seven days was totally unknown to the early Egyptians, and the evidence brought forward for its existence in very late times is far from convincing.

The day and the night were each divided into 12 hours, but since the day was measured sometimes from sunrise to sunset and sometimes from the appearance of daylight to its disappearance, the length of day and of night varied through the year. Consequently the Egyptians cannot claim to have established the hour as a fixed unit of time. (T. E. P.)

V. HINDU CALENDAR

1. Nakshatra System and Other Early Systems.—In the most ancient Indian texts, the four Vedas, some elements of the calendar in use at that time are alluded to, although not fully described. At the time of the Rigveda (about 1500 B.C.) the duration of a civil year seems to have been estimated at 360 days, or 12 months of 30 days plus one intercalary month added to every cycle of five years. This is more clearly attested in subsequent texts, with some variations evidencing the diversity of the attempts to establish a convenient calendar. This calendar was lunisolar, simultaneously taking into account the revolutions of both the moon and the sun. The daily positions of the moon and the monthly positions of the sun were referred to 27 or 28 constellaions on the ecliptic—the *nakshatras*. The list of these, beginning with *Krittika*, the Pleiades, is already given by the Yajurveda and by the Atharvaveda (between 1500 and 1000 B.C.). Thus, the *nakshatra* system was already in use at that time.

Although the method is not indicated, it must have been very simple, as it was in later times. The numbers 27 (Yajurveda) and 28 (Atharvaveda) both corresponded to a rough estimate of the duration of the lunar month. The positions of the moon and the un each night among the *nakshatras* could be found—the positions of the moon were directly observable except at new moon, and those of the sun were deduced, at full moon, from the sun's opposition to the moon. At every midnight, the *nakshatra* culminating in the meridian indicated the sun's actual position, because the un was, at that time, in the *nakshatra* 180° removed from that bserved at the meridian. Any error in such a determination f the sun's daily position could be corrected at the next full moon.

The days of the new moon (*amavasya*) and full moon (*purnamasi*) divided the lunar month into two parts: the "bright one" *sukla*), *i.e.*, fortnight of increasing light from the new moon nward; and the "black one" (*krishna*), *i.e.*, fortnight of decreasing rightness after full moon.

For some sacrificial and cosmographical purposes the civil *savana*) month (*masa*) of 30 days (*ahoratra*) was used; it was intermediate between the lunar month and the solar month, each ay being divided into 30 "moments" (*muhurta*). The number f these moments in an ordinary civil year (*samvatsara*) of 360 ays was thus 10,800 (*Satapathabrahmana*). The adjustment of the civil year to both the lunar and the solar year was done not only by adding one civil intercalary month (*amhasaspati, malimuca* or *samsarpa*) every five years but also by the addition of days. The average length of a year at the end of a period of five years *yuga*) covering 61 civil months (1,820 days) plus 10 days, was 66 days (1,830 days in 5 years). According to the same compuation, 62 lunar months of 29.5 days would elapse during the same eriod.

The year was generally divided for religious purposes into three periods of four months each. Each period was itself divided into two seasons (*rtu*). Thus the seasons were six in number: *vasanta*, spring (months called Madhu, Madhava); *grisma*, hot season (months Sukra, Suci); *varsah*, rains (months Nabhas, Nabhasya); *sarad*, autumn (months Isa, Urja); *hemanta*, winter (months Sahas, Sahasya); *sisira*, dewy season (months Tapas, Tapasya).

The year was also divided into two other periods according to the apparent motion of the sun alternatively toward north and south. The first was the northward course, *uttarayana*, during which the point of sunrise is gradually moving northward from the winter solstice. The second was the southward course, *daksinayana*, during which the point moves southward from the summer solstice.

A brief treatise, the *Jyotisavedanga* ("The article of knowledge dealing with the heavenly lights"), which exists in two versions as a technical appendix to the Vedas and which probably dates from the last centuries B.C., uses the same calendar elements with some additions. It gives essentially the "knowledge of the times" (*kalajnana*) for the cycle of five years (*yuga*) beginning with the bright fortnight of the month of Magha (January–February) and ending with the black fortnight of the month of Pausha (December–January). That is, it begins at new moon, the sun and the moon being in conjunction in the constellation Delphinus, this time being taken also as the beginning of the northward course. Already, classical denominations of months appear side by side with the Vedic names. The times of junction between two consecutive fortnights (*paksa*) are called *parvan*.

Two kinds of seasons of two months were in use: the civil one (*savana*), consisting of 60 days, and the solar one of 61 days. A lunar season is one-sixth of the lunar month, and the lunar month is also divided into 30 lunar days (*tithi*).

The calendar of the Brahmanical books of rules (*sutra*) generally agrees with the *Vedangajyotisa* calendar; in it, the dates of rituals are adjusted to those of the latter. The ancient religious communities of Buddhists and Jains used a quite similar calendar. The most important Jain work on the subject is the *Suriyapannatti*.

2. Classical Calendar Forms.—With the introduction into India of much scientific material from Mesopotamian and Greek sources during antiquity and especially during the first centuries A.D., Indian astronomy no longer confined itself to adjusting ritual operations to the cosmic order. Methods of astrology and forecasting came into vogue, using largely Greek astronomical and astrological data side by side with the Brahmanical data. The main feature of the new calendar was the adoption of the zodiacal system without abandoning the *nakshatra* system.

The Sanskṛit names of the zodiacal signs (*rasi*) are: Mesha (Aries), Vrishabha (Taurus), Mithuna (Gemini), Karkata (Cancer), Simha (Leo), Kanya (Virgo), Tula (Libra), Vrischika (Scorpio), Dhanus (Sagittarius), Makara (Capricornus), Kumbha (Aquarius), Mina (Pisces).

The *nakshatras* are mathematically defined as covering 13° 20′ each, while the zodiacal signs cover 30° each. A *nakshatra* being divided into four parts (3° 20′ each), every zodiacal sign corresponds to two *nakshatras* and a quarter. The entering of the sun into a given sign or constellation (these no longer coincide because of the precession of the equinoxes) is called *samkranti*. The most noticeable *samkrantis* are *Mesasamkranti* and *Makarasamkranti*, theoretically corresponding to the vernal equinox and to the winter solstice respectively. Two systems of notation are in use. The first (*sayana*) takes into account the precession and makes the distinction between the sun's entering into the constellation (Aries) and the true vernal equinox now in Pisces, but it gives to the entrance corresponding to the winter solstice the designation *Mesasamkranti*, *mesa* referring in this case to the so-called sign and not to the constellation. In the second system (*nirayana*) the precession is not taken into account and a theoretical vernal equinox is considered as occurring when the sun enters the constellation Aries.

In the Malayalam country (Kerala state, southwest coast), the names of the months are borrowed from the names of the zodiacal constellations in which the sun is situated. Elsewhere, the months are named according to the *nakshatras* in which the full moon appears; *e.g.,* the month during which the full moon appears in the asterism *Citra* (the star Spica or α Virginis) is Chaitra. At that time, the sun is diametrically opposite, in the sign of Aries (now the constellation of Pisces). The month begins either with the new moon (*amanta* or *sukladi* system) or with the full moon (*purnimanta* or *krishanadi* system).

The Sanskrit names of months generally in use are: Chaitra (March–April), Vaisakha (April–May), Jyaishtha (May–June), Ashadha (June–July), Sravana (July–Aug.), Bhadrapada (Aug.–Sept.), Asvina (Sept.–Oct.), Karttika (Oct.–Nov.), Margasirsha (Nov.–Dec.), Pausha (Dec.–Jan.), Magha (Jan.–Feb.), Phalguna (Feb.–March). The year generally begins with Chaitra. These months, beginning with Chaitra, regularly correspond with the vedic months from Madhu onward.

Because of the differences in duration between lunar and solar months and the inequality of length of the solar months themselves, two lunar months may begin during the same solar month. In such a case, both these lunar months are called by the same name, the first being denoted as intercalary or additional (*adhika*) and the second as natural (*nija*). It is in the latter that the beginning of a new solar month occurs, and therefore it is the latter which is the starting point of a new period of adjustment between lunar and solar months. Less frequently, two solar *samkrantis* may occur in the same lunar month. Then there is a lack of one lunar month corresponding to the second *samkranti; i.e.,* one month suppressed (*ksayamasa*). Similarly, when two sunrises occur on the same lunar day (*tithi*), a second day is added with the same date number. When no sunrise occurs during another lunar day, one is omitted. In this way the solar and lunar elements of the calendar are made to agree by periodic adjustments.

The Hindu week, of seven days, is identical with the western week. The names of the days are: Ravivara (Sunday), Somavara (Monday), Mangalavara (Tuesday), Budhavara (Wednesday), Guruvara (Thursday), Sukravara (Friday), Sanivara (Saturday).

The classical Hindu almanac is called *panchanga,* "having five members," because it chiefly indicates: (1) *tithis,* or lunar days; (2) *varas,* or weekdays; (3) *nakshatras,* or constellations through which the moon is successively passing; (4) *yogas,* or times during which the joint motions of the sun and moon cover the space of a *nakshatra;* (5) *karanas* or half *tithis.*

The most popular *panchangas* are based on the classical astronomical treatise *Suryasiddhanta,* which dates, in its present state, from about the 9th century A.D. They are used for both ordinary and astrological purposes, and vary slightly in different parts of the country. Because one lunar month generally ends and the next begins during the course of a solar month, the solar month, taken as the current civil month, receives, for example, in the Tamil country the name of the first of these lunar months and in Bengal the name of the second. Therefore, the successive Tamil months Cittirai and Vaikaci correspond to the Bengali months Boisakho and Jyoistho, etc. The Tamil names of the months are: Cittirai (April–May), Vaikaci (May–June), ANi (June–July), Adi (July–Aug.), Avani (Aug.–Sept.), Purattaci (Sept.–Oct.), Aippaci (Oct.–Nov.), Karttikai (Nov.–Dec.), MarkaLi (Dec.–Jan.), Tai (Jan.–Feb.), Maci (Feb.–March), PankuNi (March–April).

The main divisions of the civil day (*divasa*) are the vedic *muhurta* (48 min.), or more usually the *ghatika* (24 min.), containing 30 *kala* (48 sec.), 60 *pala* (24 sec.), 360 *prana* (4 sec.), 3,600 *vipala* (0.4 sec.) or 216,000 *prativipala* (0.00666 sec.).

With a view to unification of the Hindu calendar for official purposes, the government of India introduced throughout India a new calendar from 1 Chaitra, 1879 *Saka* era (*see* CHRONOLOGY: *Hindu*), which corresponds to March 22, 1957. (J. L. A. F.)

VI. BABYLONIAN AND ASSYRIAN CALENDARS

Two methods of time reckoning were available to the early inhabitants of Babylonia and Assyria in the preliterate period: one was based on the periodic motion of the sun, the moon and the stars, the other on the equally periodic growth of plants, such as cereal grains and fruit trees. The former method originated among populations worshiping the heavenly bodies, whereas the latter was used by farmers whose gods embodied the forces of nature that influence plant life. With the development of writin and the ensuing recording of observations, calendars based on th statistical evaluation of such observations came into use.

1. Babylonian Calendar.—The daily rising and setting of th sun provided the basic time unit of the Babylonian calendar, th day (Akkadian *umu,* Sumerian *ud*). The day began at sunse and was, for astronomical purposes, divided into six watches o vigils, three from sundown to sunrise and three from sunrise t sundown. Only on the days of the equinoxes were the six watche of equal length. In everyday life, the day comprised 12 doubl hours (*beru*) of equal length. Sundials and water clocks serve to count the hours.

The moon provided the next time unit, the month (Akkadia *warkhu,* Sumerian *itu* or *iti*), *i.e.,* the period of 29 or 30 days fro one appearance of the lunar crescent to the next. The next larg unit, used in the earliest lunar calendar of southern Babyloni was based upon the observation that a lunar eclipse occurs approx mately once every six months. Because lunar eclipses wer interpreted as the moon god's descent to the nether world, the were marked by the celebration of a festival, the *akitu,* in whic the moon's absence from his heavenly abode was symbolized b the transfer of the deity's statue to a suburban sanctuary. Th god's resurrection from the realm of the dead, which manifeste itself in the appearance of the next crescent, marked the beginning of a new "year" that comprised the approximately six month until the next eclipse. The early use of the "years" of six month which was not limited to the moon worshipers of Babylonia, e plains not only certain features of the later Babylonian calenda described below but also may explain the superhuman length a tributed by the Bible to the lives of certain personages.

In the early historic period, the calendars in use in the variou city-states of Babylonia comprised 12 lunar months of 354 days these were brought into agreement with the seasons by the occasional insertion of an intercalary month, without which they wou have rotated throughout the agricultural year. Since several o the early Sumerian month names allude to the agricultural activit taking place during the month so named, and since, in particula the 12th month was called *iti* She-gur-ku, "month of the grai harvest," it is reasonable to assume that it was decided by th authorities whether or not an extra month should be inserte according to the state of ripeness of the standing grain. If th grain was not ripe at the beginning of the 12th month, an inte calary month (Sumerian *iti* Dirig) was added, so that the grai harvest always occurred during the month named for it.

In the Sumerian period, each of the city-states had its ow series of month names. With the unification of these states i the Old Babylonian period (about 1900 to 1600 B.C.), the nam in use at Babylon replaced the older series. These names, wit their Sumerian equivalents, are listed in Table IV.

Intercalary months were the second Ululu and the second Adar A letter addressed by the famous lawgiver King Hammural to a provincial governor states that the following month would b a second Ululu and that taxes normally due in Tashritu were to b paid in this intercalary month. The habit of doubling eithe the sixth or the twelfth month for intercalation and the designa tion of the seventh month as Tashritu, "beginning," bear witne to the relationship of this calendar to the archaic lunar calenda that had "years" comprising approximately six months.

Because planting and harvesting time vary considerably withi a large area, the old method of intercalation based on the ripene of the grain eventually proved unsatisfactory. About the 9t century B.C., after centuries of statistical recording, the Babylon ans discovered that 235 lunar months contain almost exactly th same number of days as do 19 solar years, and that, therefor

TABLE IV.—*Babylonian and Sumerian Month Names*

Babylonian	Sumerian	Babylonian	Sumerian
Nisanu	Bar-zag-ga	Tashritu	Du-ku
Ayaru	Gu-si-sa	Arakh-samna	Apin du-a
Simanu	Sig-ga	Kislimu	Gan gan
Du'uzu	Shu-numun	Tebetu	Ab ba-e
Abu	Ne-ne-gar	Shabatu	Ziz-am
Ululu	Kin-Ninni	Adaru	She-kin-kud

lunar and solar years can be adjusted to each other if seven months are intercalated over a period of 19 years. Within this cycle, later called the Metonic cycle, the intercalary months were arranged so as to limit the variations of the first day of Nisanu to a period of 27 days around the vernal equinox.

In the Sumerian and Old Babylonian periods, years were named for the most important event that had taken place in the preceding year, numerous year names alluding to military achievements or to pious deeds. From the Kassite period on until the end of Babylonian independence, the years were designated as "year 1, 2, 3, etc., of king so-and-so," year 1 being the first full year following a king's accession to the throne. The Babylonian year began with an *akitu* festival for Marduk, the god of Babylon, which lasted 11 days. The months were divided into halves, the middle of each month being characterized by a festival called *isinnu* (Sumerian *ezen*). Certain days, in particular the 7th, 14th, 21st and 28th of each month, were considered ominous days, whereas the 20th was a lucky day. The belief in these ominous days with numbers divisible by seven, on which people were to refrain from certain activities, seems to have led to the institution of the seven-day week as a time unit.

2. Assyrian Calendar.—The oldest Assyrian calendar is known from the so-called Kültepe texts, which consist of letters and documents found at this site (the ancient city of Kanesh) that were written by Assyrian merchants doing business in the eastern part of Asia Minor. The following month names are used in these documents:

1. Ab-sharrani
2. Khubur
3. Sippum
4. Qarratum
5. Tanmarta
6. Ti'inatum or Sin
7. Kuzallu
8. Allanatum
9. Belti-ekallim
10. Narmak Ashshur-sha-saratim
11. Narmak Ashshur-sha-kinatim
12. Makhur-ili

At least two of these names were chosen for astronomical phenomena which occurred every year during the months so named: Tanmarta, "heliacal rising," was the month of the rising of the constellation Canis Major, the principal star of which, Sirius, played an important part in the Assyrian pantheon; and Makhur-ili, "meeting of the gods," alludes to the conjunction between the moon and the Pleiades prior to the heliacal setting of the latter—an event to which Assyrian mythology attributed great significance. In agreement with these names, which point to a stellar rather than to a lunar year, the year attested in the Kültepe texts of the 19th century B.C. had 360 days which were supplemented very three years by the insertion of 15 epagomenal (additional) days called *shapattum*. Thus the year was divided into 12 months of equal length. Throughout the years and the epagomenal days, the Assyrians counted ten-day periods called *khamshatum* (sing. *hamushtum*). For three years, these *khamshatum* ran congruently with the months and with the years. Then, after the insertion of a 15-day *shapattum* period, they overlapped from one month into the next, returning to congruency with the months after the next *shapattum*. Each year bore the name of an official, the *limmu*, who functioned in the capital city, Ashur. The *khamshatum* were also named for officials. Because the days were rarely numbered, a date in an Old Assyrian document had the following form: *khamushtum* of A (name of an official); month M; *limmu* C (name of an official). Lists of the *limmu* as well as of the *khamushtum* officials were used to identify the dates.

This calendar disappeared with the advent of a usurper, King Shamshi-Adad I, who introduced the following series of month ames:

1. Mana
2. Aiarum
3. Makranum
4. Dumuzi
5. Abum
6. Tirum
7. Niqmum
8. Kinunum
9. Tamkhirum
10. Nabrum or Dagan
11. Mamitum
12. Adarum

In this calendar, an intercalary month was called *warakh* Dirigum ("supplementary month"). Since the beginning of the grain harvest (which, in Assyria, falls around May 10 in the Gregorian calendar) fell in the last days of Aiarum, the year began, like that of the Babylonians, about half a month before the vernal equinox which, in the 18th century B.C., fell around April 5. Two of the month names of this series, viz., Kinunum and Tamkhirum, recur occasionally in the later Assyrian sources; the former, which was named for the brazier used for heating purposes (*kanunu* or *kinunu*), survived as the name of a month in the calendars of the Aramaeans and the Arabs.

In a later period, the Assyrians resumed the use of the older calendar. In the region of Nuzi and Arrapkha (modern Kirkuk), which had long been an Assyrian dependency before it became part of an independent Hurrian state, the year of 365 days was in use about 1400 B.C. In documents from Ashur, and from provincial Assyrian towns, the old month names occur in date formulas as late as the time of King Tiglath-Pileser I. However, neither the *khamushtum* period of ten days nor the *shapattum* period of 15 epagomenal days is traceable in these documents. Moreover, the beginning of the year had been shifted to the month of Sippum.

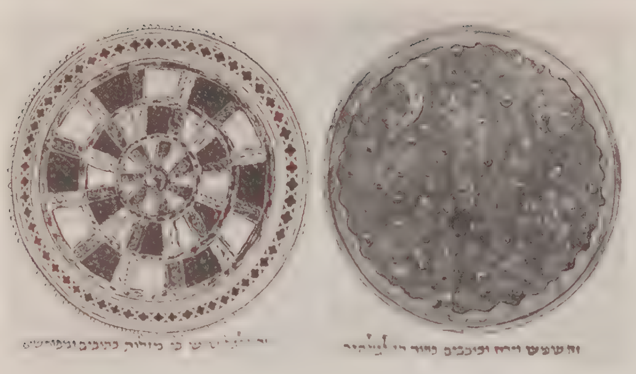
During the reign of Tiglath-Pileser I who, by conquering Babylon, brought Assyrians into closer touch with Babylonia, Babylonian dates begin to appear occasionally in Assyrian inscriptions. In the centuries that followed, the use of Babylonian dates became increasingly frequent until, in the neo-Assyrian period, the Old Assyrian calendar had completely disappeared and only the Babylonian lunisolar calendar and the Babylonian month names were used.

The Assyrian sources include vestiges of a time unit larger than the year. Especially in records dealing with the reconstruction of sacred buildings, mention is made of a unit of 350 years, the rule being to postpone such restorations until 350, 700 or 1,050 years had elapsed since the previous reconstruction or the original erection of a temple. A further peculiarity, traceable particularly in neo-Assyrian royal inscriptions, is the designation of the days of the month not only by their number but also by the name of the deity to whose service the day was dedicated. This habit passed from the Assyrians to the Persians and from the Persians to the Romans, and explains the present-day practice of designating the days of the week by names referring to the planetary deities of old under the names by which they were known to the Romans or the Germanic peoples, or to both. (HI. LE.)

VII. JEWISH CALENDAR

The Jewish calendar in use today is lunisolar, the years being solar and the months lunar. Because the solar year exceeds 12 lunar months in length by about 11 days, a 13th month of 30 days is intercalated in the 3rd, 6th, 8th, 11th, 14th, 17th and 19th years of a 19-year cycle. For practical purposes, *e.g.*, for reckoning the commencement of Sabbaths, the day begins at sunset; but the calendar day of 24 hours always begins at 6 P.M. The hour is divided into 1,080 parts (*halaqim*), each part (*heleq*) equaling $3\frac{1}{3}$ sec. The *heleq* is further divided into 76 *rega'im*. A synodic month is the interval between two mean conjunctions (conjunction = *molad*), which is reckoned at 29 days 12 hr. 44 min. $3\frac{1}{3}$ sec. In the calendar month, however, only complete days are reckoned, the full (*male*) month containing 30 days and the defective (*haser*) month 29 days. The months Nisan, Sivan, Ab, Tishri, Shebat and (in a leap year) I Adar are always full; Iyyar, Tammuz, Elul, Tebet and Adar (reckoned as II Adar in a leap year) are always defective; while Heshvan and Kislev vary.

The number of days in a year varies. The number of days in a synodic month multiplied by 12 in a common year and by 13 in a leap year would yield fractional figures. Hence, again reckoning complete days only, the common year has 353, 354 or 355 days and the leap year 383, 384 or 385 days. A year in which both



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(LEFT) ORBITAL SPHERES OF MOON, SUN AND FIXED STARS WITH HEBREW NAMES OF SIGNS OF THE ZODIAC; (RIGHT) CELESTIAL VAULT WITH SUN, MOON AND STARS WITHIN; FROM AN ILLUMINATED 13TH-CENTURY MANUSCRIPT OF A JEWISH CALENDRIC TREATISE

Heshvan and Kislev are full, called complete (*shelema*), has 355 or (if a leap year) 385 days; a normal (*sedura*) year, in which Heshvan is defective and Kislev full, has 354 or 384 days; while a defective (*hasera*) year, in which both these months are defective, has 353 or 383 days. The character of a year (*qevi'a*, literally "fixing") is described by three Hebrew letters, the first and third giving the respective days of the weeks on which New Year occurs and Passover begins, while the second is the initial of the Hebrew word for defective, normal or complete. There are 14 types of *qevi'oth*, 7 in common and 7 in leap years. The new year begins on Tishri 1, which may be the day of the *molad* of Tishri but which is often delayed by one or two days for various reasons. Thus, in order to prevent the Day of Atonement (Tishri 10) from falling on a Friday or Sunday, and the seventh day of Tabernacles (Tishri 21) from falling on a Saturday, the new year must avoid commencing on Sundays, Wednesdays or Fridays. Again, if the *molad* of Tishri occurs at noon or later, New Year is delayed by one or, if this would cause it to fall as above, two days. These delays (*dehiyyoth*) necessitate, by reason of the above-mentioned limits on the number of days in the year two other delays.

The mean beginning of the four seasons is called *tequfa* (literally "orbit" or "course"); the *tequfa* of Nisan denoting the mean sun at the vernal equinoctial point, that of Tammuz the mean sun at the summer solstitial point, that of Tishri the mean sun at the autumnal equinoctial point and that of Tebet the mean sun at the winter solstitial point. The mean length of the seasons was reckoned by Mar Samuel (*c.* 165–254, head of the academy at Nehardea in Babylon) at 91 days and 7½ hr. Hence, with his solar year of 365¼ days (52 weeks and 1¼ days), the *tequfoth* moved forward in the week, year after year, by 1¼ days. Accordingly, after 28 years the *tequfa* of Nisan reverted to the same hour on the same day of the week (Tuesday 6 P.M.) as at the beginning. This cycle is called the great or solar cycle (*mahzor gadol* or *hamma*. Retaining the above length of the solar year for observance of a few minor rituals only, the present Jewish calendar is mainly based on the value 365 days 5 hr. 55 min. $25\frac{25}{57}$ sec.—more accurate, yet still in excess of the true tropical year by about 6½ min. It is often ascribed, on no sound grounds, to Rabbi 'Adda (perhaps Rabbi 'Adda bar Ahava, a Babylonian Talmudic teacher of the 3rd century).

To a far greater extent than the solar cycle of 28 years, the Jewish calendar employs, as mentioned above, a small or lunar cycle (*mahzor qatan*) of 19 years, adjusting the lunar months to the solar years by means of intercalations. Passover on Nisan 15 is not to begin before the spring *tequfa;* therefore the intercalary month is added after Adar. The *mahzor qatan* is akin to the Metonic cycle, and is based on the nearly correct notion that 235 lunar months = 19 solar years; hence there are 7 intercalations ($19 \times 12 = 228$; $228 + 7 = 235$), at the intervals set forth above, in a 19-year cycle.

The era in use today is that of the creation (*Anno Mundi, lizira,* with its epoch in 3761 B.C., *see* Chronology: *Jewish*). The Jewish year 5719 A.M., which was the 19th in the 301st lunar cycl and the 7th in the 205th solar cycle, was a leap year of 13 months or 383 days. The *qevi'a* was *BHH*, which indicates that new yea began on the 2nd ($B = 2$) and Passover on the 5th ($H = 5$) da of the week and that the year was defective ($H =$ *hasera*) *i.e.*, Heshvan and Kislev had 29 days each. This year (1958–5 of the Christian era) began on Sept. 15, 1958, and ended on Oct. 1959. Neglecting the thousands, current Jewish years A.M. ar converted into years of the current Christian era by adding 23 or 240;—239 from the Jewish new year (about September) t Dec. 31, and 240 from Jan. 1 to the eve of the Jewish new yea The adjustment differs slightly for the conversion of dates of no antiquated varieties of the Jewish era of the creation and/or the Christian era. For exact conversion of dates the best tables ar in E. Mahler's *Handbuch der jüdischen Chronologie* (1916).

1. Months and Important Days.—The months of the Jewis year and the notable days are as follows:

Tishri: 1–2, Rosh Hashana (New Year); 3, Fast of Gedaliah (I Kings xxv, 22–25; Zech. viii, 19); 10, Yom Kippur (Day of Atonement); 15–21, Sukkoth (Tabernacles); 22, Shemini Azeret (Eighth Day of Solemn Assembly); 23, Simhath Torah (Rejoicin of the Law).

Heshvan.

Kislev: 25, Hanukkah (Feast of Dedication) begins.

Tebet: 2 or 3, Hanukkah ends; 10, Fast (II Kings xxv, 1; Zecl viii, 19).

Shebat: 15, New Year for Trees (Mishnah, *Rosh hash-Shana* i, 1).

Adar: 13, Fast of Esther (*She'ilthoth* 66); 14–15, Purim (Fea of Lots).

II Adar or Veadar (intercalated month): Adar holidays fall i Veadar during leap years.

Nisan: 15–22, Pesach (Passover).

Iyyar: 5, Israel Independence Day.

Sivan: 6–7, Shabuoth (Feast of Weeks [Pentecost]).

Tammuz: 17, Fast (II Kings xxv, 3; Zech. viii, 19; Mishnal *Ta'anith* iv, 6).

Ab: 9, Fast (II Kings xxv, 8; Zech. viii, 19; Mishnah, *Ta'anit* iv, 6).

Elul.

See also Jewish Holidays.

2. Origin.—The Jewish calendar is the result of long development: its present form is not of great antiquity. Before the Babylonian exile the months were commonly designated by number the Bible recording only four ancient Hebrew names of the month *i.e.*, Abib (1), Ziv (2), Ethanim (7) and Bul (8). During th exile the Jews adopted the Babylonian names. From the Diaspor where they are attested in the Murashu documents and the Asw papyri (5th century B.C.), they spread to Palestine, where Nisa Sivan, Elul, Kislev, Tebet, Shebat and Adar are used in the Bibl By the 1st Christian century all 12 names are used in the Scro of Fasting (*Megillath Ta'anith*).

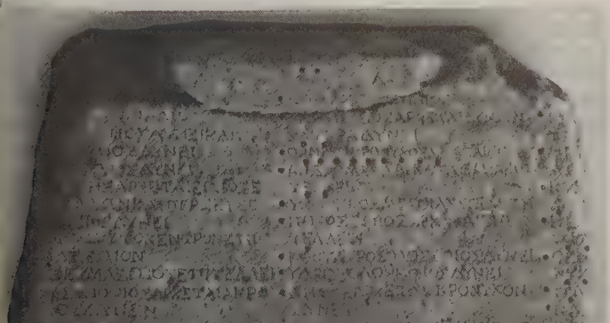
Intercalation, already evident from Ezek. i, 1, iii, 15, iv, 4- and viii, 1, was at first empirical, an intercalary month being add for various reasons at irregular intervals. The length of each the months was determined from the observation of witness who reported having seen the new crescent moon and who we carefully questioned by the authorities (at first perhaps the pries and eventually the Sanhedrin), while the length of the year vari from 352 to 356 days or (if a leap year) from 382 to 386 day Gradually observation gave place to calculation, with the rig to adjust the calendar reserved to the patriarchate. The establis ment of the present continuous calendar, with some of its princip elements traceable in Talmudic records, is traditionally ascrib to the Palestinian patriarch Hillel II in the 4th century A.D., thoug modern scholars believe it may have originated in Babylon son centuries later. The rights of the patriarchs (presidents of t Sanhedrin) were at first successfully defended against t Babylonian claims. However, a great calendric controversy aro in A.D. 921. Ben Meir, claiming the old Palestinian prerogati as a descendant of the patriarchs (whose office had been abolish by the Romans in the 5th century A.D.), maintained that new ye ras not to be deferred unless the *molad* occurred $\frac{642}{1080}$ of an hour fter noon. The controversy ended, mainly through the championhip of Saadia (892–942), with complete Babylonian victory. ince then the Jewish calendar has remained unchanged. The sole ifference between Babylon on the one hand and Palestine (with taly and France) on the other, as to whether the year should egin with Tishri or Nisan, was settled about 1250 in favour of abylon; *i.e.*, commencement with Tishri.

The Book of Jubilees (usually dated in the 2nd century B.C.) dvocates a peculiar calendar whose details are supplemented in ertain calendric fragments found among the Dead sea scrolls. his sectarian calendar was based on a solar year of 364 days or xactly 52 weeks, with 8 months of 30 days and 4 months of 31 ays. All years commenced on Wednesday and all festivals fell n fixed days of the week—the first days of Passover and of abernacles and New Year's day on Wednesday, Pentecost on unday and the Day of Atonement on Friday. Scholars disagree s to the date or identity of the sect using this calendar.

The Karaites vehemently opposed the views of the Rabbanites n the calendar; they regarded calculation as impious and sought reintroduce observation. This easily disproved the theory of heir great Rabbanite opponent Saadia that calculation preceded bservation, a theory which was also rejected by notable Rabbanes; *e.g.*, Maimonides (1135–1204). Yet by about A.D. 1500 the araites were constrained to adopt calculation. (Er. Wi.)

VIII. GREEK CALENDAR

The sturdy independence of the Greek city-states, so marked a haracteristic of their political history, is evidenced also by the riking diversity of their calendars. However, although one city night name its months differently from another, and begin its ear at a different season, the underlying basis of all the calendars as the same; viz., an attempt to combine in a single system he lunar year of 12 lunar months totaling 354 days and the solar ear of 365.25 days. The fundamental incompatibility of these vo "years" led to an attempt to reconcile them by means of an ght-year span or octaeteris; G. Thomson (*Journ. Hell. Stud.*, iii, 52–65, 1943) believes that this may go back to the Mycenaean eriod. The difference between eight lunar years (2,832 days) nd eight solar years (2,922 days) is 90 days, or some three lunar onths. Intercalation of three months in each octaeteris thus ept the calendar roughly in step with natural phenomena, and eems to have been practised as early as the time of Hesiod (*c.* 8th entury B.C.). To begin the month with the new moon remained constant requirement, and for ordinary use this intercalation as found adequate. Farmers and seafarers used their own reckning based on observation of the heliacal rising and setting of he constellations (such and such work to be done when the Pleiaes rose; navigation dangerous after the setting of Arcturus; etc.) nd on seasonal phenomena such as migration of birds. Many eople had calendars (*parapegmata*) on which, by moving a peg om one hole to another, it was possible to check the relative positions of the lunar month and such seasonal indications.



M STAATL. MUSEEN BERLIN

AGMENT OF LATE 2ND CENTURY B.C. GREEK CALENDAR (PARAPEGMA) UND AT MILETUS, ASIA MINOR

Theories advanced in the interests of greater accuracy had little general effect; the Greeks did not have clocks and apparently did not demand calendric exactitude. The Athenian astronomer Meton, however, proposed a 19-year cycle or "great year," in the course of which seven months were intercalated. This gave on an average a month of 29 days 12 hr. 45 min. 57 sec.—less than two minutes too long. It has been contended that the Metonic cycle, begun on Hecatombaeon 1 (*c.* mid-July), 432 B.C., was adopted by the Athenians as the basis of their official calendar, but this view cannot be reconciled with the evidence. Meton's system was later improved upon by Callippus of Cyzicus (*c.* 370–300 B.C.), whose cycle contained four of those of Meton, and finally Hipparchus of Nicaea (2nd century B.C.) combined four of Callippus' cycles into one great cycle of 304 years to obtain a substantial degree of accuracy.

1. Days and "Thirds."—The first day of the month (*noumenia*) officially began at sunset, but was ordinarily reckoned from the following dawn, so that its predecessor, the last day of the previous month, was called the "old-and-new" day (*hene kai nea*). The day had no regular division into hours; the Greeks ordinarily used terms such as "cockcrow," "when the market place is full," etc., but reckoning by shadow lengths of a man or of a gnomon was also used. There were no weeks, but there was a division into "thirds"; the *men histamenos* or "beginning month" and the *men phthinon*, "waning month," described the first and last ten-day periods. For the middle section there was no regular description. Thus at Athens *Hekatombaionos hekte histamenou* = Hecatombaeon 6, and *Hekatombaionos hekte epi deka* = Hecatombaeon 16. But *Hekatombaionos hekte phthinontos* (or, after *c.* 330 B.C., *hekte met eikadas*, "after the twenties") = Hecatombaeon 24 or 25, since in the last period the days were counted backward from the end of the month, as explained below.

Days, like months, could be intercalated, but this was not always done for the sake of calendric accuracy; the double dating "by the archon" and "by the god" found in some Athenian inscriptions testifies to arbitrary tampering for political or religious purposes.

2. Months.—The Athenian calendar, which is the one best known and most studied, customarily began its year with the first new moon after the summer solstice. The months were called Hecatombaeon, Metageitnion, Boedromion, Pyanopsion, Maemacterion, Poseideon, Gamelion, Anthesterion, Elaphebolion, Munychion, Thargelion and Scirophorion. When intercalation was necessary a second Poseideon followed the first. Each month consisted of 29 or 30 days, being designated either "hollow" (*koilos*) or "full" (*pleres*). There was no rigid alteration of full and hollow months, although in practice the principle of alternation was probably followed, with an occasional doubling of the 30-day month if the first of the month strayed too far from the observable new moon. *Hekatombaionos hekte phthinontos* meant either the 25th or the 24th day (counting back from the last day), depending on whether the month was full or hollow.

The Macedonian calendar became of importance in the Hellenistic period; its year (like that of Sparta) began at the autumnal equinox, and its months were Dios, Apellaios, Audynaios, Peritios, Dystros, Xanthikos, Artemisios, Daisios, Panemos, Loios, Gorpiaios and Hyperberetaios. The Egyptian calendar achieved wide popularity among Greeks during the Ptolemaic period. In this calendar the year consisted of 365 days (12 × 30 plus 5 extra days named *epagomenai*); its discrepancy with the solar year resulted in a cycle of 1,460 years, at the end of which the calendar became correct again (see *Egyptian Calendar*, above). The Egyptian months were Thoth, Phaophi, Hathyr, Choiak, Tybi, Mechir, Phamenoth, Pharmouthi, Pachon, Pauni, Epiphi and Mesori.

The Greek months generally derived their names from festivals occurring in the season at which they fell; calendars adopted later (*e.g.*, in Achaea) used numbers rather than names. There was a general similarity of month names among cities with the same ethnic background, such as the Ionian or Dorian cities, because their festivals had a common derivation; however, similar names might not refer to the same lunar month in each case.

3. The Year.—Years were not numbered in the classical period, but were designated by the name of an eponymous magistrate or priest—*epi archontos x* or *epi stephanephorou y*. This practice, although adequate for ordinary purposes, made difficulties for writers of history and in international relations, especially when Greek horizons widened after Alexander the Great's conquests 334–323 B.C. Historians found a reckoning by the four-year periods of the Olympiads to be useful, although this was not adopted as an official system by the city administrations. The Hellenistic kings used the numbered years of their own reigns as a generally acceptable dating system, and most cities began to use an era numbered from their foundation or refoundation (*cf.* the Roman "ab urbe condita") or from some significant event such as their incorporation into a Roman province. Macedon during the Roman period used eras numbered from the years of the final Roman conquest (148–147 B.C.) and the battle of Actium (32–31 B.C.). Under the Roman empire both the Macedonian and the Egyptian calendars were reformed along Julian lines.

4. The Athenian Prytany Calendar.—Side by side with their civil (lunar) calendar, the Athenians used for administrative purposes a calendar based on the subdivisions of their council of 500, whereby the councilors from each tribe acted in turn as a standing committee or *prytany* during the year. Until 307–306 B.C. there were ten tribes, thereafter 12, except between 224–223 and 201–200, when there were 13 (as was also the case after A.D. 124). Thus Athenian public documents were dated both by the day of the *prytany* of such and such a tribe (with the ordinal numeral of its sequence in the year, which was decided by lot) and by the day of the lunar month. These equations have contributed much of great value, and much also of controversy, to the study of calendric problems.

In the period of Aristotle (4th century B.C.), when there were ten tribes, the normal succession of *prytanies* was described as 4 × 36 days followed by 6 × 35 days; however, variations in the length of the *prytanies* are known to exist, and the sequence could even have been 6 × 35 followed by 4 × 36.

(GE. W.)

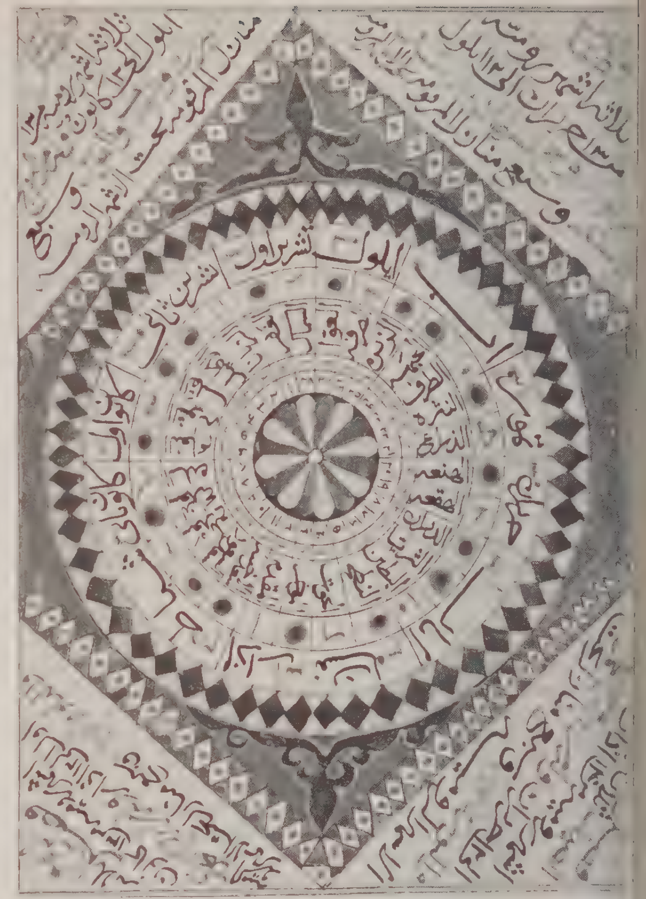
IX. MUSLIM CALENDAR

In the year A.D. 622 Mohammed, the Prophet of Islam, migrated from Mecca to Medina. The second caliph, Omar I (reigned A.D. 634–644), introduced the year of the emigration (Hegira; *q.v.*), taking as its beginning the first day of the month Muharram (*i.e.*, July 16 in 622), which had already been fixed by the Koran as the first day of the year. This era is also known as the Mohammedan era. The years are lunar and always consist of 12 lunar months alternately 30 and 29 days long, beginning with the approximate new moon. The year has 354 days, but the last month (Dhu 'l-Hijja) sometimes has an intercalated day bringing it up to 30 days and making a total of 355 days for that year. The months do not keep to the same season in relation to the sun, because there are no intercalations of months. The months retrogress through all the seasons every 32½ years.

The names of the months and the number of days in each are as follows:

Muharram	30	Rajab	30
Safar	29	Sha'ban	29
Rabi' I	30	Ramadan	30
Rabi' II	29	Shawwal	29
Jumada I	30	Dhu 'l-Qa'da	30
Jumada II	29	Dhu 'l-Hijja	29

Ramadan (*q.v.*), the ninth month, is observed throughout the Muslim world as a fast month. According to the Koran, Muslims must see the new moon with the naked eye before they can begin their fast. The practice has arisen that two witnesses should testify to this before a qadi (judge), who, if satisfied, communicates the news to the mufti, who orders the beginning of the fast. It has become usual for middle eastern Arab countries to accept, with reservations, the verdict of Cairo. Should the new moon prove to be invisible, then the month Sha'ban, immediately preceding Ramadan, will be reckoned as 30 days in length and the fast will begin on the day following the last day of this month. The end of the fast follows the same procedure.



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MUSLIM TABLE SHOWING SEASONS OF THE YEAR WITH THE POSITIONS OF TH
SUN IN THE ZODIAC AND THE SYRIAN MONTHS, A.D. 1787

The era of the Hegira is the official era in Saudi Arabia, Yeme and the principalities of the Persian (Arab) gulf. The Unite Arab Republic, Syria, Jordan and Morocco use both the Mohammedan and the Christian eras. In all Muslim countries people u the Mohammedan era in private, although the Christian era may b in official use.

Some Muslim countries have made a compromise on this matte Turkey, as early as 1088 A.H. (A.D. 1677), took over the sol (Julian) year with its month names but kept the Mohammeda era. March 1 was taken as the beginning of the year (common called *marti year* after the Turkish word *mart* for March). Late the 19th century the Gregorian calendar was adopted. In the 20 century, President Mustafa Kemal Atatürk ordered a comple change to the Christian era. Iran, under Reza Shah Pahla (reigned 1925–41), also adopted the solar year, but with Persi names for the months and keeping the Mohammedan er March 21 is the beginning of the Iranian year. Thus the Irani year 1339 began on March 21, 1960. This era is still in use of cially.

(N. A. Z.)

X. MIDDLE AMERICAN CALENDARS

1. Maya Calendar.—The various calendars of Middle Ameri do not differ structurally. The description of the Maya calend which follows therefore applies to all Middle American calenda insofar as it deals with pattern; it is not relevant to nomenclatu nor, entirely, to function.

All Middle American calendars were based on a period of 2 days. This consisted of 20 day names attached to the numbers to 13, both re-entering cycles which ran concurrently. Becau 20 and 13 have no common measure, 260 days (20 × 13) must pa before a given day name and number again coincide. A section this period, using the Maya names current in Yucatan in the 16

TABLE V.—*Maya Day Names*

1 Imix	11 Chuen	8 Imix	5 Chuen	2 Imix
2 Ik	12 Eb	9 Ik	6 Eb	3 Ik
3 Akbal	13 Ben	10 Akbal	7 Ben	4 Akbal
4 Kan	1 Ix	11 Kan	8 Ix	5 Kan
5 Chicchan	2 Men	12 Chicchan	9 Men	6 Chicchan
6 Cimi	3 Cib	13 Cimi	10 Cib	7 Cimi
7 Manik	4 Caban	1 Manik	11 Caban	8 Manik
8 Lamat	5 Etz'nab	2 Lamat	12 Etz'nab	9 Lamat
9 Muluc	6 Cauac	3 Muluc	13 Cauac	10 Muluc
10 Oc	7 Ahau	4 Oc	1 Ahau	11 Oc

entury, is given in Table V. Each column in turn should be read ownward, starting with the one on the left.

Since there are 20 names but only 13 numbers, the number at- ached to any name increases by 7 at each recurrence, while 13 deducted if the total exceeds that number. Thus the numbers ttached, for example, to Imix will be 1, 8, 2, 9, 3, 10, 4, 11, 5, 12, , 13, 7 and then 1 again. Moreover, a person could not say, for xample, that today is Ik; he had to give the number, for the two omplemented each other like the exchange name and number on he telephone.

This 260-day cycle had a ritualistic function, as noted below. or keeping count of the seasons there was a year of 365 days com- osed of 18 months of 20 days each with an extra 5 days at the nd of the year. These days formed a period of extreme misfor- une called "Uayeb" and other names descriptive of their dire ature.

The month and day names used in Yucatan at the time of the panish conquest are employed by modern students in dealing with he Maya calendar, but it must be remembered that in other parts f the Maya area other names were current. The Yucatecan onth names are: Pop, Uo, Zip, Zotz, Zec, Xul, Yaxkin, Mol, h'en, Yax, Zac, Ceh, Mac, Kankin, Muan, Pax, Kayab, Cumku. hen follow Uayeb or *u lobil kin,* "the evil days."

The days of each month are numbered from 1 to 19, but between he end of one month and the beginning of the next in sequence for example, 19 Yaxkin and 1 Mol) came a day which may be alled either "end of Yaxkin" or "seating of Mol." Glyphically his was expressed either by a sign for termination affixed to the yph for Yaxkin or a sign for seating affixed to the glyph for Mol. efore this arrangement was understood by modern scholars, the eating glyph was translated as zero, and thus written 0 Mol. his use of the zero sign for the day preceding the first of a month retained for convenience, but with the understanding that it oes not mean zero. The days of the Uayeb period are similarly esignated "seating" and 1 to 4.

The year, as used in the Classic period *c.* 100 B.C.–A.D. 900 and eemingly throughout the Maya lowlands until the Spanish con- uest, started with 1 Pop. The 260-day almanac and the 365-day ear were so interlocked that only the days Akbal, Lamat, Ben and tz'nab could fall on 1 Pop. This was so because 365 divided by e number of day names leaves a remainder of 5, which is the terval between these various days. Furthermore, 365 divided y 13 leaves a remainder of 1. It follows therefore that if 1 kbal 1 Pop is the new year day now, 2 Lamat 1 Pop, 3 Ben 1 Pop, Etz'nab 1 Pop, and 5 Akbal 1 Pop will be the next four new year ays. The sequence will continue until at the end of 52 years 1 kbal again falls on 1 Pop. The day on which the year com- enced was called the year-bearer, and late in Maya history, but robably not during the Classic period, a year took the name of its earer, so that an event was said to have occurred in the year 13 amat or whatever the year-bearer happened to be.

This period of 52 years (18,980 days) is called by Maya students e Calendar Round (its Maya name is unknown). Every one its 18,980 days has a different combination of day name, day umber, month name and month position. Every such date (12 aban 15 Ceh, for instance) is called a Calendar Round date. This urfold calendar, particularly in combination with the Long Count ee CHRONOLOGY: *Maya and Mexican*), forms a remarkably erfect system for reckoning time, because the sundry rules check e another, as in bookkeeping, by double entry. This enables stu- ents to decipher partly obliterated inscriptions; for example, an itial Series, which shows the position of a date in the Long ount, can be deciphered in many instances even if more than half its component elements are illegible. Similarly, modern students have even found mistakes in calculation or misreadings by the artist of the drawings he was supposed to copy. The Maya calendar was, however, well-constructed; it was not, as is constantly asserted, an accurate measurer of the length of the solar year. There is evidence, not accepted by all students, that the Maya calculated the error between their year of 365 days and the true solar year of 365.242199 days which had accumulated in nearly 4,000 years since the starting point of their count. Such corrections were recorded in separate entries; they were not an integral part of the calendar.

Because there was no intercalation of leap days, the Maya new year receded in the solar year at the approximate rate of 24.2 days per century. In Yucatan, 1 Pop coincided with July 25 (new style) in A.D. 1556; *i.e.,* at just about the time that the Maya system was ceasing to function correctly under pressure of the European calendar. The Chol Maya calendar, the only other lowland calendar about which there is information, was synchronous with this. The various calendars of the highland Maya were not in agreement with these: the Quiche new year of 1556 fell on June 13, and that of the Jacalteca, projected backward from the present time, would have coincided with June 14. The reason for the difference of two Maya months is not known; the further differences of 1 and 2 days were caused by local variations in the sets of days which could serve as year-bearers.

In the Maya lowlands, except for Campeche and adjacent parts of Yucatan, the year-bearers were, as already noted, Akbal, Lamat, Ben and Etz'nab, but in Campeche and some parts of western Yucatan they were Kan, Muluc, Ix and Cauac, those days coinciding with 1 Pop. It was formerly thought that this was a late innovation, but it is now known that this local variation was in force during the Classic period, because it is recorded on stelae, dating from the middle of that period, found at Etzna, Campeche. Whereas Campeche and western Yucatan used the set of days one position later than the standard Akbal group, the Quiche and Cakchiquel tribes used the set Ik, Manik, Eb and Caban, which were one position earlier than the Akbal group. Despite these shifts and local variations in the names of the days, the 260-day almanacs were completely synchronized throughout Middle America. If the day is 10 Imox (local form of Imix) in one village, it is 10 Imox throughout this whole wide area of isolated settlements, except among the Mam, who have dropped the number attached to their day names. For them the day is merely Imox. This unity over a wide area (it extends to the Mixe in remote mountain villages of Oaxaca, Mexico) bears witness to the great ritualistic importance of the 260-day count and to the care with which the local priests and shamans have kept the count inviolate without loss or gain of a day in the face of four centuries of effort by the Spaniards to suppress it.

This sacred almanac was of supreme importance as a guide to daily conduct and as an instrument of divination. Both the day names and the day numbers represented gods, and on their combined influences depended the fortune of each day. For example, the day Kan was the maize god, Chicchan was the day of the serpent god of rain and Cimi the day of the death god; and the numbers 1, 4, 5 and 8 represented respectively the moon goddess, the sun god, the old god of the interior of the earth and the maize god. Thus 8 Cimi, for example, combined the influences of the maize god and the death god; the priest, in making his divination, could weigh the benevolence of the former against the malevolence of the latter.

The calendar priest was consulted as to lucky days on which to undertake any venture, whether for the nation or for the individual. He indicated good days for starting a war or a communal hunt or for building a new house, and decided whether a youth born on such and such a day might wisely marry a girl born on day so-and-so. In some parts of the Maya area and among the Mixtec and some other Mexican groups, men and women were named for the day on which they were born. Everywhere in Middle America a man's lot in life was largely decided by the luck of the day on which he was born. Two of the three surviving Maya hieroglyphic books consist largely of 260-day sacred almanacs giving divinatory information on a variety of subjects, among them weather, crops, hunting, beekeeping, idol making and diseases. The Maya name for the 260-day cycle is not known; students sometimes call it *tzolkin*, but this usage is to be deprecated since that term is known to have had a different meaning.

2. Mexican Calendar.—The Aztec 260-day almanac was called *tonalpohualli*, and in function and structure resembled the Maya almanac, but the day names and their glyphs were different. These names are translatable and the glyphs represent them pictorially. In English they are: Crocodile monster, Wind god, House, Lizard, Snake, Death, Deer, Rabbit, Water, Dog, Monkey, Dead grass, Reed, Jaguar, Vulture, Eagle, Earthquake, Stone knife, Rain and Flower. The same glyphs were used by other peoples of central Mexico, such as the Mixtec, Cuicatec, Tlapanec and Otomi, but each group named the days in its own language. There are a few regional variations in the glyphs (*e.g.*, in one area a picture of a grinding stone replaces the eagle).

The Zapotecs, authors of the great civilization centred at Monte Alban, had day signs distinctive from both the Maya and the Mixtec-Aztec groups. Not all of their signs have been finally identified, but in essentials they clearly fall into the general Middle American pattern. The 260-day cycle survives among the Mixe of Oaxaca. The Aztec count of the early 16th century and that of the present-day Mixe and the various Maya almanacs are synchronous; throughout this area these almanacs through their divine associations still govern, as they have always done, the daily life of community and individual.

The Aztecs and related peoples also used a year composed of 18 months of 20 days plus the final 5 unlucky days, but this 365-day year was of far less importance to the Aztecs than it was to the Maya. In general, dates were reckoned not in terms of the Calendar Round but by recording the year-bearer (House, Rabbit, Reed and Stone Knife, corresponding to the Maya Akbal group) and the day itself; for instance, in the year 6 Reed on the day 12 Flower so-and-so happened. Often, the year-bearer alone was given. For example: on 9 Calli (House) Ahuitzotzin died; on 10 Tochtli (Rabbit) Moctezuma became the ruler. Because a year denominated 9 Calli will recur after 52 years, confusion easily arises as to the position of an event in a longer chronological sequence.

Religious festivals were related in some cases to the 260-day almanac, in others to the 20-day months. Glyphs of the months are rare and the codices in which they occur are of post-Spanish conquest date or contemporaneous with it. (J. E. S. T.)

For the French republican calendar, *see* the separate entry FRENCH REPUBLICAN CALENDAR. *See* also references under "Calendar" in the Index.

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CALENDER, a machine that has wide application in the finishing of textile fabrics, the production of vinyl plastic sheeting, rubber sheeting, coated fabrics and the manufacture of paper The mechanized plain calender was in common use in the mid-18th century after having been introduced into England from Flanders in the 17th century. A special type called the friction calende was patented in 1805 by William Smith, and the schreiner calender was developed about 1895. Calenders for embossing and moiréing are other types in use.

Calenders are made in many different forms and employ from 2 to 12 heavy rollers, usually mounted vertically in a series on strong frame. The essentials of the machine are the pressure an temperature applied when the material being processed passe under or between the rollers. The number, arrangement an type of rollers are the chief factors that determine how the calender functions. In the finishing of broad-woven fabrics, calendering produces results similar to ironing clothes at home. The pressure applied closes the threads, removes creases from the cloth flattens it to the required thickness and imparts a smoothness an lustre, or other special effects, to the cloth.

In the plastics industry calendering is the leading method fo producing vinyl film or sheeting. Resin and other ingredients ar blended and formed into a hot plastic mass and passed throug the hot rollers of the calender. The plastic emerges as a flat film or sheet whose thickness is determined and made uniform by th gap set on the gauging rollers of the calender. Similar applications are employed in the production of coated fabrics or rubbe sheeting. *See* PAPER MANUFACTURE: *Manufacturing Operation and Equipment;* RUBBER: *Manufacturing Processes.*

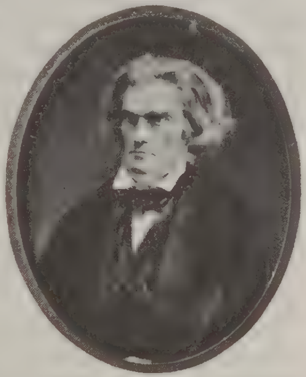
(J. E. Ho.)

CALGARY, a city of southern Alberta, Can., on the wester edge of the Great Plains (elevation 3,438 ft. [1,048 m.]) at th junction of the Bow and Elbow rivers, about 40 mi. (64 km.) from the foothills of the Rocky Mountains. The population of the cit in 1966 was 330,575.

Calgary ranks with the provincial capital, Edmonton, 182 m (293 km.) to the north, as a leading city in the province. Whea farming is important, and the region is Canada's outstanding ranc ing area. The city is Alberta's most important wholesaling centr its distributing area including all of southern Alberta and sout eastern British Columbia. Coal, electric power (developed on th Bow River), and natural gas and oil are all available from th immediate vicinity. Industry is based on the processing of loc raw materials. Calgary has flour mills, meat-packing plants, distillery, a malting plant, oil refineries, and plants making nitr gen fertilizers and sulfur from natural gas. Metal products a fabricated, chiefly for the oil industry, and the city has large rai way shops. It is also a construction-industry centre, manufactu ing asphalt roofing, gypsum, and lime products.

It was founded as Ft. Calgary by the Northwest Mounted Police in 1875. Canada's first transcontinental railway reached there in 1883. Calgary was incorporated as a town in 1884 and was chartered as a city in 1893. In 1904 large-scale irrigation projects were undertaken in the Western Irrigation district near Calgary, and thereafter such crops as alfalfa, sugar beets, and canning vegetables were grown on the irrigated land. Natural gas and oil were discovered at Turner Valley (38 mi. [61 km.] SW) in the early 1900s; after the discovery of oil at Leduc, Alta., in 1947, Calgary became the administrative, operations, and financial centre of the petroleum industry in western Canada. After 1952 the municipal government of Calgary was operated on the commission-with-council plan. The city owns and operates the urban electric light, heat, and power systems, and the waterworks and transit systems. It is the seat of Mount Royal (junior) College (1910), the Provincial Institute of Technology and Art (1916), and the University of Calgary, which originated as an affiliate of the University of Alberta in Edmonton in 1945 and gained full autonomy as a university in 1966. The Calgary "Stampede" is an annual rodeo and exhibition. (Jn. H. W.)

CALHOUN, JOHN CALDWELL (1782–1850), U.S. statesman and controversial political philosopher, was born in Abbeville district, S.C., March 18, 1782. He was of Scotch-Irish stock, the son of a hill-country farmer who owned a few slaves. An immigrant from County Donegal, Ire., his father, "Pat" Calhoun, was a political leader in the up-country of South Carolina who disliked even the restrictions of the federal constitution. John C. Calhoun, largely self-educated until he was 18, had two years at the famed "log college" taught by his brother-in-law, the Rev. Moses Waddel (1770–1840), a Presbyterian minister who later became president of the University of Georgia. Calhoun then entered the junior class at Yale and graduated with distinction in 1804.


BY COURTESY OF THE LIBRARY OF CONGRESS
CALHOUN, DAGUERREOTYPE BY MATHEW BRADY, ABOUT 1849

He studied at the law school in Litchfield, Conn., conducted by Tapping Reeve and heard Reeve expound the right of secession. He took up the practice of law n South Carolina and served as a member of the South Carolina legislature during the sessions of 1808 and 1809. It was during these years that South Carolina hammered out the constitutional compromise that recognized the up-country farmers and the low-country planters as two separate interests, and gave the up-country control of the lower house and the low country control of the upper house. Although Calhoun was always avowedly an up-country man, his marriage in 1811 to his young cousin, Floride Bonneau Calhoun of Charleston, did more than give him entry to South Carolina plantation society. It gave him an understanding of the aristocratic ideal, which he was later to transmute into philosophy of government.

In the same year he took his seat in the United States house f representatives. When Calhoun entered congress, Henry Clay vas speaker of the house and one of the leaders of the group that vas eager for war with England. Clay named Calhoun to a place n the important committee on foreign affairs. This committee, of vhich Calhoun soon became the dominating member, recommended the adoption of resolutions urging war with England. These resolutions were adopted by the house of representatives, nd it is estimated that no other two members of congress were nore influential in precipitating the War of 1812 than were Clay nd Calhoun.

After the war he became secretary of war in President Monroe's cabinet and in 1824 was elected vice-president under John Quincy Adams and re-elected in 1828 under Andrew Jackson. Three vents shaped Calhoun's thinking during his years in this office. He became an active farmer; the cotton economy began to decline; and he came under the influence of the brilliant, if unstable, John Randolph of Roanoke. During the Missouri Compromise debates in 1820 Randolph had decided that if the south conceded to the northern congressional majority the power to prohibit slavery in the territories, it was thereby conceding the power of simple majority rule—a power never disputed by the south in general, except when it led to legislation or election results (*e.g.*, in 1860) considered by the south to be inimical to its regional interests.

The immediate issue in the late 1820s, however, was the so-called "tariff of abominations." Years earlier, under the stress of war emergency, Calhoun had urged that the vast American nation be linked together by highways and that its young industries receive tariff protection. In thus promoting the general welfare Calhoun had seen no threat to the south that he loved. But time and John Randolph were to change his opinions. He became convinced that a permanent tariff program was, in effect, a subsidy paid by the agriculturists of the south for the benefit of the industrialists of the north.

When congress offered no relief, Calhoun wrote his famed *Exposition and Protest*, and in 1831, the *Fort Hill Letter*. Both concluded that, as the states had joined together (though out of dire necessity) to make the union, they were therefore the ultimate judges of the powers they had delegated. It was their duty, he wrote, to interpose or to nullify acts of the federal government that they deemed unconstitutional, rendering them void within their own state boundaries. In a different context, Jefferson and Madison had taken the same stand at the turn of the century in the Kentucky and Virginia resolutions that had brought about the end of the Alien and Sedition laws.

Nullification by South Carolina of the Tariff act of 1832 had no such effect on the tariff. Pres. Andrew Jackson saw the question more as one of anarchy than of constitutional theory, and threatened to arrest Calhoun. Calhoun had resigned the vice-presidency, but returned to Washington in 1833 as a senator from South Carolina to debate the issues with Daniel Webster. For the next 17 years he served in the senate, taking his stands courageously, without regard to party alignments, with a brief interlude (1844–45) as secretary of state under President Tyler.

When Jackson was authorized by the "Force Bill" in 1833 to halt resistance in South Carolina, Henry Clay brought in a compromise settlement of the tariff question. The duties were reduced, but the tariff principle was retained. South Carolina repealed its act of nullification, but the great questions remained unanswered.

Jackson, in his subsequent war with the Bank of the United States, thought big government was necessary to counter big business; Calhoun, in his battle against the tariff, viewed big government as no less of a threat than big business. Both men, however, had recognized unrestrained finance capitalism as the common enemy of the labouring masses, the southern planters and the small farmers everywhere. Calhoun, therefore, strove to unite these dissident groups within the Democratic party, and laboured to dedicate the party to states' rights and agricultural interests, as a barrier against both financial and federal centralization. Constitutions, he said, were created to protect minorities against the inherent selfishness of majorities; the majority could look after itself. Liberty and equality he saw as incompatible.

During the 1840s Calhoun expanded his ideas in two books—*A Disquisition on Government* and *A Discourse on the Constitution and Government of the United States*—works remarkable for their insight into the nature of the American political system. He saw, for instance, that political parties were vital mechanisms in the American form of government. He saw that the citizenry had a natural tendency to divide itself into blocs, and that the genius of the American system was to utilize these blocs, not against, but for the vital interests of each other. In a country of such diversity as the United States, he believed, justice could be secured only by obtaining the concurrent agreement of each interest group, not by a simple numerical majority. Calhoun recognized that by 1850 the north and south were virtually two countries and that only force, military or legal, could compel the north to recognize southern rights. His final thinking, however, was not specifically in terms either of nullification or states' rights. He believed that the great economic interests of his time could only be safeguarded regionally, and sought legislation that would artificially restore the lost equilibrium between the two sections.

During the impassioned debates of the 1840s, Calhoun took an unyielding stand. He led the opposition to the Wilmot Proviso, which would have denied the south's "right" to slavery in the territories. He set his face indomitably against the compromise of 1850. No compromise of the immediate issues, he foresaw, could long settle the fundamental questions.

Worn out by illness and anxiety, he dragged himself to the senate to hear his last warning read, and Daniel Webster's rejoinder a few days later. He died on March 31, 1850. "The dissolution of the Union," he had said, "is the heaviest blow that can be struck at civilization and representative government." He did not deny the south's right to secede: he predicted secession within ten years; but secession would mean that the great American experiment in diversity had failed. To the end, he clung to the union.

John C. Calhoun is remembered not so much for what he did as for what he thought and felt and believed. His life has been described as a Greek tragedy. He wore out his great powers in a futile attempt to avert the conquest of the south that he foresaw but could not tell how to avoid.

See also references under "Calhoun, John Caldwell" in the Index.

See Charles M. Wiltse, *John C. Calhoun,* 3 vol. (1944–51); Margaret L. Coit, *John C. Calhoun: American Portrait* (1950).

(M. L. Co.; X.)

CALI, one of the leading cities of Colombia, capital of the department of Valle del Cauca. It stands 3,327 ft. above sea level on the western side of the Cauca valley, one of the richest agricultural areas of Colombia. The Río Cali, a left-bank tributary of the Cauca, bisects the city. Its population in 1964 (census) was 618,215.

In the 1950s Cali was one of the most rapidly growing cities in the country and distinctly modern. The Cauca valley development project, a 20-year scheme to promote the agricultural and industrial development of the surrounding region and modeled after the Tennessee Valley authority, has its headquarters there (*see* Cauca River). The nearby coal fields at Yumbo are the most important in Colombia. Both railroad and highway connect Cali with the port of Buenaventura, 100 mi. W. on the Pacific coast. All the traffic between Buenaventura and the interior of the republic, including nine out of every ten sacks of Colombian coffee exported, is channeled through Cali. The international airport is a regular stop on flights between Panamá and Quito, Ecuador.

Cali was founded in 1536 by Sebastián de Belalcázar, who had come north from Quito, but its landlocked position long retarded its economic development. Cali rivals Bogotá, Barranquilla and Medellín as an industrial centre, with branches of numerous foreign manufacturing concerns located in its environs. The agriculture of the 120-mi. long Cauca valley, an old inter-Andean lake bed that was once in great cattle and sugar estates, is rapidly being intensified and diversified. (Js. J. P.)

CALIBRATION: *see* Graduation and Calibration.

CALIBRE, the interior or bore diameter of a gun, the diameter of a projectile fired from a gun or the length of a gun expressed in relation to its interior diameter. In rifled weapons the calibre is normally obtained by measuring between opposite lands (not grooves). With small arms, British and American practice has been to express calibre as a fraction of an inch, as calibre .30 or calibre .50, the bore diameter of a calibre .30 rifle being $\frac{30}{100}$ in., that of a calibre .50 weapon, $\frac{1}{2}$ in. In former years British usage carried the figure to another decimal point, as in the calibre .303 rifle of World War II. In both Great Britain and the United States the trend after 1950 was to follow the metric system, with calibre 7.62 mm. corresponding to calibre .30. The bore diameter of artillery weapons may be expressed either in inches or millimetres, a 75-mm. gun corresponding roughly to a 3-in. gun (or 15-pounder in British terminology). The bore of a shotgun is indicated by the term gauge.

The word calibres (always in the plural) is also used to indicate the length of big guns in relation to their bore diameters. The number of calibres is determined by dividing the length of the bore (from muzzle to breech face) by the bore diameter. Thus a gun with a bore diameter of 5 in. and length of 200 in. is said to be 40 calibres long. (H. C. T.)

CALICO, a trade term that designates an inexpensive variety of all-cotton fabric woven in plain or "tabby" weave and printed with simple designs in one or more colours.

Calico is one of the oldest staples known. The name is derived from Calicut, India, where the fabric originated. Calicut was an important seaport in southwestern Madras and, after Goa, was the chief centre for Indian trade in the 16th century. The term calico at that time was a general one for many varieties of cotton cloth imported from western India, whether figured or plain. These cloths were known to the trade by such names as Calecut, Calicute, Kalyko, Calyco, etc.

The most important early calicoes were those with printed and painted designs, the outline being printed and the coloured pattern filled in with a brush. These were imported into Europe from India by foreign merchants, particularly the Portuguese and Spanish, who held a monopoly on the trade and caused the price to remain so high that only royalty and wealthy nobility could afford them. At that time, calico was the favoured material for handkerchiefs, inner sleeves and doublets and, with linens, rivaled silk in popularity. The monopoly of Indian trade was broken in 1599 when the British East India company was founded. After that date, calico was imported into Europe in larger quantities and became more commonly used.

About 1772, England began to manufacture calico which rapidly became one of the staple products of that country. Calico was also made in France and gained great popularity because of its fine quality and beautiful colours. Some of the early European calicoes were made of linen and cotton but most were all-cotton fabrics.

Calico was well-known and popular in colonial America, and many small establishments in the early days printed imported plain material. The manufacture of calico in the United States began after the Industrial Revolution and grew to importance with the rising cotton industry.

The technique of calico weaving is a simple one: one set of warp threads are woven one-over and one-under with one set of weft threads. Calico fabrics are almost invariably woven in the "gray" state; *i.e.*, in the natural colour of the raw cotton staple. A considerable quantity of calico is used in the gray state for domestic purposes and is also shipped in large quantities all over the world. In the Manchester district and in Great Britain generally the term calico designates a plain gray or white shirting or sheeting free from any ornamentation.

A considerable amount of calico is bleached, dyed and printed for every conceivable household use and for articles of clothing. Generally, calicoes are in two colours, one for the ground and the other for the figure or design. The ground colour is usually piece-dyed in some solid colour and the design printed on the cloth later by means of a revolving cylinder on which the design has been stamped or cut out. Such machines are capable of printing several colours in one design. Calico fabrics include an infinite variety of textures and qualities according to the different uses for which they are intended, ranging from the finest muslin and cambric to those of coarser and stronger textures.

See also Cotton Manufacture. (M. Da.)

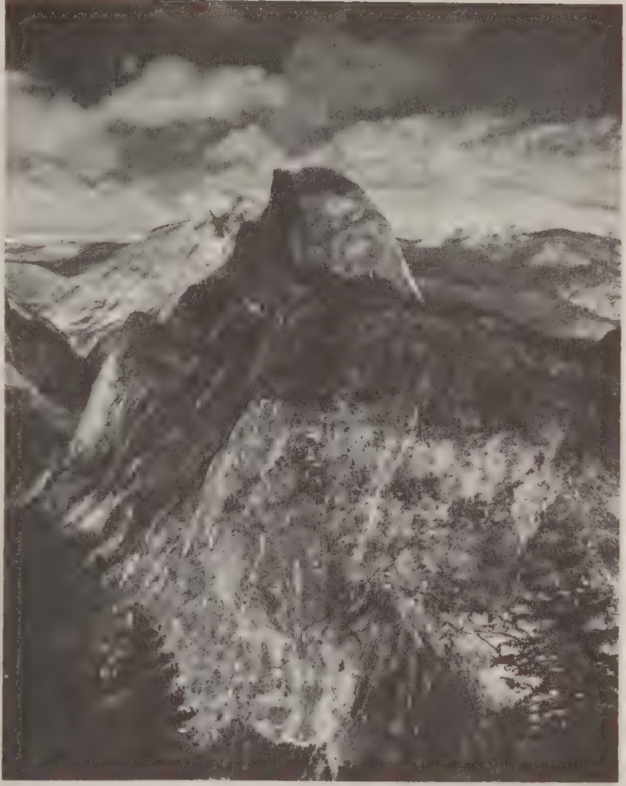
CALICUT: *see* Kozhikode.

CALIFORNIA, most southwestern of the Pacific coast group of the United States, was admitted to the Union in 1850, as the 31st state. In size California ranks third in the Union, Alaska and Texas being larger. Geographically bounded on the north by Oregon, east by Nevada and Arizona, south by Mexico's state o Baja California Norte, and west by the Pacific Ocean, the state extends from latitude 32°30′ to 42° N. Extreme longitudinal limits are approximately 114° and 124°29′ W. Length of its north–south medial line is 770 mi. (1,239 km.) and its breadth varies from 150 to a maximum of 589 mi. (241 to 948 km. in an east–west direction. Total area is 158,693 sq.mi. (411,01 sq.km.), including 2,156 sq.mi. (5,584 sq.km.) of water. The general coastline, which does not recognize all of the details, is 840 mi. (1,352 km.) in length. When all details of indentations—bays, sounds, and other bodies of water to the head of the tidewater—are included, the shoreline measures 3,427 mi. (5,515 km.). California was nicknamed the "Golden State" because of its early and sustained gold production. It officially adopted the golden poppy, the California valley quail, and the California redwood as its state flower, bird, and tree respectively. The grizzly bear is the official state animal, and the state fish is the South Fork golden trout. The state capital is Sacramento.

PHYSICAL GEOGRAPHY

Physical Features.—California's physiography is simple; its main features are few and bold; a mountain fringe along the ocean, another mountain system along the east border, between them—closed in at both ends by their junction—a splendid valley, and outside all this a great area of barren, arid lands, belonging partly to the Great Basin and partly to the open basin region. Along the Pacific, and about 20–40 mi. (32–64 km.) in width, runs the Coast Range, composed of numerous indistinct chains that are broken into innumerable ridges and spurs, and small valleys drained by short streams of rapid fall. The range is cut by numerous fault lines, some of which betray evidence of recent seismic activity; it is probable that movements along these faults cause the earthquake tremors to which the region is subject, all of which seem to be tectonic. Coast Range altitudes vary from about 2,000 to 8,000 ft. (610 to 2,438 m.); near San Francisco Bay the culminating peaks are about 4,000 ft. in height (Mt. Diablo, 3,849 ft. [1,173 m.]; Mt. St. Helena, 4,344 ft. [1,324 m.]), and both north and south the elevation of the range increases. In the eastern part of the state is the magnificent Sierra Nevada, a great block of the earth's crust, faulted along its eastern side and tilted up so as to have a gentle back slope to the west and a steep fault escarpment facing east. The Sierra proper, from Lassen Peak to Tehachapi Pass in Kern County, is about 400 mi. (644 km.) long (from Mt. Shasta in Siskiyou County to Mt. San Jacinto in Riverside County, more than 600 mi. [965 km.]). Far higher and grander than the Coast Range, the Sierra is much less complicated, being indeed essentially one chain of great simplicity of structure. Precipitous gorges, often from 2,000 to 5,000 ft. (610 to 1,524 m.) in depth, become a more and more marked feature of the range as one proceeds northward; over great portions of it they average not more than 20 mi. (32 km.) apart. The eastern slope is very steep, because of a great fault which hrew the rocks of the great basin region abruptly downward several thousand feet. Few passes cross the chain. Between latiudes 36°20′ and 38° N, east of Fresno, the lowest gap of any kind s more than 9,000 ft. The Tioga, most used of all, is 9,941 ft. 3,030 m.) high. About 40 peaks are catalogued between 5,000 and 8,000 ft., and there are 11 above 14,000. The highest portion of the system is between latitudes 36°30′ and 37°30′ N; there the peaks range upward to Mt. Whitney, 14,495 ft. (4,418 m.), being he highest summit of the U.S., ouside Alaska.

Of the mountain scenery the granite pinnacles and domes of the ighest sierra opposite Owens Lake, where there is a drop eastward into the valley of about 10,000 ft. (3,048 m.) in ten miles; the nowy volcanic cone of Mt. Shasta, rising 11,000 ft. (3,353 m.) bove the adjacent plains; and the lovely valleys of the Coast Range, and the south fork of the Kings River—all these have their harms; most beautiful of all is the unique scenery of the Yosemite Valley (*see* YOSEMITE NATIONAL PARK). Much of the ruggedness nd beauty of the mountains was caused by the erosive action of many alpine glaciers that once existed on the higher summits and left behind their evidences in valleys and amphitheatres with towring walls, polished rock expanses, glacial lakes and meadows, nd tumbling waterfalls. Remnants of these glaciers are still to e seen—notably on Mt. Shasta—though shrunk to small dimenons. The canyons are largely the work of rivers. The finest of the lakes is Tahoe, 6,229 ft. (1,898 m.) above sea level, lying between the true Sierras and the basin ranges, with peaks on several sides rising 4,000–5000 ft. above it.



RAY ATKESON

HALF DOME MOUNTAIN, YOSEMITE NATIONAL PARK

Lava covers most of the northern half of the range, and there are many craters and ash cones, some recent and of perfect form. Of these the most remarkable is Mt. Shasta. In Owens Valley, east of the Sierra Nevada, is a fine group of extinct or dormant volcanoes.

Earthquakes.—Among other indications of great geological disturbances on the Pacific coast may be mentioned the earthquakes to which California like the rest of the coast is subject. They occur in all seasons, scores of tremors being recorded every year; they are of slight importance, and even of these the number affecting any particular locality is small. In 1812 great destruction was wrought by an earthquake that affected all the southern part of California; in 1868 the region about San Francisco was violently disturbed; in 1872 the whole Sierra and the state of Nevada were shaken; in 1906 San Francisco was largely destroyed by a shock (and ensuing fire) that caused great damage elsewhere in the state (*see* EARTHQUAKE); and in 1925 Santa Barbara was severely shaken. In February 1971, Los Angeles and the San Fernando Valley area were jolted by an earthquake that took more than 60 lives and caused great property damage, estimated as high as $1,000,000,000.

The Central Valley.—North of latitude 40° N the Coast Range and Sierra system unite, forming an extremely rough country. The eastern half of this area is very dry and barren, lying between precipitous, although not very lofty, ranges; the western half is magnificently timbered and, toward the coast, excessively wet. Between latitudes 35° and 36° N the Sierra, at its southern end, near Bakersfield, turns westward toward the coast as the Tehachapi Range. The Central Valley is thus closed to the north and south, and surrounded by a mountain wall broken at a single place, the gap behind the Golden Gate at San Francisco. Through this passes the entire drainage of the interior. The length of the valley is about 450 mi. (725 km.), while its breadth averages about 40 mi. (64 km.) if the lower foothills be included, the entire area being about 18,000 sq.mi. (46,620 sq.km.). From the mouth of the Sacramento River to Redding, at the northern head of the valley, the rise is 552 ft. in 192 mi., and from the mouth of the San Joaquin southward to Kern dry lake bed it is 282 ft. in 260 mi.

The two rivers for which the valleys forming the Central Valley are named—the Sacramento and the San Joaquin—drain this interior basin. The San Joaquin Valley comprises more than three-fifths of the entire basin, while the Sacramento comprises the remainder. The eastward flanks of the Coast Range are scantily forested, and they furnish not a single stream permanent enough to reach either river throughout the dry season.

On the eastern side of both major rivers are various important tributaries, fed by the more abundant rains and melting snows of the Sierra's western flank. Feather River is the most important tributary emptying into the Sacramento. A striking feature of the Sacramento system is that for 200 mi. N of the Feather it does not receive a single important tributary.

Another peculiar and very general feature of the state's drainage system is the presence of numerous so-called river sinks, where the waters disappear, either directly by evaporation or (as in Death Valley) after flowing for a time beneath the surface. These sinks are therefore not the true sinks of limestone regions. Some of the mountain lakes indicate by terraces about them that water stood during the glacial period much higher than it does now. Tulare Lake, which has practically disappeared, was formerly a shallow body of water, about 25 mi. broad, that received the drainage of the southern Sierra, a flow that is believed to have shrunk greatly after 1850.

Southern California.—Finally along the sea below Point Conception are fertile coastal plains of considerable extent, separated from the interior deserts by various mountain ranges from 5,000 to 7,000 ft. high, and with peaks much higher (San Bernardino, 10,691 [3,259 m.]; San Jacinto, 10,831 [3,301 m.]; and San Antonio, 10,064 [3,068 m.]). Unlike the northern Sierra, the ranges of southern California are broken in a number of places. It is over these passes—Soledad, 3,210 ft. (978 m.); Cajon, 3,820 ft. (1,164 m.); and San Gorgonio, 2,590 ft. (789 m.)—that railways cross to the coast.

That part of California which lies south and east of the Coast Range and of the Sierra comprises an area of fully 50,000 sq.mi. (129,500 sq.km.) and belongs to the basin range region. Generally it is excessively hot and barren. The Mojave Desert (*q.v.*)—embracing parts of Kern, Los Angeles, and San Bernardino, as also a large part of San Diego, Imperial, and Riverside counties—belongs to the Great Basin, while a narrow strip along the Colorado River, which divides California from Arizona, belongs to the open basin region. They have no drainage to the sea, except fitfully for slight areas through the Colorado River. In San Diego, Imperial, and Riverside counties a number of creeks or so-called rivers, with beds that are normally dry, flow centrally toward the desert of Salton Sink or Sea; this is the lowest part of a large area that is depressed below sea level, being 273 ft. (82 m.) below at Salton.

In 1900 the Colorado River (*q.v.*) was tapped south of the Mexican boundary for water for irrigation in Imperial Valley along the Southern Pacific Railway, south of Salton Sea. The river enlarged the canal and, finding a steeper gradient than that to its mouth, was diverted into the Colorado Desert, flooding Salton Sea; when the break in this river was closed in 1907, a lake of 300 sq.mi. (777 sq.km.) in area was left. The region east of the Sierra, between the crest of that range and the Nevada boundary, is very mountainous.

Near Owens Lake the scenery is extremely grand, for the valley there is very narrow, and on either side the mountains rise from 7,000 to 10,000 ft. above the lake and river. Still farther east, about 40 mi. from the lake, is Death Valley (*q.v.*)—named for the fate of a party of "forty-niners," 13 of whose members perished there by thirst or by starvation and exposure. Death Valley, approximately 50 mi. long and on the average 20–25 mi. broad from the crests of the enclosing mountain ranges (or 5–10 mi. at their base), constitutes an independent drainage basin. It is 282 ft. (86 m.) below sea level at its lowest point (the lowest point on the continent), and is one of the most remarkable physical features of California. The mountains about it are high and bare and brilliant with varied colours.

The Amargosa River, entering the valley from Nevada, disappears in the salty basin. Enormous quantities of borax and of nitrate of soda, have been extracted from the surrounding country, the borax an almost pure borate of lime (colemanite) in Tertiary lake sediments.

Climate.—The climate is very different from that of the Atlantic coast, and indeed very different from that of any part of the country save that bordering California. The climate of the entire Pacific coast is milder and more uniform in temperature than that of the states in corresponding latitudes east of the mountains. A mean annual temperature as low as that of Halifax, Nova Scotia (latitude 44°39′ N), is not found at any Pacific coast point south of Sitka, Alaska (latitude 57° N), while the mean at San Diego is 6° to 7° less than that at Vicksburg, Miss., and Charleston, S.C., in roughly the same latitude. Moreover, the means of winter and summer are much nearer the yearly mean in California than in the east. This condition is not so marked as one goes inward from the coast; yet everywhere, save in the high mountains, the winters are comparatively mild.

Division of the year into two seasons—a wet one and a dry one—marks this portion of the Pacific coast in the most decided manner, being truly characteristic neither of Baja California (Lower California) nor of the greater part of Oregon, though more so of Nevada and Arizona. And finally, except on the coast (where temperatures rarely exceed 90° F [32.2° C]) the dryness of the air and the consequent rapidity of evaporation greatly lessen the disagreeableness of summer heat.

Precipitation.—Along both the Coast Range and the Sierra considerable rainfall is certain, although, because of slight snow accumulations the streams of the former are decidedly variable. A heavy rain belt, with normal fall of more than 40 in. (1,016 mm.), covers all the northern half of the Sierra and the northwest counties; shading off from this is the region of 10–20 in. (254–508 mm.) fall, which covers all the rest of the state except Inyo, Kern San Bernardino, and Imperial counties and the eastern portion of Riverside County, all in the southeastern section of the state; the precipitation of this belt is from 0 to 10 in. (0 to 254 mm.). In the mountains precipitation increases with altitude; above 6,000 or 7,000 ft. it is almost wholly in the form of snow which, melting in summer, is of immense importance to the state, supplying water at one time for placer mining and later for irrigation. The northwest counties are extremely wet; many localities there have normal annual rainfalls of 60–70 in. (1,524–1,778 mm.) and even higher. Along the entire Pacific coast, but particularly north of San Francisco, there is a night fog from May to September. Below San Francisco precipitation decreases along the coast, until at San Diego it is only about 10 in. (254 mm.). The extreme hea of the southeast is tempered by the extremely low humidity characteristic of the Great Basin. Many places in northern, southern central, mountain, and southern coastal California normally have more than 200 clear days a year, and many in the mountains and the south, even on the coast, have more than 250.

Water Resources.—Water for irrigation and for industrial and urban use has become one of the state's primary problems. The state's water resources are unequally distributed both geographically and seasonally; more than 80% of annual precipitation occur during the five months of winter and spring, and there is wide variation from year to year, often deviating 25 to 50% from normal in the driest and wettest years. Irrigation was introduced in southern California before 1780, but its use was desultory and its spread slow until after 1850. By 1890, however, about 1,000,000 ac. were irrigated.

In the south artesian wells and canals, and in the Central Valley the rivers of the Sierra slope are the main sources of water supply In the 1930s federal agencies entered the field of water resource development. The construction of great dams such as Hoove Dam and others on the Colorado River and the Friant and Shast dams in the Central Valley project helped relieve some of th shortage. But the domestic, sanitation, and industrial needs continued to increase, especially in the Los Angeles and San Dieg areas. The voters in 1960 approved a bond issue including the huge Feather River project for carrying water from northern to southern California (see *Agriculture*, below). Oroville Dam, largest of the 20 dams included in this project, was completed in 1967. Additions to the Central Valley project by federal agencies also provided water storage and transport facilities.

Temperature.—The Colorado Desert (together with the lower Gila Valley of Arizona) is the hottest part of the United States. Along the line of the Southern Pacific Railway the yearly extreme is frequently from 124° to 129° F (51.1° to 53.9° C), in the shade, which approaches the greatest heat recorded in any part of the world. At the other extreme, temperatures of −20° to −36° (−28.9° to −37.8°) are recorded yearly near Lake Tahoe. Normal annual means of the coldest localities of the state are from 37° to 44° F (2.8° to 6.6° C), monthly means from 20° to 65° F (−6.7° to 18.3° C).

The normal annual means of Indio, Mammoth Tanks, Salton and Volcano Springs are from 73.9° to 78.4° F (23.3° to 25.6° C); the monthly means from 52.8° to 101.3° F (11.7° to 38.3° C) frequently 95° to 98° [35.0° to 36.7°]). Another weather factor is the winds, which are extremely regular in their movements. There are brisk diurnal sea breezes, and seasonal trades and countertrades. Along the coast an onshore breeze blows every summer day; in the evening it is replaced by a night fog, and the cooler air is drawn down the mountain sides in opposition to its movement during the day.

There is variety of local climates. At some points in southern California one may actually look from sea to desert and from snow to orange groves. Distance from the ocean, situation with reference to mountain ranges, and altitude are all important determinants of these climatic differences; of these the last seems most important. Death Valley surpasses for combined heat and aridity any meteorological stations on earth where regular observations are taken, although for extremes of heat it is exceeded by places in the Colorado Desert.

Soil.—Sand and loams in great variety, grading from mere sand to adobe, make up the soils of the state. The plains of the northeast counties are volcanic, and those of the southeast sandy. It is impossible to say with accuracy what part of the state may properly be classed as tillable. Much land seems too rough, too elevated, or too arid to be made agriculturally available, but irrigation, and the work of state and national agricultural bureaus in introducing new plants and promoting scientific farming, have accomplished much that once seemed impossible.

Plant and Animal Life.—California's plant and animal life is as diverse as the six natural geographical divisions (climate and temperature zones) which comprise the state. These zones depend more on altitude than latitude for their characteristics—Lower Sonoran (less than 500 ft.), Upper Sonoran (up to 3,000–,000 ft.), Transition (a narrow elevational range, 2,000–5,000 ft.), Canadian, Hudsonian, and Arctic-Alpine (above 5,000 ft.).

The range of plant life extends from the creosote bush, greasewood, mesquite, yucca, and giant cacti of the Sonoran zones, through the pines and cedars, and the enormous sequoia and redwood of the Transition zone, the fir, pine, and aspen of the Canadian zone, and the hemlock and heather of the Hudsonian zone, to the dwarf willow and stunted mountain plants of the Arctic-Alpine zone.

About 400 species of mammals have been identified in the state. The best-known desert mammals of the Lower Sonoran zone are the Fresno pocket gopher, the California ground squirrel, the black-tailed jack rabbit, the California badger, several mice, and the coyote. Among larger animals are the Yuma cougar, the desert wildcat, and rarely the desert bighorn or mountain sheep. The Upper Sonoran zone, which once boasted herds of antelope and California elk (wapiti), is the habitat of the raccoon, fox, and coyote. In higher zones bear, deer, and occasional mountain lions are found.

Among the 600 species of birds identified within the state are found the valley quail, mourning dove, burrowing owl, and the curious road runner (a species of cuckoo) of the Lower Sonoran zone; the tiny Anna's hummingbird, towhee, and phainopeplas of the Upper Sonoran; the sage hen, band-tailed pigeon, and robin of the Transition; and the rare California condor and the grouse, hawks, and eagles of the upper zones. California birds are generally grayer and paler, and of slighter build, than eastern ones. There are fewer species of snakes but more of lizards than in other states, and few native fresh-water fish. Porpoises are encountered in coastal waters, and the harbour, or hair, seal and the sea lion frequent the rocky coast isles. Gulls, terns, cormorants, pelicans, and sea ducks abound.

Parks and Monuments.—Some of California's finest scenery is preserved in Lassen Volcanic, Yosemite, Kings Canyon, and Sequoia national parks (*qq.v.*) and Point Reyes National Seashore. In 1968, after a vigorous campaign by conservationists, Redwood National Park was added to the system.

There are eight national monuments in the state, Lava Beds (established 1925), Muir Woods (1908), Cabrillo (1913), Pinnacles (1908), Joshua Tree (1936), Channel Islands (1938), Devils Postpile (1911), and Death Valley (1933) (*q.v.*). California also has nearly 180 state parks and monuments and contains all or parts of 22 national forests and several small state forest reserves.

HISTORY

"Gold made California!" The most important feature of modern Californian history is the way in which the territory came to be a part of the United States, with gold as the underlying dramatic element. In the 18th century fear lest England or Russia might obtain California, and thus threaten Mexico, caused Spain at length to occupy it. The Spanish occupation merely kept others out, to the ultimate advantage of the American Union, which would not have been strong enough to take over California much prior to the time when it actually did so. If the Spanish settlers had discovered California's gold, the destiny of the province would have been different from what it proved to be; in that event California might have become a Spanish-American republic, or England might have acquired it. Gold was not discovered there, however, until the Americans were already pouring into the province. Thereafter the rush of American settlers put the stamp of certainty on the connection with the United States.

Exploration and Early Settlement.—The name California was taken from Garci Ordóñez de Montalvo's story, *Las Sergas de Esplandián* (1510), of black Amazons ruling an island of this name "at the right hand of the Indies . . . very close to that part of the Terrestrial Paradise." The name was given to the southern part of Lower California probably in 1533–34, but at any rate before 1542. By extension it was applied in the plural to the entire Pacific coast north from Cape San Lucas. Necessarily the name had for a long time no definite geographic meaning. The lower Colorado River was discovered in 1540 by a Spanish expedition under Hernando de Alarcón, which saw but did not penetrate California; in 1542–43 Juan Rodríguez Cabrillo and his successor, Bartolomé Ferrelo, explored probably the entire coast to a point just north of the state boundary; in 1579 Sir Francis Drake (*q.v.*) repaired his ships in Drake's Bay (north of San Francisco) and named the land New Albion; Spanish galleons en route from the Philippines to Acapulco usually sighted the coast, and certainly did so in the voyages of 1584 and 1595; and in the famous voyage of 1602–03 Sebastián Vizcaíno carefully explored the coast, and discovered the Bay of Monterey. There was apparently no increase of knowledge thereafter for 150 years. Most of this time California was generally supposed to be an island or a group of islands.

Jesuit missionaries entered Lower California as early as 1697, and maintained themselves there until expelled in 1767 by order of Charles III of Spain; not until Russian explorations in Alaska from 1745 to 1765 did the Spanish government take definite action to occupy Upper California. Because of the fear of foreign danger, and the longfelt need of a refitting point on the California coast for the galleons from Manila, San Diego was occupied in 1769 and Monterey in 1770. San Francisco Bay was discovered in 1769. Meanwhile the Jesuit property in the peninsula had been turned over to Franciscan monks, but in 1772 the Dominicans took over the missions, and the Franciscans not unwillingly withdrew to join their brethren who had gone with the expeditions of 1769 to Upper California. There they were to thrive remarkably for about 50 years. (*See* CALIFORNIA, LOWER.)

The Mission Period.—In all, 21 missions were established in California between 1769 and 1823, extending from San Diego in the south to Sonoma in the north. Economically the missions were the blood and life of the province.

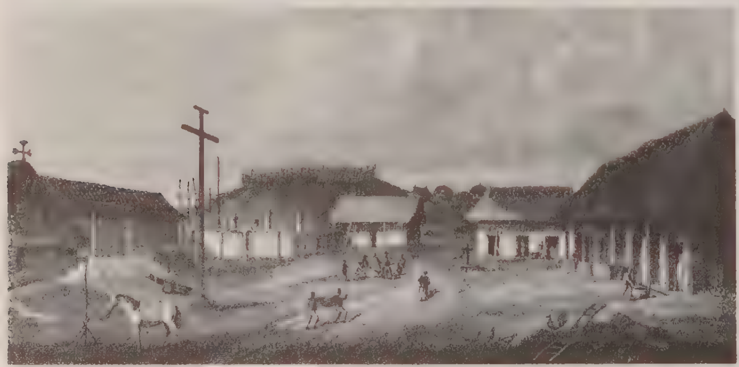
The hides and tallow yielded by the great herds of cattle at the missions were the support of foreign trade, and did much toward paying the expenses of the government. As for the intellectual development of the Indians the mission system accomplished nothing; beyond the care of their souls they received little instruction, and though they were not slaves they were trained into a fatal dependence, so that once coercion was removed they relapsed at once into native customs (see *Missions*, below). The missions, however, were only one phase of Spanish institutions in California. The government of the province was in the hands of a military officer stationed at Monterey. There were also several other military establishments and civilian towns in the province, as well as a few private ranches.

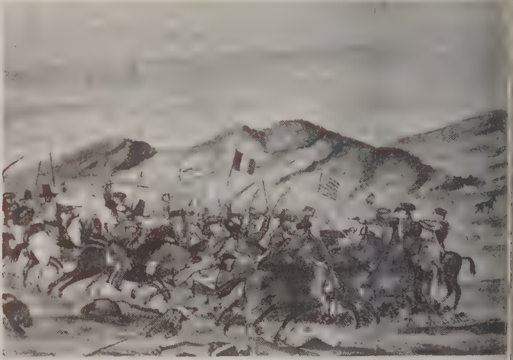
The political upheavals in Spain and Mexico following 1808 made little stir in this far-off province. When revolution broke out in Mexico (1810), California remained loyal to Spain. In 1820 when the liberal Spanish constitution of 1812 was again proclaimed it was duly sworn to in California. In 1822 allegiance was given to newly independent Mexico.

The Mexican Period.—Under the Mexican federal constitution of 1824 Upper California, first alone (it was made a distinct province in 1804) and then with Lower California, received representation in the Mexican Congress. The following years before American occupation may be divided into two periods. From about 1840 to 1848 foreign relations were the centre of interest. From 1824 to 1840 there was a complicated and not uninteresting movement of local politics and a preparation for the future—the missions fell, republicanism grew, the sentiment of local patriotism became a political force, there was a succession of sectional controversies and personal struggles among provincial chiefs, and an increase of foreign commerce, immigration, and influence.

The Franciscans were mostly Spaniards in blood and in sympathies. They viewed with displeasure and foreboding the fall of Agustín de Iturbide's Mexican Empire and the creation of the republic. After 1821 secularization of the missions was the burning political question. Active and thorough secularization of the missions did not begin until 1834; by 1835 it was consummated at 16 missions out of 21, and by 1840 at all. In 1831 the mission question led to a rising against the reactionary clerical rule of Gov. Manuel Victoria. He was driven out of the province. This was the first of the *opéra bouffe* wars. The causes underlying them were serious enough. In the first place, there was a growing dissatisfaction with Mexican rule, which accomplished nothing tangible, although its plans were as excellent as could be asked had there been peace and means to realize them. In the second place, there was growing jealousy between northern towns and southern towns, northern families and southern families. In 1831 Governor Victoria was deposed; in 1836 Gov. Mariano Chico was frightened out of the province; in 1836 Gov. Nicolás Gutiérrez and in 1844–45 Gov. Manuel Micheltorena were driven out of office. The leading native Californians headed this last rising. There was talk of independence, but sectional and personal jealousies could not be overcome. Pastoral California had few schools, no newspapers, hospitals, or cities worthy of the name; yet from this colourful feudalistic era derive place names, land titles, trails which became highways, and the traditions of Mexican law which became the heritage of the later state.

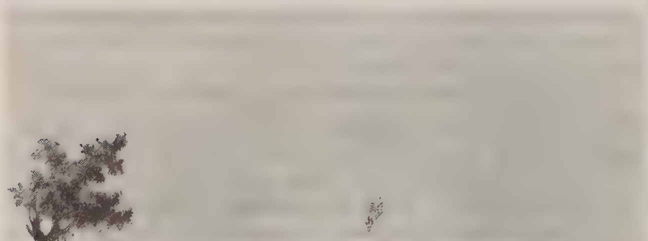
Foreign Influence.—Foreign commerce, which was contrary to all Spanish laws, was active by the beginning of the 19th century.





BY COURTESY OF (TOP LEFT, BOTTOM LEFT) THE LIBRARY OF CONGRESS, (TOP RIGHT) FRANKLIN D. ROOSEVELT LIBRARY, (BOTTOM RIGHT) CALIFORNIA STATE LIBRARY

(Top left) Spanish mission of San Carlos outside Monterey, erected in 1770; engraving by Alexandre Tardieu, 1799. (Top right) Battle near San Diego during the Mexican War, 1846; detail from "Fight at San Pasqual," a watercolour drawing by William Meyer. (Bottom left) Sutter's Fort, an American trading post near Sacramento; lithograph by S. Shannon, 1847. (Bottom right) Miners panning for gold at the head of Auburn Ravine, northwest of Sacramento; daguerreotype, 1852



It was greatly stimulated during the Spanish-American revolutions n South America, for, as the Californian authorities practically gnored the law, smuggling was unnecessary. In the early 1840s bout three-fourths of the imports, even at Monterey itself, are aid to have paid no duties, being landed by agreement with the fficials. Trade with the United States was by far the most imortant. The trade supplied almost all the clothing, merchanise, and manufactures used in the province; hides and furs were iven in exchange. If foreign trade was not to be received, still ess were foreign travelers, under the Spanish laws. However, ussians came in 1805 and founded in 1812 at Fort Ross a post hey held until 1841, whence they traded and hunted (even in an Francisco Bay) for furs. In 1826 U.S. hunters first crossed to he coast; in 1830 the Hudson's Bay Company began operations northern California. The true overland immigration from the Jnited States began only about 1840. As a class, foreigners were espected, and they were influential beyond proportion to their umbers. Many were naturalized, held generous grants of land, nd had married into California families, not excluding the most elect and influential. The most prominent foreigner in the inerior was John A. Sutter (1803–0), who held a grant of about 0,000 ac. encompassing the present site of Sacramento, whereon e built a fort. Though Sutter imself was Swiss, his establishent became a centre of U.S. inuence. His position as a Mexian official, and the location of his rtified post on the border, made im of great importance in the ears preceding and immediately ollowing U.S. occupation.

RAY ATKESON

RESTORED RUSSIAN CHURCH AT FT. ROSS, A RUSSIAN TRADING POST FROM 1812 TO 1841

U.S. Interests.—Americans ere hospitably received and very ell treated by the government d the people. There was, however, some jealousy of the ease ith which they secured land ants, and an entirely just dise of "bad" Americans. Many the later comers wanted to make California an independent public. As early as 1805 (at the time of James Monroe's negoations for Florida), there are traces of Spain's fear of U.S. amtions, even in this faraway province. Spain's fears passed on to exico, the Russians being feared only less than the Americans. n offer made by Pres. Andrew Jackson in 1835 to buy the northn part of California, including San Francisco Bay, was refused. om 1836 on, foreign interference was much talked about. Americans supposed that Great Britain wished to exchange Mexican nds for California; France also was thought to be watching for opening for gratifying supposed ambitions; and all parties saw at, even without overt act by the United States, the progress of S. settlement seemed likely to gain the province.

In 1842 Commodore Thomas ap Catesby Jones (1790–1858) the U.S. Navy, believing that war had broken out between his untry and Mexico and that a British force was about to seize lifornia, raised the American flag over Monterey (Oct. 19), but ding that he had acted on misinformation, he lowered the flag e next day with due ceremony and warm apology. By 1845 there s certainly an agreement in opinion among all American residnts (then not 700 in number) regarding the future of the coun-y.

The U.S. consul at Monterey, Thomas O. Larkin (1802–58), s instructed in 1845 to work for the secession of California from exico, without overt aid from the United States, but with their od will and sympathy. He very soon gained from leading ofers assurances of such a movement before 1848. At the same e U.S. naval officers were instructed to occupy the ports in case war with Mexico, but first and last to work for the good will of local population.

Capt. J. C. Frémont (*q.v.*), while engaged in a government surveying expedition, aroused the apprehensions of the Californian authorities by suspicious and, very possibly, intentionally provocative movements, and there was a show of military force by both parties. In violation of international amities, and practically in disobedience of orders, he broke the peace, caused a band of Mexican cavalry mounts to be seized, and prompted some American settlers to occupy Sonoma, near San Francisco, (June 14, 1846). This episode is known as the Bear Flag War, inasmuch as there was short-lived talk of making California an independent state, and a flag with a bear as an emblem flew for a few days at Sonoma. Fortunately for the dignity of history, and for Frémont, it was quickly merged in a larger question, when Commodore John Drake Sloat (1781–1867) on July 7 raised the flag of the U.S. over Monterey, proclaiming California a part of the U.S.

The opening hostilities of the Mexican War had occurred on the Rio Grande. The aftermath of Frémont's filibustering acts, followed as they were by wholly needless hostilities and by some injustice then and later in the attitude of Americans toward the inhabitants, was a growing misunderstanding and estrangement, regrettable in California history.

Admission to the Union.—By the treaty of Guadalupe Hidalgo, in 1848, Mexico ceded California to the United States. Gold was discovered at Sutter's Mill on the American River in 1848 (for details see *Mineral Products*, below), and the new territory took on great national importance. Discussion as to what should be done with California began in Congress in 1846, immediately involving the question of slavery. A furious conflict developed, so that nothing was accomplished in two successive sessions; even at the end of a third, in March 1849, the only progress made toward creating a government for the territory was that the national revenue laws had been extended over it, and San Francisco had been made a port of entry. Meanwhile conditions grew intolerable for the inhabitants. Never was a population more in need of clear laws than the motley Californian people of 1848–49; yet they had none when, with peace, military rule and Mexican law technically ended.

Early in 1849 temporary local governments were set up in various towns, and in September a convention framed a free state constitution and applied for admission to the Union. On Sept. 9, 1850, a bill finally passed Congress admitting California as a free state. This was one of the bargains in the Compromise of 1850 (*q.v.*).

The Gold Rush.—Meanwhile the gold discoveries culminated and surpassed "three centuries of wild talk about gold in California." Settlements throughout the state were completely deserted; homes, farms, and stores were abandoned. Ships deserted by their sailors crowded the bay at San Francisco—there were 500 of them in July 1850; soldiers deserted wholesale, churches were emptied, town councils ceased to sit, merchants, clerks, lawyers and judges and criminals, everybody in fact, flocked to the foothills. Gold fever spread to the rest of the nation. It is estimated that 80,000 men reached the coast in 1849, about one-half of them coming overland; three-fourths were Americans. Rapid settlement, excessive prices, reckless waste of money, and wild commercial ventures that glutted San Francisco with all objects usable and unusable, made the following years astounding from an economic point of view; but not less bizarre was the social development, nor less extraordinary the problems of state-building in a society "morally and socially tried as no other American community ever has been tried" (Josiah Royce; *q.v.*). There was, of course, no home life in early California. In 1850 women numbered only 8% of the population, and in the mining counties only 2%. Mining times brought out some of the most ignoble and some of the best traits of American character. Through varied instruments—lynch law, popular courts, vigilance committees—order was, however, enforced as time went on, until stability was achieved.

The gold rush changed California as much culturally as it had economically and politically. Rapid influx of a cosmopolitan population, combined with sudden increases in wealth, provided consumers and purchasing power for the amenities of civilized life. Virtually overnight new towns and cities were founded and old ones expanded. San Francisco, the new western metropolis, boasted magazines, newspapers, theatres, libraries, and even able historians. Artists, such as C. C. Nahl, depicted the drama of the scene, while Bret Harte, Mark Twain, and others created a gold rush literature.

The slavery question was not settled for California in the Compromise of 1850. Until the American Civil War the division between the Whig and Democratic parties, whose organization in California preceded statehood, was based essentially on slavery. The followers of Sen. William M. Gwin, one of the first two U.S. senators to represent the state, hoped to divide California into two states and hand the southern over to slavery; on the eve of the Civil War they considered the scheme of a Pacific coast republic. The state remained loyal to the North, however, when war came. The later 1850s are characterized by H. H. Bancroft as a period of "moral, political and financial night." National politics were put first, to the complete neglect of needed reform of excessive taxation, financial extravagance, ignorant legislation, and corruption.

Land Grants.—During the Mexican period, California's social, economic, and political life had centred about large cattle ranches. The great majority of grants date from Mexican rule; less than 30 applications for land grants had been received during the entire Spanish era and not all of these were confirmed. By 1846, 8,000,000 ac. were in the possession of 800 grantees, whose holdings in several outstanding instances resembled kingdoms in the wealth and power they brought to their owners. But the complicated formalities theoretically essential to the validity of the grants were very often, if not usually, only in part attended to. Instead of confirming all claims existing when the country passed to the United States, and so ensuring an immediate settlement of the matter, the U.S. government undertook, through a land commission and courts, to sift the valid from the fraudulent. Claims of enormous aggregate value were thus considered, and a large part of those dating from the last years of Mexican dominion, many probably antedated after the commission was at work, was finally rejected.

1865–1910.—In state gubernatorial elections after the Civil War the Democrats won in 1867, 1875, 1882, 1886, 1894; the Republicans were successful in all the other contests. Features of political life and of legislation after 1876 were a strong labour agitation, the struggle for the exclusion of the Chinese, for the control of hydraulic mining, irrigation, and the advancement by state aid of the fruit interests. Labour conditions were peculiar in the decade following 1870. Mining, war times, and the building of the Central Pacific had up to then inflated prices and prosperity. Then there came a slump. The dismissal by the Central Pacific lines (principally in 1869–70) of about 15,000 Chinese, who flocked to San Francisco, augmented discontent and the reaction from flush times. Labour unions became strong and demonstrative. This is called the "sand-lots agitation" from the favourite meeting place (in San Francisco) of the agitators.

The outcome of these years was the constitution of 1879, and the exclusion of Chinese by national law. Congress reenacted exclusion legislation in 1902. All authorities agree that the Chinese in early years were often abused in the mining country and their rights most unjustly neglected by the law and its officers. The exclusion had much to do with making the huge single-crop ranches unprofitable and with leading to their replacement by small farms and varied crops.

In 1906–07 there was throughout the state a remarkable anti-Japanese agitation, centring in San Francisco and affecting international relations and national politics. The Japanese question was brought to an acute situation in 1913 by the Webb Alien Land Law, which prevented Japanese from holding real estate. The question was then taken up diplomatically between the United States and Japan, and Japan agreed to the exclusion of further immigration of its citizens.

The 20th Century.—The period 1910–25 was one of reform designed largely to secure greater popular control of government The state's subsequent history broadly paralleled that of the nation as a whole.

The economic depression of the 1930s, although generally less pronounced than in most other states, created great social unrest accentuated by the influx of migrant labourers, chiefly from the dust bowl area of the Great Plains. A result was the rise of various radical socioeconomic nostrums (such as the "end poverty in California" [EPIC] plan, a comprehensive social welfare scheme presented by Upton Sinclair [*q.v.*], and various old-age pension plans) and the rapid growth of the Democratic Party, long of minor importance in the state. Except for four years (1939–43) California was led by Republican governors during the first half of the 20th century, including among others Earl Warren, who resigned the governorship in 1953 to become chief justice of the United States, the first Californian to hold that office.

In 1958, however, a Democratic victory installed Edmund Brown as governor. With the Republican defeat, which reflected a national trend, Democrats not only won gubernatorial and U.S. senatorial races but for the first time in the 20th century received a majority of seats in both houses of the state legislature In 1959 the Democrats ended the California system of cross-filing whereby a candidate could file for both parties in primary elections—a system that had most often been of profit to the Republicans. Governor Brown was reelected in 1962. In the 1966 elections, Republicans made a comeback, carrying into the governor's office Ronald Reagan, a former actor, and winning all of the highest elective executive positions except that of attorney general

RAY ATKESON

(LEFT) FISHING FLEET IN MONTEREY BAY. (RIGHT) SKIING IN SQUAW VALLEY; LAKE TAHOE IS IN THE FAR DISTANCE TO THE LEFT

Democrats maintained a narrow majority in both houses of the tate legislature and kept a clear majority of registered voters. Problems of civil rights, economy, and education faced the administration. Democrats lost control of the state legislature in 968 but regained a majority in both houses in 1970 although Governor Reagan was reelected.

The state's large population growth after World War II gave t an increasingly influential position in national politics. Conressional reapportionment after the 1950 census raised the number of California's representatives from 23 to 30 and after the 960 census the number rose to 38, second only to New York (41) nd, for the first time, exceeding Pennsylvania (27). The 1970 ensus showed California to be the most populous state in the nation; its representation in the House rose to 43 seats.

Missions.—Perhaps the unique cultural heritage of California is the extensive chain of Franciscan missions, from San Diego in he south to Sonoma in the north, which were established during he Spanish occupation. Constructed between 1769 and 1823 hese institutions of hispanic control were more effective than he accompanying institutions—the presidio and the pueblo. The mission was not merely a religious institution but had political and economic significance as well. Its role was not only to spread he faith but also to act as civilizing agent for the Spanish monrchy.

The coastal chain founded by the Franciscans in Upper Califoria comprised the following missions (date of founding in parenheses): San Diego (1769), San Carlos (1770), San Antonio 1771), San Gabriel (1771), San Luis Obispo (1772), San Franisco (1776, better known as Mission Dolores), San Juan Capistrano (1776), Santa Clara (1777), San Buenaventura (1782), Santa Bárbara (1786), La Purísima Concepción (1787), Santa Cruz (1791), La Soledad (1791), San José (1797), San Juan Bautista (1797), San Miguel (1797), San Fernando (1797), San uis Rey (1798), Santa Inés (1804), San Rafael (1817), and San Francisco Solano (1823). Mission sites were chosen with regard to contiguity of Indian rancherias (villages). Intervening distances between establishments required about one day's travel. Proximity to the coast was a general characteristic of California missions, but near the end of the mission period a parallel chain f inland establishments was proposed but left unbuilt. Two attempts at inland foundations in the Colorado River area during the early period—Purísima Concepción and San Pedro y San Pablo—met with disaster at the hands of hostile Yuma Indians who massacred four priests and many of the soldiers of the accompanying garrison.

Noteworthy was the singleness of purpose and devotion to duty of the padres. Outstanding among the leaders was the first father resident, Junípero Serra (*q.v.*), under whose leadership (1769–4) the initial struggles for stability were successful. A holy, devout man, Serra founded the first nine missions. Another important leader was Father Fermín Francisco de Lasuén, founder of nine other establishments. Education consisted of instrucon in the Spanish language, Christian dogma, and hymn singing. ustomarily two priests were assigned to each mission, and a mission guard of four or five soldiers was provided by the nearest residio.

Economically the missions were large-scale production units mbracing orchards, gardens, fields, pastures, workshops, looms, ranaries. When secularization occurred and the missions' land onopoly was broken in 1834 there were 31,000 Indians in the 21 missions. More than 750,000 head of livestock (the majority cate) were owned by the missions. There can be little doubt concerning the economic prosperity of the missions. Results of the ystem as regards the natives were not entirely satisfactory. Many were converted, but many also died from disease in the process of assimilating the white man's civilization. However, ecularization was far harder on the California Indians than was he mission system. With the secularization of the missions, the ndians were to obtain rights of citizenship and one half of ll mission lands, livestock, and agricultural implements. But horn of protection, they were despoiled and exploited as never efore.

The distinctive architecture of the missions gave rise at a later date to a typical California style of building. The missions had solid, massive, stucco-covered adobe walls with broad undecorated wall faces, and were customarily built around a patio with a fountain or garden. Arcaded corridors and low-pitched red-tile roofs with wide projecting eaves characterized most of these buildings. Style was determined mostly by materials of construction rather than by choice. The ravages of time destroyed much of the original structures, but preservation and reconstruction tend to maintain the old mission atmosphere. All of the existing former missions are open to the public; some are state historical monuments but most are under church administration.

GOVERNMENT

California's first constitution was framed by a convention at Monterey, ratified by the people and proclaimed by U.S. military governor Bennett Riley all in the same year, 1849. The second constitution, still in effect in the second half of the 20th century, was framed by a convention in 1878–79; it came into full effect in 1879, and was subsequently amended. It reflected demands of the Workingmen's Party, passed at a time of high discontent, and went at great length into the details of government, as was demanded by the state of public opinion. The qualifications required for suffrage are in no way different from those common throughout the Union, except that by a constitutional amendment of 1894 it is necessary for a voter to be able to read the state constitution and write his name. In 1970 the California Supreme Court ruled that literacy specifically in English could not be required. The second constitution showed many advances toward popular control, legislative power being everywhere curtailed. Power was taken from the legislature by specific inhibition in 31 subjects previously within its power. Lobbying was made a felony; provisions were inserted to tax and control common carriers and great corporations, and to regulate telegraph, telephone, storage, and wharfage charges. The constitution may be amended by a two-thirds vote of all elected members of each house of the legislature, followed by ratification by a majority of the qualified electors voting on the proposition. Since 1911 amendments may be submitted directly to the people by means of the initiative. A constitutional convention may be called if approved by a two-thirds vote of the entire membership of the legislature and by a majority vote at the following general election. Work of the convention itself must be submitted to the people for approval or rejection.

State executive officers include the governor, lieutenant governor, secretary of state, treasurer, controller, attorney general, and superintendent of public instruction. Election to office is for a four-year term. In addition there are more than 50 administrative and other boards, commissions, and officers appointed by the governor, in some cases subject to confirmation by the senate. The legislature is bicameral—a senate of 40 members and an assembly of 80 members, both reapportioned according to population in 1965 and elected for four-year and two-year terms, respectively. The legislature meets annually, and its sessions are divided into two parts, with a recess of 30 days intervening. A maximum five-day veto session 30 days following each general session was provided for by constitutional amendment in 1965.

The state's judicial powers are vested in a supreme court, courts of appeal, superior courts, municipal courts, and justice courts. The supreme court, consisting of a chief justice and six associate justices, holds regular sessions at Sacramento, San Francisco, and Los Angeles. The state is divided into five appellate districts, with varying numbers of judges in each; but in every case three judges constitute a separate court. In the late 1960s there were 48 judges of the courts of appeal.

Supreme and district court judges serve 12-year terms. Under a constitutional amendment of 1934 they are appointed by the governor, with the approval of a special judicial commission comprising the chief justice, the attorney general, and the ranking appellate court justice. At the following general election, however, and again at the expiration of his term, the new appointee is subject to removal by a majority vote of the electorate. Any county so desiring may elect to adopt a similar system. Each county has

*California: Places of 5,000 or More Population (1970 Census)**

Place	Census				
	1970	1960	1950	1940	1900
Total state	19,953,134	15,717,204	10,586,223	6,907,387	1,485,053
Alameda	70,968	63,855	64,430	36,256	16,464
Alamo-Danville	14,059	—	—	—	—
Albany	14,674	14,804	17,590	11,493	—
Alhambra	62,125	54,807	51,359	38,935	—
Alondra Park	12,193	—	—	—	—
Altadena	42,380	40,568	—	—	—
Alum Rock	18,355	18,942	—	—	—
Anaheim	166,701	104,184	14,556	11,031	1,456
Anderson	5,492	4,492	—	—	—
Antioch	28,060	17,305	11,051	5,106	674
Apple Valley	6,702	—	—	—	—
Aptos	8,704	—	—	—	—
Arcadia	42,868	41,005	23,066	9,122	—
Arcata	8,985	5,235	3,729	1,855	952
Arden-Arcade	82,492	73,352	—	—	—
Arroyo Grande	7,454	3,291	1,723	1,090	—
Artesia	14,757	9,993	—	—	—
Arvin	5,090	5,310	5,007	—	—
Ashland	14,810	—	—	—	—
Atascadero	10,290	5,983	3,443	—	—
Atherton	8,085	7,717	3,630	1,908	—
Atwater	11,640	7,318	2,856	1,235	—
Auburn	6,570	5,586	4,653	4,013	2,050
August School Area	6,293	—	—	—	—
Avocado Heights	9,810	—	—	—	—
Azusa	25,217	20,497	11,042	5,209	863
Bakersfield	69,515	56,848	34,784	29,252	4,836
Baldwin Park	47,285	33,951	—	—	—
Banning	12,034	10,250	7,034	3,874	—
Barstow	17,442	11,644	6,135	—	—
Beale East	7,029	—	—	—	—
Beaumont	5,484	4,288	—	—	—
Bell	21,836	19,450	15,430	11,264	—
Bellflower	51,454	45,909	—	—	—
Bell Gardens	29,308	26,467	—	—	—
Belmont	23,667	15,996	5,567	1,229	—
Benicia	8,783	6,070	7,284	2,419	2,751
Berkeley	116,716	111,268	113,805	85,547	13,214
Beverly Hills	33,416	30,817	29,032	26,823	—
Big Bear	5,268	1,562	1,434	—	—
Bloomington	11,957	—	—	—	—
Blythe	7,047	6,023	4,089	2,355	—
Brawley	13,746	12,703	11,922	11,718	—
Brea	18,447	8,487	3,208	2,567	—
Broderick-Bryte	12,782	—	—	—	—
Buena Park	63,646	46,401	5,483	—	—
Burbank	88,871	90,155	78,577	34,337	—
Burlingame	27,320	24,036	19,886	15,940	—
Calexico	10,625	7,992	6,433	5,415	—
Calwa	5,191	—	—	—	—
Camarillo	19,219	—	—	—	—
Camarillo Heights	5,892	1,704	—	—	—
Cambrian Park	5,316	—	—	—	—
Campbell	24,770	11,863	—	—	—
Capitola	5,080	2,021	1,848	—	—
Cardiff-by-the-Sea	5,724	3,149	—	—	—
Carlsbad	14,944	9,253	4,383	—	—
Carmichael	37,625	20,455	4,499	—	—
Carpinteria	6,982	4,998	2,864	—	—
Carson	71,150	38,059	—	—	—
Castro Valley	44,760	37,120	—	—	—
Ceres	6,029	4,406	2,351	1,332	—
Cerritos	15,856	3,508	—	—	—
Cherryland	9,969	—	—	—	—
Chico	19,580	14,757	12,272	9,287	2,640
Chico North	6,656	—	—	—	—
China Lake	11,105	—	—	—	—
Chino	20,411	10,305	5,784	4,204	—
Chula Vista	67,901	42,034	15,927	5,138	—
Citrus Heights	21,760	—	—	—	—
Claremont	23,464	12,633	6,327	3,057	—
Clovis	13,856	5,546	2,766	1,626	—
Coachella	8,353	4,854	2,755	—	—
Coalinga	6,161	5,965	5,539	5,026	—
Colton	19,974	18,666	14,465	9,686	1,285
Commerce	10,536	9,555	—	—	—
Compton	78,611	71,812	47,991	16,198	—
Concord	85,164	36,208	6,953	1,373	—
Corcoran	5,249	4,976	3,150	2,092	—
Corona	27,519	13,336	10,223	8,764	1,434
Coronado	20,910	18,039	12,700	6,932	935
Corte Madera	8,464	5,962	1,933	1,098	—
Costa Mesa	72,660	37,550	11,844	—	—
Covina	30,380	20,124	3,956	3,049	—
Cucamonga	5,796	—	—	—	—
Cudahy	16,998	—	—	—	—
Culver City	31,035	32,163	19,720	8,976	—
Cupertino	18,216	3,664	—	—	—
Cypress	31,026	1,753	—	—	—
Daly City	66,922	44,791	15,191	9,625	—
Davis	23,488	8,910	3,554	1,672	—
Del Aire	11,930	—	—	—	—
Delano	14,559	11,913	8,717	4,573	—
Diamond Bar	12,234	—	—	—	—
Dinuba	7,917	6,103	4,971	3,790	—
Dominguez	5,980	—	—	—	—
Downey	88,445	82,505	—	—	—
Duarte	14,981	13,962	—	—	—
Dublin	13,641	—	—	—	—
East Compton	5,853	—	—	—	—
East La Mirada	12,339	—	—	—	—
East Los Angeles	105,033	104,270	—	—	—
East Palo Alto	17,837	—	—	—	—
Edwards	10,331	—	—	—	—
El Cajon	52,273	37,618	5,600	1,471	—
El Centro	19,272	16,811	12,590	10,017	—
El Cerrito	25,190	25,437	18,011	6,137	—
El Encanto Heights	6,225	—	—	—	—
El Monte	69,837	13,163	8,101	4,746	—
El Paso de Robles	7,168	6,677	4,835†	3,045	1,224
El Rio	6,173	6,966	1,376	—	—
El Segundo	15,620	14,219	8,011	3,738	—
El Toro	8,654	—	—	—	—
El Toro Station	6,970	—	—	—	—
Encinitas	5,375	2,786	—	—	—
Enterprise	11,486	4,946	—	—	—
Escondido	36,792	16,377	6,544	4,560	755
Eureka	24,337	28,137	23,058	17,055	7,327
Fairfax	7,661	5,813	4,078	2,198	—
Fairfield	44,146	14,968	3,118	1,312	—
Fair Oaks	11,256	—	—	—	—
Fallbrook	6,945	4,814	1,735	—	—
Fillmore	6,285	4,808	3,884	3,252	—
Florence-Graham	42,895	38,164	—	—	—
Florin	9,646	—	—	—	—
Folsom	5,810	3,925	1,690	—	—
Fontana	20,673	14,659	—	—	—
Foster City	9,327	—	—	—	—
Fountain Valley	31,826	2,068	—	—	—
Freedom	5,563	4,206	2,765	—	—
Fremont	100,869	43,790	—	—	—
Fresno	165,972	133,929	91,669	60,685	12,470
Fullerton	85,826	56,180	13,958	10,442	—
Gardena	41,021	35,943	14,405	5,909	—
Garden Acres	7,870	—	—	—	—
Garden Grove	122,524	84,238	3,762	—	—
George	7,404	—	—	—	—
Gilroy	12,665	7,348	4,951	3,615	1,820
Glen Avon	5,759	3,416	—	—	—
Glendale	132,752	119,442	95,702	82,582	—
Glendora	31,349	20,752	3,988	2,822	—
Grand Terrace	5,901	—	—	—	—
Grass Valley	5,149	4,876	5,283	5,701	—
Grossmont-Mt. Helix	8,723	—	—	—	—
Grover City	5,939	5,210	—	—	—
Hacienda Heights	35,969	—	—	—	—
Hanford	15,179	10,133	10,028	8,234	2,929
Hawaiian Gardens	8,811	—	—	—	—
Hawthorne	53,304	33,035	16,316	8,263	—
Hayward	93,058	72,700	14,272	6,736	1,965
Healdsburg	5,438	4,816	3,258	2,507	—
Hemet	12,252	5,416	3,386	2,595	—
Hemet East	8,598	1,936	—	—	—
Hermosa Beach	17,412	16,115	11,826	7,197	—
Highland	12,669	—	—	—	—
Hillsborough	8,753	7,554	3,552	2,747	—
Hollister	7,663	6,071	4,903	3,881	1,315
Home Gardens	5,116	1,541	—	—	—
Huntington Beach	115,960	11,492	5,237	3,738	—
Huntington Park	33,744	29,920	29,450	28,648	—
Imperial Beach	20,244	17,773	—	—	—
Indio	14,459	9,745	5,300	2,296	—
Inglewood	89,985	63,390	46,185	30,114	—
Isla Vista	13,441	—	—	—	—
Kensington	5,823	—	—	—	—
La Cañada-Flintridge	20,652	18,338	—	—	—
La Crescenta-Montrose	19,594	—	—	—	—
Ladera Heights	6,079	—	—	—	—
Lafayette	20,484	7,114	—	—	—
Laguna Beach	14,550	9,288	6,661	4,460	—
Laguna Hills	13,676	—	—	—	—
La Habra	41,350	25,136	4,961	2,499	—
Lakeside	11,991	—	—	—	—
Lakewood	82,973	67,126	—	—	—
La Mesa	39,178	30,441	10,946	3,925	—
La Mirada	30,808	22,444	—	—	—
Lamont	7,007	6,177	3,571	—	—
Lancaster	30,948	26,012	3,594	—	—
La Palma	9,687	622	—	—	—
La Puente	31,092	24,723	—	—	—
Larkspur	10,487	5,710	2,905	1,558	—
La Verne	12,965	6,516	4,198	3,092	—
Lawndale	24,825	21,740	297‡	354	—
Lemon Grove	19,690	19,348	—	—	—
Lemoore Station	8,512	—	—	—	—
Lennox	16,121	31,224	—	—	—
Lincoln Village	6,722	—	—	—	—
Linda	7,731	6,129	—	—	—
Lindsay	5,206	5,397	5,060	4,397	—
Live Oak	6,443	3,518	—	—	—
Livermore	37,703	16,058	4,364	2,885	1,493
Lodi	28,691	22,229	13,798	11,079	—
Loma Linda	9,797	—	—	—	—
Lomita	19,784	14,983	—	—	—
Lompoc	25,284	14,415	5,520	3,379	972
Long Beach	358,633	344,168	250,767	164,271	2,252
Los Alamitos	11,346	4,312	—	—	—
Los Altos	24,956	19,696	—	—	—
Los Altos Hills	6,865	3,412	—	—	—
Los Angeles	2,816,061	2,479,015	1,970,358	1,504,277	102,479
Los Banos	9,188	5,272	3,868	2,214	—
Los Gatos	23,735	9,036	4,907	3,597	1,915
Lynwood	43,353	31,614	25,823	10,982	—
Madera	16,044	14,430	10,497	6,457	—
Manhattan Beach	35,352	33,934	17,330	6,398	—
Manteca	13,845	8,242	3,804	1,981	—
Marina	8,343	3,310	—	—	—
Martinez	16,506	9,604	8,268	7,381	1,380
Marysville	9,353	9,553	7,826	6,646	3,497
Mather	7,027	—	—	—	—
Maywood	16,996	14,588	13,292	10,731	—
Meiners Oaks-Mira Monte	7,025	—	—	—	—
Menlo Park	26,734	26,957	13,587	3,258	—
Merced	22,670	20,068	15,278	10,135	1,969

California: Places of 5,000 or More Population (1970 Census) (Continued)*

Place	Census				
	1970	1960	1950	1940	1900
Millbrae	20,781	15,873	8,972	—	—
Mill Valley	12,942	10,411	7,331	4,847	—
Milpitas	27,149	6,572	—	—	—
Mira Loma	8,482	3,982	1,555	—	—
Mission Viejo	11,933	—	—	—	—
Modesto	61,712	36,585	17,389	16,379	2,024
Monrovia	30,015	27,079	20,186	12,807	1,205
Montclair	22,546	13,546	—	—	—
Montebello	42,807	32,097	21,735	8,016	—
Monterey	26,302	22,618	16,205	10,084	1,748
Monterey Park	49,166	37,821	20,395	8,531	—
Moraga	14,205	—	—	—	—
Morgan Hill	6,485	3,151	1,627	1,014	—
Morro Bay	7,109	—	—	—	—
Mountain View	51,092	30,889	6,563	3,946	—
Muscoy	7,091	—	—	—	—
Napa	35,978	22,170	13,579	7,740	4,036
National City	43,184	32,771	21,199	10,344	1,086
Newark	27,153	9,884	1,532	—	—
Newhall	9,651	4,705	2,527	—	—
Newport Beach	49,422	26,564	12,120	4,438	—
Norco	14,511	—	—	—	—
North Fair Oaks	9,740	—	—	—	—
North Highlands	31,854	21,271	—	—	—
North Island	6,002	—	—	—	—
Norwalk	91,827	88,739	—	—	—
Novato	31,006	17,881	3,496	—	—
Oakdale	6,594	4,980	4,064	2,592	—
Oakland	361,561	367,548	384,575	302,163	66,960
Oceanside	40,494	24,971	12,881	4,651	330
Oildale	20,879	—	—	—	—
Ojai	5,591	4,495	2,519	1,622	—
Olivehurst	8,100	4,835	3,588	—	—
Ontario	64,118	46,617	22,872	14,197	722
Opal Cliffs	5,425	3,825	—	—	—
Orange	77,374	26,444	10,027	7,901	1,216
Orangevale	16,493	—	—	—	—
Orcutt	8,500	1,414	1,001	—	—
Orinda Village	6,790	5,568	—	—	—
Oroville	7,536	6,115	5,387	4,421	—
Otay-Castle Park	15,445	—	—	—	—
Oxnard	71,225	40,265	21,567	8,519	—
Pacifica	36,020	20,995	—	—	—
Pacific Grove	13,505	12,121	9,623	6,249	1,411
Palmdale	8,511	11,522	—	—	—
Palm Desert	6,171	1,295	—	—	—
Palm Springs	20,936	13,468	7,660	3,434	—
Palo Alto	55,966	52,287	25,475	16,774	1,658
Palos Verdes Estates	13,641	9,564	1,963	987	—
Palos Verdes Peninsula	39,616	—	—	—	—
Paradise (Butte County)	14,539	8,268	—	—	—
Paramount	34,734	27,249	—	—	—
Parkway-Sacramento South	28,574	—	—	—	—
Pasadena	113,327	116,407	104,577	81,864	9,117
Pendleton North	11,803	—	—	—	—
Pendleton South	13,692	—	—	—	—
Petaluma	24,870	14,035	10,315	8,034	3,871
Pico Rivera	54,170	49,150	—	—	—
Piedmont	10,917	11,117	10,132	9,866	—
Pinole	15,850	6,064	1,147	934	—
Pittsburg	20,651	19,062	12,763	9,520	—
Placentia	21,948	5,861	1,682	1,472	—
Placerville	5,416	4,439	3,749	3,064	—
Pleasant Hill	24,610	23,844	5,686	—	—
Pleasanton	18,328	4,203	2,244	1,278	—
Pomona	87,384	67,157	35,405	23,539	5,526
Porterville	12,602	7,991	6,904	6,270	—
Porterville West	6,200	—	—	—	—
Port Hueneme	14,295	11,067	3,024	—	—
Poway	9,422	1,921	—	—	—
Rancho Cordova	30,451	7,429	—	—	—
Rancho Rinconada	5,149	—	—	—	—
Red Bluff	7,676	7,202	4,905	3,824	2,750
Redding	16,659	12,773	10,256	8,109	2,946
Redlands	36,355	26,829	18,429	14,324	4,797
Redondo Beach	56,075	46,986	25,226	13,092	855
Redwood City	55,686	46,290	25,544	12,453	1,653
Reedley	8,131	5,850	4,135	3,170	—
Rialto	28,370	18,567	3,156	1,770	—
Richmond	79,043	71,854	99,545	23,642	—
Ridgecrest	7,629	5,099	2,028	—	—
Rio Linda	7,524	2,189	—	—	—
Riverside	140,089	84,332	46,764	34,696	7,973
Rodeo	5,356	—	—	—	—
Rohnert Park	6,133	—	—	—	—
Rolling Hills Estates	6,027	3,941	—	—	—
Roseland	5,105	4,510	1,552	—	—
Rosemead	40,972	15,476	—	—	—
Roseville	17,895	13,421	8,723	6,653	—
Rossmoor	12,922	—	—	—	—
Rowland Heights	16,881	—	—	—	—
Rubidoux	13,969	—	—	—	—
Sacramento	254,413	191,667	137,572	105,958	29,282
Salinas	58,896	28,957	13,917	11,586	3,304
San Anselmo	13,031	11,584	9,188	5,790	—
San Bernardino	104,251	91,922	63,058	43,646	6,150
San Bruno	36,254	29,063	12,478	6,519	—
San Carlos	25,924	21,370	14,371	3,520	—
San Clemente	17,063	8,527	2,008	479	—
San Diego	696,769	573,224	334,387	203,341	17,700
San Dimas	15,692	—	—	—	—
San Fernando	16,571	16,093	12,992	9,094	—
San Francisco	715,674	740,316	775,357	634,536	342,782
San Gabriel	29,176	22,561	20,343	11,867	—
Sanger	10,088	8,072	6,400	4,017	—
San Jose	445,779	204,196	95,280	68,457	21,500
San Leandro	68,698	65.962	27,542	14,601	2,253
San Lorenzo	24,633	23,773	—	—	—
San Luis Obispo	28,036	20,437	14,180	8,881	3,021
San Marino	14,177	13,658	11,230	8,175	—
San Mateo	78,991	69,870	41,782	19,403	1,832
San Pablo	21,461	19,687	14,476	—	—
San Rafael	38,977	20,460	13,848	8,573	3,879
Santa Ana	156,601	100,350	45,533	31,921	4,933
Santa Barbara	70,215	58,768	44,913	34,958	6,587
Santa Clara	87,717	58,880	11,702	6,650	3,650
Santa Cruz	32,076	25,596	21,970	16,896	5,659
Santa Fe Springs	14,750	16,342	—	—	—
Santa Maria	32,749	20,027	10,440	8,522	—
Santa Maria South	7,129	—	—	—	—
Santa Monica	88,289	83,249	71,595	53,500	3,057
Santa Paula	18,001	13,279	11,049	8,986	—
Santa Rosa	50,006	31,027	17,902	12,605	6,673
Santee	21,107	—	—	—	—
Saratoga	27,110	14,861	—	—	—
Sausalito	6,158	5,331	4,828	3,540	1,628
Seal Beach	24,441	6,994	3,553	1,553	—
Seaside	35,935	19,353	10,226	—	—
Selma	7,459	6,934	5,964	3,667	1,083
Shafter	5,327	4,576	2,207	1,258	—
Sierra Madre	12,140	9,732	7,273	4,581	—
Signal Hill	5,582	4,627	4,040	3,184	—
Simi Valley	56,464	—	—	—	—
Solana Beach	5,023	—	—	—	—
Soledad	6,843	2,837	2,441	861	—
Soquel	5,795	—	—	—	—
South El Monte	13,443	4,850	—	—	—
South Gate	56,909	53,831	51,116	26,945	—
South Lake Tahoe	12,921	—	—	—	—
South Modesto	7,889	5,465	4,672‖	—	—
South Pasadena	22,979	19,706	16,935	14,356	1,001
South San Francisco	46,646	39,418	19,351	6,629	—
South San Gabriel	5,051	26,213	—	—	—
South San Jose Hills	12,386	—	—	—	—
South Whittier	46,641	—	—	—	—
South Yuba City	5,352	3,200	—	—	—
Spring Valley	29,742	—	—	—	—
Stanford	8,691	—	—	—	—
Stanton	17,947	11,163	—	—	—
Stockton	107,644	86,321	70,853	54,714	17,506
Sun City	5,519	—	—	—	—
Sunnymead	6,708	3,404	—	—	—
Sunnyvale	95,408	52,898	9,829	4,373	—
Susanville	6,608	5,598	5,338	1,575	—
Temple City	29,673	31,838	—	—	—
Thousand Oaks	36,334	2,934	1,243	—	—
Tiburon	6,209	—	—	—	—
Torrance	134,584	100,991	22,241	9,950	—
Tracy	14,724	11,289	8,410	4,056	—
Tulare	16,235	13,824	12,445	8,259	2,216
Turlock	13,992	9,116	6,235	4,839	—
Tustin	21,178	—	—	—	—
Tustin-Foothills	26,598	—	—	—	—
Twentynine Palms	5,667	—	—	—	—
Twentynine Palms Base	5,647	—	—	—	—
Ukiah	10,095	9,900	6,120	3,731	1,850
Union City	14,724	6,618	—	—	—
Upland	32,551	15,918	9,203	6,316	—
Vacaville	21,690	10,898	3,169	1,614	1,220
Valinda	18,837	—	—	—	—
Vallejo	66,733	60,877	26,038	20,072	7,965
Vandenburg	13,193	—	—	—	—
Ventura (San Buenaventura)	55,797	29,114	16,534	13,264	—
Victorville	10,845	—	—	—	—
View Park-Windsor Hills	12,268	—	—	—	—
Visalia	27,268	15,791	11,749	8,904	3,085
Vista	24,688	14,795	1,705	—	—
Walnut	5,992	934	—	—	—
Walnut Creek	39,844	9,903	2,420	1,578	—
Walnut Creek West	8,330	—	—	—	—
Walnut Park	8,925	—	—	—	—
Wasco	8,269	6,841	5,592	—	—
Watsonville	14,569	13,293	11,572	8,937	3,528
West Athens	13,286	—	—	—	—
West Carson	15,501	—	—	—	—
West Compton	5,748	—	—	—	—
West Covina	68,034	50,645	4,499	1,072	—
West Hollywood	29,448	28,870	—	—	—
Westminster	59,865	25,750	—	—	—
West Modesto	6,135	1,897	2,038	—	—
Westmont	29,310	—	—	—	—
West Pittsburg	5,969	5,188	—	—	—
West Puente Valley	20,733	—	—	—	—
West Sacramento	12,002	—	—	—	—
West Whittier-Los Nietos	20,845	—	—	—	—
Whittier	72,863	33,663	23,820	16,115	1,590
Willowbrook	28,705	—	—	—	—
Woodland	20,677	13,524	9,386	6,637	2,886
Yorba Linda	11,856	—	—	—	—
Yreka City	5,394	4,759	3,227	2,485	—
Yuba City	13,986	11,507	7,861	4,968	—
Yucaipa	19,284	—	—	—	—

*Populations are reported as constituted at date of each census.
†Returned until 1941 as Paso Robles.
‡Returned until 1910 as Lordsburg.
‖Returned as South Modesto-River Road in 1950.
Note: Dash indicates place did not exist during reported census, or data was not available.

RAY ATKESON

FILMING A WESTERN MOVIE IN THE ALABAMA HILLS OF THE SIERRA NEVADA

a superior court, with one or more judges, serving six-year terms. In each judicial district with a population of more than 40,000 there is a municipal court, and in each with a population of 40,000 or less, a justice court.

The California constitution provides that agreement by three-fourths of a jury shall be sufficient in civil cases and that jury trial may be waived in minor criminal cases, the latter procedure based on experience under Mexican law.

City government is diverse in type—the mayor-council, commission, and city-manager systems are all in common usage. Notable among measures granting a greater popular control of government are the primary law of 1909 and the constitutional amendments of 1911 establishing the initiative and referendum, the recall (including recall of judges), and the adoption of the short ballot.

Finance.—The chief source of local revenue is the property tax. Until 1911 the state, too, drew most of its general revenue from levies on property, but thereafter no state levy was made, although a 1933 constitutional amendment permitted a property tax up to 25% of the amount of state appropriations.

In the late 1960s, the state's revenue from all sources amounted to more than $9,000,000,000 annually. The chief sources of state revenue are retail sales tax (adopted 1933), gasoline tax, bank and corporation franchise, personal income tax, motor vehicle registration, and motor vehicle licence fees. State expenditures went chiefly for education (about 33%, and the largest single item), highway construction and maintenance, social welfare and public health, and mental hygiene and corrections. The state's income after mid-20th century was about six times as large as it had been just before World War II. Per capita annual income had tripled in the same period and was among the highest in the Union (about $4,270 in 1969).

POPULATION

The population of California in 1850, the year the state entered the Union, was 92,597, of which 92.6% was rural. California's population ranked 30th among the 37 states and territories that then composed the Union. Thirty years later the state's population was 864,694, of which 57.1% was rural, and ranked 24th among the 48 states and territories. By 1910 the population totaled 2,377,549, of which 61.8% was urban, and ranked 12th among the states. In the next three decades, California's population almost tripled, to 6,907,387 (1940), of which 71% was urban, and ranked 5th in the Union. In the next three decades California's population again almost tripled, to 19,953,134 (1970). California's rapid and enormous growth, as well as its high percentage of urban dwellers (90.9% in 1970), was reflected in the state's emergence as one of the most influential elements in national politics.

The 14 standard metropolitan statistical areas existing in 1970 (Anaheim-Santa Ana-Garden Grove, Bakersfield, Fresno, Los Angeles-Long Beach, Oxnard-Ventura, Sacramento, Salinas-Monterey, San Bernardino-Riverside-Ontario, San Diego, San Francisco-Oakland, San Jose, Santa Barbara, Stockton, and Vallejo-Napa) contained 90.7% of the total state population, compared with 86.5% in 1960.

The population per square mile in 1970 was 125.7, as compared with 56.2 for the United States as a whole. The population of the state was distributed by colour in 1960 as follows: 92% white; and 8.0% nonwhite, including 5.6% Negro, 0.6% Chinese, 1.0% Japanese, and 0.4% Filipino. The American Indian population of the state was 39,014 (0.2%).

EDUCATION

The educational system of California provided a complete system of free instruction from kindergarten through the state university until 1970, when tuition to the state university was introduced for state residents. In the elementary schools textbooks are furnished without cost to individual pupils. At the head of the public school system are the state superintendent of public instruction and the state board of education, a body consisting of seven members appointed by the governor. All schools are governed by local boards of education. Outside the cities the school districts are governed by boards of trustees of three members and, in the case of union districts, of five members. There was a compulsory attendance law passed in 1874 which later was amended to require all children between the ages of 8 and 16 to attend for the entire school year unless graduated from a four-year high school or exempted by the proper school authorities Secondary schools are closely affiliated with, and inspected by, the state university. School personnel pension funds in all cities are authorized by state law. Local units are responsible for supplementing the state support of $125 per student in average daily attendance at all education levels. In addition, equalization funds which vary from district to district, are provided by the state Notwithstanding the enormous growth in California's school population after mid-20th century, the state spent more money pe public school student than the United States spent as a whole.

Schools for the physically handicapped include a school fo the blind, a school for the deaf and two schools for cerebra palsied children.

California was the first state to make legal provision for junio colleges (1907), and opened its first public junior college a Fresno (1910). The state also pioneered in the junior high schoo movement; the first such institution was opened at Berkeley i 1909.

Of the institutions of higher education, the University of California (1868), with campuses at Berkeley, Davis, Irvine, Lo Angeles, Riverside, San Diego, San Francisco, Santa Barbara, an Santa Cruz, is the largest in the state. The university began instruction in 1869 in Oakland. In 1873 removal was made to th present site of the Berkeley campus, where instruction is give in the colleges of letters and science, agricultural sciences, environmental design, chemistry, and engineering and the schools of business administration, criminology, education, forestry, journalism law, librarianship, optometry, public affairs, public health, an social welfare. Davis is the site of colleges of agriculture, letter and science, and engineering, schools of medicine, law, and veterinary medicine, and the university farm. At San Francisco ar the schools of medicine, nursing, dentistry, and pharmacy, th university hospital, and various medical clinics and research organizations. The San Francisco Art Institute and Hastings Colleg of the Law, both affiliated with the university, are also there. Th Los Angeles campus offers instruction in colleges of letters an science, engineering, and fine arts and schools of architecture an urban planning, business administration, dentistry, education, law library science, medicine, nursing, public health, and social welfare. The Riverside campus is the location of the citrus experiment station, colleges of letters and science and biological an agricultural sciences and schools of education and engineerin At Mount Hamilton is the Lick Observatory, at the San Dieg campus the Scripps Institution of Oceanography and Mui Revelle, and Third colleges, and at the Santa Barbara campus colleges of creative studies, engineering, and letters and science. Th Los Alamos Scientific Laboratory, New Mexico, is operated unde contract with the Atomic Energy Commission. Innovations a

Santa Cruz and Irvine featured clusters of small separate liberal arts colleges as units of the parent institutions. California also maintains several state colleges: at San Jose, San Diego, San Francisco, Fresno, Chico, Sacramento, Arcata (Humboldt), Los Angeles, Long Beach, Fullerton, Dominguez Hills, Hayward, San Bernardino, Rohnert Park (Sonoma), Bakersfield, and Turlock (Stanislaus); California State Polytechnic College at San Luis Obispo, California State Polytechnic at Pomona, and San Fernando Valley State at Northridge. The California Maritime Academy (Vallejo) is a special technical institute. Stanford University and the University of Southern California (Los Angeles) are the largest private universities in the state. Smaller schools include the University of the Pacific (Stockton), Mills College (Oakland), Occidental College (Los Angeles), the University of Redlands (Redlands), Whittier College (Whittier), and the Claremont colleges—Claremont Men's College, Claremont Graduate School, Harvey Mudd College, Pitzer College for women, Pomona College, and Scripps College. The University of San Francisco, the University of Santa Clara, the University of San Diego, and Loyola University of Los Angeles are Roman Catholic institutions. California Institute of Technology at Pasadena and the nearby astronomical observatories (Mount Wilson and Mount Palomar) are world-renowned centres of scientific research.

ECONOMY

Agriculture.—Rapid development of irrigation and of intensive cultivation and increase of small farms made California an important agricultural region and a great fruit-producing area. By the middle of the 20th century less than 5% of California's popu-ation lived on farms, and less than 9% of its area was under cultivation. The state accounted for only 2% of the nation's otal utilized crop lands. Yet California led the nation in cash ncome from agriculture, surpassing Iowa and Texas.

By 1890, about 1,000,000 ac. were under irrigation, and by 1920 almost 4,000,000 ac. In the 1960s California led all states with more than 8,000,000 ac. irrigated. Staple products changed with increasing knowledge of climatic conditions, of life zones, and of fitness of crops. Completion of the immense Shasta (1945) and Oroville (1967) dams and of numerous smaller dams in the 1950s and 1960s added to the water resources of the state (*see* also *Precipitation: Water Resources*, above).

BY COURTESY OF THE WINE INSTITUTE

VINEYARD WORKER GATHERING GRAPES

Horticultural products are the principal products of the soil. The modern orange industry practically began with the introduction into southern California n 1873 of two seedless orange trees from Brazil; from their tock were developed, by budding, millions of trees bearing a eedless fruit which acquired a high rank in the U.S. market. Shipments continued all the year round. Southern California by no means monopolizes the warm-zone fruits. Oranges, lemons, and walnuts come chiefly from that section, but citrus fruits grow also in the Sierra foothills of the great interior valley. Almonds nd peaches, pears, plums, cherries, and apricots come mainly rom the north. More than one-half of the prune crop comes from Santa Clara County, and the bulk of the raisin output from Fresno County. Olives thrive as far north as the head of the great valley. Vines were first introduced by the Franciscans in 1771 from Spain, and until 1860 "Mission" grapes were practically the only tock in California. Afterward many hundreds of European varieties were introduced with great success. California ranks first mong the states in the production of grapes, accounting for all the raisins and over 90% of the wine, as well as most of the table grapes grown in the United States.

Highly intensive cultivation accounts for much of California's agricultural wealth. Every major crop, with the exception of tobacco and soybeans, produced anywhere in the nation is grown commercially. The state leads in the production of such specialties as lemons, almonds, apricots, plums, prunes, walnuts, olives, dates, and figs. It is among the U.S. leaders in sugar beets, lettuce, asparagus, beans, carrots, spinach, and melons. In the second half of the 20th century California accounted for more than one-third of the fruit and almost one-third of the truck crops grown in the nation.

Cash farm income reached over $4,000,000,000 annually in the 1960s. The average size of farms in 1850, when the large Mexican grants were practically the only farms, was 4,466 ac.; in 1910 it was 316.7 ac. and in 1935 only 202.4 ac., from which it rose again to over 600 ac. in the late 1960s. There were about 37,000,000 ac. in farms in the state.

Increasing urbanization after World War II reduced the state's cultivatable or cultivated land at the rate of about ⅙ ac. for each new resident and 26 ac. for each mile of new highway. In Los Angeles County alone, fruit-nut acreage diminished by 40,000 ac. during 1949–56. On the other hand, more acreage was being devoted to truck farming because of the large local market for vegetables in California's growing cities. In the late 1960s, however, the harvested fruit-nut acreage exceeded that of vegetable crops.

Perhaps the most interesting development in California agriculture after World War II was the increasing area dedicated to cotton production, principally in the southern San Joaquin Valley. In the decade 1940–50 the value of cotton produced increased 1,048.3%, and by the end of the succeeding decade cotton was in most years the most important cash crop in the state. By the late 1960s, however, cotton was surpassed in value by grapes, hay, and tomatoes.

The livestock industry was started by Spanish Franciscan fathers and flourished in both the Spanish and Mexican periods; it was once California's chief economic asset. After mid-20th century California's one important livestock specialty was turkey growing, and the state produced about one-sixth of the U.S. output. By the late 1960s, the state's first two ranking farm products were cattle and calves, and dairy products.

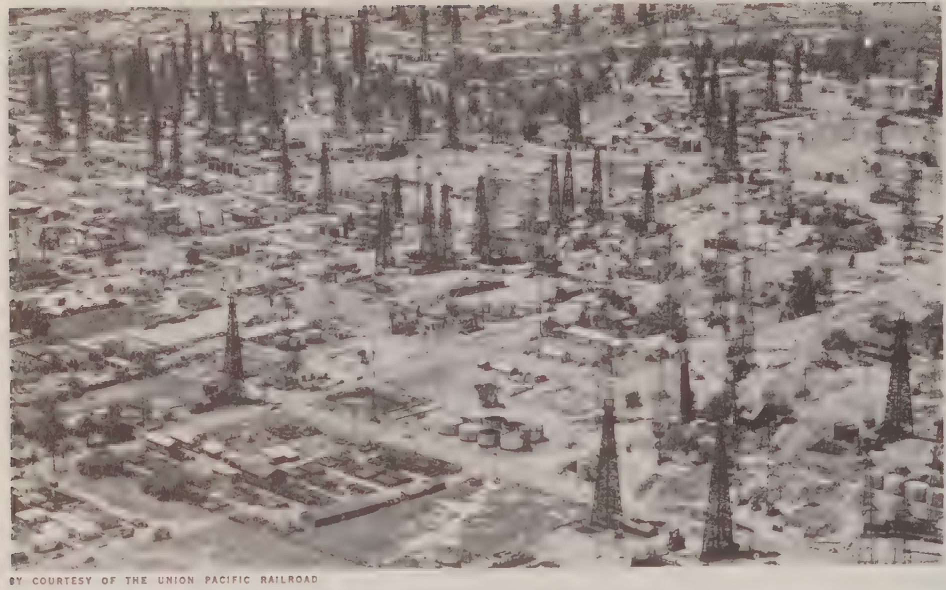
To assist California agriculture, its farm labour supply is supplemented by the employment of numerous migrant labourers.

Fisheries.—Although in value fishing represents a small fraction of California's total production, the output is greater than that of any other state. The total commercial fish catch landed in 1949, a peak year, was more than 1,000,000,000 lb. Of this amount about 300,000,000 lb. were taken from waters south of the international boundary. The most important fish taken were sardines, tuna, and mackerel. But 20 years later the total of commercial fish landed was only about 570,000,000 lb., resulting from the disappearance, at least temporarily, of the sardine. Other important commercial fish caught by the California fishing fleet include anchovies, barracuda, rockfish, salmon, sole, and yellowtail. California exceeds all other states in the canning of both tuna and imported sardines. Chief port areas for the fishing fleets are Eureka, San Francisco, Monterey, Santa Barbara, Los Angeles, and San Diego.

Manufacturers and Employment.—Prior to 1860 almost everything used in the state was imported from the east or from Europe. For many years manufacturing was handicapped by lack of coal, but the opening of petroleum fields and the development of electric power obviated the difficulty. By 1919 manufacturing had replaced agriculture as the state's leading industry, increasing in relative importance thereafter.

Before World War II California's civilian labour forces totaled 2,997,000. Ten years later it had almost doubled to 4,639,000 (1950). By 1960 it exceeded 6,000,000, and was estimated at about 8,000,000 by the end of the decade.

Despite the decline of the war-fostered shipbuilding industry, California industry, as a whole, grew continuously after World War II. In the 1960s the value added by manufacturing far exceeded the combined total value of products of raw-material producing enterprises—agriculture, mining, forestry, and fishing. In



BY COURTESY OF THE UNION PACIFIC RAILROAD

DWELLINGS IN THE SIGNAL HILL OIL FIELD

1900 California was responsible for only 2% of the nation's manufacturing output, but by the second half of the 20th century, it accounted for approximately 8% of the total. After mid-20th century manufacturing expanded more rapidly than did population. The development of new sources of supply of steel, wood, aluminum, rubber, paper, and chemicals in the west and the expansion of electric power, natural gas, fuel, oil, and water supplies were important incentives to the growth of manufacturing in the state.

Transportation equipment (aircraft and parts, automotive manufactures and shipbuilding) was first in importance among California industries, and the largest manufacturing employer in the state, employing more than 200,000 persons. California's second largest manufacturing enterprise was food and beverage manufacturing. The state produces about 55% of the national output of dried and dehydrated fruits and vegetables and is a leader in the frozen food industry, which increased its production by more than 500% in the decade following the end of World War II. The production of motion pictures and television films has its centre in Hollywood (*q.v.*). The manufactures of machinery and electrical equipment were also important. The state's aerospace industry was the largest in the United States.

In lumber production California ranks second in the United States. The state has the largest per capita use of lumber in the nation—approximately 5,000,000,000 bd.ft. being used yearly within the state. Estimated timber cut on private and national forest land is 5,000,000,000 bd.ft. per year, while the growth rate of forests is about 1,300,000,000 bd.ft. annually. The disparity between growth and cutting rates threatens to exhaust the state's forest reserves. Chief varieties of commercial timber are Douglas fir, true firs, ponderosa pine, Jeffrey pine, redwood, and sugar pine.

Transportation.—The transportation facilities increased rapidly after the completion of the first continental line in 1869 by the connection of the Central Pacific and Union Pacific lines. Total railway mileage after mid-20th century was about 7,500 mi. This was supplemented by almost 2,000 mi. of electric railroads.

After 1919 there was rapid improvement of highways. The state highway system has over 16,000 mi. of roads, supplemented by many miles of surfaced and unsurfaced county roads. In 1947 the state inaugurated a ten-year highway development plan for modernization of highways and establishment of freeways. Subsequent federal legislation provided for further aid.

Epochal events in the development of highway communication were the opening in 1936 of the 8¼-mi. San Francisco-Oakland Bay Bridge, and in the following year the opening of the Golden Gate Bridge linking San Francisco with Marin County. The San Francisco Bay Bridge between San Rafael and Richmond was opened in 1956. Highway transportation by truck, motor coach, and automobile was more highly developed in California than in any other state. Metropolitan areas were dependent on trucking to supply agricultural freight.

State vehicle registrations more than doubled in the decade after World War II, and by 1960 there was an average of one vehicle registered for every two persons (considerably higher than the average for the nation as a whole). Consequently multilane highway construction increased, and there appeared continuous highway systems, such as the Golden State Freeway between Los Angeles and Sacramento and the coast highway between San Diego and San Francisco. More than 2,000 mi. of freeways had been built by the early 1970s.

Normally there is frequent freight and passenger service from San Francisco and the port of Los Angeles to Hawaii, Australia, and Asia, as well as to American ports on both the Atlantic and Pacific. World War II materially affected the volume and nature of shipping handled by California ports. Normally the chief exports are petroleum, grains, fruit, vegetables, fish, and manufactured products. Developments in man-made harbours include the dredging and subsequent growth of San Pedro—the port of Los Angeles—and the growing importance of the interior deep-water port of Stockton on the San Joaquin River. San Diego has an excellent harbour, but it is principally used by the Navy. San Francisco, formerly the most important port, was surpassed by Los Angeles. By the late 1960s about $6,000,000,000 annually in exports and imports moved through Los Angeles, San Francisco, and San Diego customs districts.

Mineral Products.—The existence of gold had been suspected in California long before 1848, and there had been desultory washings in parts where there was very little to reward prospectors. The first authenticated discovery was made near Los Angeles in 1842. The discovery of real historical importance was made on Jan. 24, 1848, at John A. Sutter's mill, on the south fork of the American River near Coloma, by an associate, James W. Marshall (1810–85).

At the time of the greatest productiveness of gold washings, from 1850 to 1853, the highest yield was probably not less than $65,000,000 a year. From the record of actual exports and a comparison of the most authoritative estimates of total production, i may be said that from 1848 to 1856 the yield was almost certainly not less than $450,000,000, and that about 1870 the $1,000,000,000 mark had been passed. Placer-mining was of chief importance in the early years, followed by an important but devastating era of hydraulic mining; after the richer deposits had been exploited the machine-worked quartz mines came into prominence. By 1933 more than half the gold output was from such mines. Quartz veins are often as rich at a depth of 3,000 ft. as at the surface. A remarkable feature of mining after 1900 was gold dredging. (Fo detail on dredging *see* Gold: *Mining: Placer Mining.*) Thousands of acres of land were thus treated.

In 1933 the stimulus of higher prices for the metal resulted in a marked expansion of gold mining. The number of mines increased and production of gold likewise rose. Until 1941 California was the national leader in gold production. The total value of gold produced in California in the century following the Sutter

Mill discovery was more than $2,000,000,000. Preeminence was regained in 1948 with production valued at $14,751,555, but again declined in the succeeding decades. Many of the important lode mines, closed by government orders in World War II, were not reopened. Gold production continued to decline after mid-century as several underground mines ended operations.

Petroleum and the products associated with it have an annual value far in excess of the historically important gold. The production of crude petroleum grew rapidly after 1895, its output soaring from 4,325,000 bbl. in 1900 to 262,876,000 bbl. in 1923. In 1929 it ascended to 292,534,000 bbl. The depression of the 1930s drove production downward, but by 1939 production figures reached 224,354,000 bbl. By the end of the succeeding decade annual production exceeded 300,000,000 bbl., and in some years exceeded that level; 375,000,000 bbl. were produced in 1969. The value of petroleum production is almost equal to the combined total of the value of all other mineral resources within the state; about 50% of the state's total mineral production value is from petroleum. Leading petroleum producing areas are in Wilmington, Long Beach, Huntington Beach, Midway-Sunset, Kettleman Hills, and Coalinga.

California is third, after Texas and Louisiana, in crude oil productive capacity and provides about 15% of U.S. oil. The existence of oil pools offshore had been known since 1896, but not until 954 was the first offshore well drilled from a man-made island; within a year seven additional wells had been drilled from the island. The federal Tidelands Act of 1953 and California's Shell Bill of 1955 were designed to promote exploration and development in this activity to meet state needs for more fuel. (*See* PETROLEUM: *Production: Offshore Drilling.*)

California has a greater variety of valuable minerals in workable form than any other area of its size on earth. It has the largest known reserves of boron minerals, and after World War II produced more than 90% of the world's requirements. The first shipment of uranium ore was made from San Bernardino County in 1954 and by 1960 radioactive minerals had been discovered in about 300 places, mostly in desert areas of southern California.

Other leading mineral products were natural gas, sand and ravel, cement, stone, salt, clay, lead, lime, magnesium compounds, nd gypsum. California was also the chief source of mercury, sbestos, diatomite, tungsten, sodium sulfate, sulfur ore, and rare-arth metals. The state's mineral production reached an all-time igh of $1,808,147 in 1968, ranking third in the nation.

See also references under "California" in the Index.

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(C. E. Ch.; R. H. Sh.; D. C. Cr.; J. E. Ba.; X.)

CALIFORNIA, LOWER (Spanish BAJA CALIFORNIA), a peninsula belonging to Mexico, 760 mi. long and 25 to 150 mi. wide, bounded by the Pacific Ocean on the west and south and by the Gulf of California on the east. To the north is the boundary separating Lower California from the state of California (U.S.). The Colorado River divides the peninsula from Sonora. The area (55,518 sq.mi. [143,791 sq.km.]) is shared almost equally between a northern state and a federal territory in the south, while the population (1969 est.) is unevenly distributed, 1,044,000 in the state and only 106,000 in the territory.

The basic geological feature is a fault block rising precipitously on the Gulf side and dropping gently into the Pacific, crowned with a chain of rugged peaks tending in a northwest–southeast direction. The granitic Juárez and San Pedro Mártir mountains, the latter rising 10,154 ft. above sea level, form the divide in the north, with lower parallel ranges much interrupted by erosion along both coasts. The centre of the peninsula is dominated by volcanoes (Las Tres Vírgenes, 6,547 ft. [1,996 m.], was last reported active in 1746) and vast lava flows extending westward in a sub-peninsula. In the vicinity of La Paz the mountains disappear in a low, narrow isthmus, after which they reemerge in a final lofty (7,100 ft.) [2,100 m.] granite range.

The most extensive plains are along the Pacific shore in the south, from near La Paz to Ojo de Liebre (Scammon's) Lagoon. At the head of the Gulf is a delta formed by the alluvia of the Colorado River; the Mexicali and Imperial "valleys" (the latter in the U.S.) are vestiges of this delta, fertile floodplains reclaimed from the sea.

Lower California has 2,000 mi. (3,220 km.) of coastline with many islands on both sides. The largest are barren Ángel de la Guarda, Carmen, San José, Espíritu Santo, and Cerralvo in the Gulf, and Margarita, Cedros, and Guadalupe in the Pacific. There are sheltered deepwater harbours on the west coast (Todos Santos Bay, Magdalena Bay) as well as on the Gulf (Los Ángeles Bay, Concepción Bay, Pichilingue Harbour). Spring tidal range, only 3–8 ft. on the Pacific side, increases in the funnel-shaped Gulf to 31.5 ft. (9.6 m.) at the mouth of the Colorado.

Three zones of climate divide the region biotically. The northwest corner receives winter cyclonic cold fronts bringing rain and fog from California. Precipitation there, mostly from October to April, decreases from about 11 in. (280 mm.) annually at Tijuana to 5 in. (130 mm.) at El Rosario, although the northern mountains get far more rain and occasional snow. Vegetation and fauna in this part are similar to those of southern California. Southward from El Rosario and east of the Juárez–San Pedro

Mártir massif is an excessively arid zone extending through the waist of the peninsula to La Paz. Parts of this great central desert are quite barren, but most of it is covered with forests of xerophytes, notably the giant cactus or cardon (*Pachycereus*) and two unique species, the cirio (*Idria columnaris*) and the elephant tree (*Pachycormus discolor*). The region south of La Paz receives late summer tropical rains averaging 5 in. annually on the coast and 25 in. (635 mm.) or more in the higher mountains, with desert shrub below and semideciduous forest above. Lowland temperatures range from below freezing (even in the south) to over 100° F (37.8° C). The Gulf coast is hot and humid in summer, while the Pacific side is much cooler. Hurricanes, which occasionally do great damage, are most apt to strike in September. Surface water, excepting the Colorado River, is confined to a few permanent streamlets in the northwest and extreme south, and rare springs forming oases elsewhere. Of the latter, the most notable are San Ignacio, Mulegé, Loreto, Comondú, and La Purísima, all with extensive groves of date palms.

Lower California is of special archaeological interest because of its isolated situation, in which cultural features long extinct elsewhere have been preserved into historical times. Man first moved into this cul-de-sac from the north perhaps 9,000 or 10,000 years ago, when the climate was more humid and huge Pleistocene mammals roamed the area. The oldest human remains known are of a hyperdolichocephalic type (quite uncharacteristic of American Indians) found in cave burials south of La Paz dated 69–114 B.C. These people apparently died out and were followed by successive waves of others. When the Spaniards landed at the end of 1533, they found what were among the most primitive cultures in America. An estimated 60,000 to 70,000 Indians lived at that time in small groups, each of which exploited a definite territory—hunting, fishing, and gathering wild plants. Agriculture was not practised except in the Colorado delta, where there was a denser population. South of Loreto, three distinct languages (Guaycuran, Huchiti, Pericú) were spoken, related to each other but with no apparent outside affiliation. The central desert was inhabited by Yuman-speaking people (Cochimí), relative late-comers, while in the north were other groups of Yumans who had arrived so much later that they could not communicate with the earlier ones.

A ship sent out by Hernán Cortés touched at the La Paz area in December 1533, and this discovery led to a short-lived (1535–36) Spanish settlement. Both coasts of the peninsula were explored by Francisco de Ulloa in 1539–40. Pearls in the shallow Gulf waters attracted occasional Spanish expeditions during the next 200 years, but further attempts to colonize Lower California were fruitless until Jesuit missionaries established a permanent settlement at Loreto in 1697, the first in a chain of 30 missions where the Indians were congregated, clothed, catechized, taught agriculture and animal husbandry, and practically exterminated in a series of epidemics introduced unwittingly by the Spaniards. In 1768 the Jesuits were replaced by Franciscans who moved on to Upper California, leaving the peninsular missions to the Dominican order five years later. By this time few Indians remained in the south, and the Dominicans concentrated on founding new missions in the north to convert the still undecimated tribes there. In 1777 the capital of California was moved from Loreto to Monterey, but a separate governor again resided at Loreto after 1804.

Independence from Spain, recognized in Lower California in 1822, had little impact. The missions were gradually abandoned and the vanished Indians were replaced by a sparse mestizo population of farmers and cattlemen. In 1828 Loreto was destroyed by a hurricane, and government offices were moved to La Paz. During the Mexican War (1846–48) U.S. troops occupied La Paz and San José del Cabo, after which the Treaty of Guadalupe Hidalgo divided the two Californias between the contenders. In 1887 Lower California was split into two federal districts, with capitals at La Paz and Ensenada (later moved to Mexicali), redesignated federal territories in 1931. After 1902, when irrigation of the Imperial-Mexicali Valley began, cotton production coupled with immigration from central Mexico caused the Northern Territory to surpass the south in population and importance. Lower California became the 29th state in the Mexican federation in January 1952.

In the 1960s, the border cities of Tijuana (pop. [1960] 152,374) and Mexicali (174,540), the latter the capital of the state, experienced a phenomenal growth, shared to a lesser extent by Ensenada (42,561). Proximity to U.S. markets had much to do with this, although an increasing production was directed toward central Mexico. Expanded agriculture (predominantly cotton, followed by wheat, grapes, and olives) and industry (cottonseed and food processing, clothing, shoes, fish packing, beer, wine, soap, etc.) absorbed many immigrants, but a large idle surplus of unskilled workers, formerly employed seasonally in the United States and denied entry in the late 1960s, remained. Wages and the cost of living, while higher than in the rest of Mexico, were lower than in the United States, and foreign companies, encouraged by tax and customs exemptions (Lower California is a restricted "free zone"), began to establish factories in the border region. Although the restricted freshwater supply inhibited further expansion, a nuclear-powered desalinization plant was projected at San Felipe, on the Gulf.

The more isolated southern half of the peninsula, still a federal territory and relatively neglected, progressed less spectacularly. Much new acreage of cotton was planted near La Paz (pop. [1960] 24,253) and on the Magdalena plain around Villa Constitución (2,000), irrigated from deep wells. Olives and sugarcane are also produced. Industry was largely confined to processing of cotton by-products, fish packing plants, and saltworks. The famed Boleo copper deposits at Santa Rosalia (5,361), exploited by a French company (1884–1953), were being worked on a reduced scale with government subsidy. Cattle-raising and subsistence agriculture were still the mainstays in isolated areas. Tourism is an important source of income.

Communications, the near absence of which made Lower California a backwater for centuries, were being improved in the late 1960s. Paved roads connect the principal cities in the north, while both a railroad and a good highway unite Mexicali with Sonora and the rest of Mexico. Roads from La Paz to Villa Constitución and San José del Cabo were paved. The construction of a trans-peninsular highway (the roads south of Ensenada were still only a rough track for over 500 miles) was being considered. A modern car ferry between La Paz and Mazatlán was inaugurated in 1965. Harbour facilities were improved at Ensenada, Magdalena Bay (Puerto San Carlos), and La Paz (Pichilingue Harbour). Airlines provide frequent service, and many landing strips were cleared.

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(PE. GE.)

CALIFORNIA, UNIVERSITY OF, a state university, with campuses at Berkeley, Davis, La Jolla, Los Angeles, Mount Hamilton, Riverside, San Francisco, and Santa Barbara. *See* CALIFORNIA: *Education.*

CALIFORNIA INSTITUTE OF TECHNOLOGY (established as the Throop Polytechnic Institute in 1891), a private college and research institute for men (women admitted at the graduate level) in Pasadena, Calif. *See* PASADENA.

CALIFORNIUM, a synthetic chemical element, has the symbol Cf and atomic number 98. It is the ninth member of the actinide series in the periodic system (*see* PERIODIC LAW; TRANSURANIUM ELEMENTS). Californium was discovered by S. G. Thompson, K. Street, Jr., A. Ghiorso, and G. T. Seaborg in 1950 at the University of California, Berkeley. The first isotope identified is now assigned the mass number 245; it was produced by bombardment of the curium isotope Cm^{242} with helium ions in the 60-in. cyclotron. The discoverers suggested the name californium to honour the state and the university where the work was done.

The long-lived isotopes of californium are produced from the berkelium isotope Bk^{249}. Cf^{249} results from the beta particle decay of Bk^{249}, and thus can be prepared in isotopically pure form; the heavier isotopes are produced by intensive slow neutron irradiation of either Bk^{249} or Cf^{249}. In the case of Bk^{249} the capture of a neutron results in the production of Bk^{250}, which decays with negative beta particle emission to yield Cf^{250}. The irradiation of Cf^{249} with neutrons produces successively Cf^{250}, Cf^{251}, and finally Cf^{252}.

Isotopes of Californium

Isotope	Half-life	Type* and energy of radiation (Mev)
Cf^{242}	$\sim$2 min.	α7.3
Cf^{243}	$\sim$15 min.	α7.1
Cf^{244}	25 min.	α7.17
Cf^{245}	44 min.	EC (70%) α(30%) 7.11
Cf^{246}	35.7 hr.	α6.753 (78%) 6.711 (22%)
Cf^{247}	2.5 hr.	EC
Cf^{248}	350 days	α6.26
Cf^{249}	360 yr.	α6.190 (3%) 5.91 (6%) 5.82 (90%)
Cf^{250}	13 yr.	α6.024 (83%) 5.980 (17%)
Cf^{251}	800 yr.	α5.884, 5.667
Cf^{252}	2.65 yr.	α(97%) 6.112 (82%) 6.069 (15%) SF (3%)
Cf^{253}	17.6 days	β^-0.27 α(0.31%) 5.98
Cf^{254}	60 days	SF (>99%) α($\sim$0.2%) 5.84

*EC = electron capture; SF = spontaneous fission; α = alpha particle; β^- = negative beta particle.

As in the case of a number of the other actinide elements, there is no unambiguous designation of an atomic weight. In those instances where there is a formal requirement for this quantity, the use of the mass number of the longest-lived isotope might be considered.

Californium (as a mixture of Cf^{249}, Cf^{250}, Cf^{251}, and Cf^{252}) was first isolated in weighable amounts by B. B. Cunningham and Thompson at Berkeley in 1958. The first compound of proven molecular structure (shown by X-ray diffraction) was isolated in 1962 by Cunningham and J. C. Wallmann as three-tenths of a microgram of californium (as isotopically pure Cf^{249}) oxychloride. The pure oxide (Cf_2O_3) and trichloride ($CfCl_3$) have also been prepared and shown to have monoclinic and hexagonal structures, respectively. The other halides are expected to have structures and chemical properties similar to those of other actinide trihalides.

Metallic californium should be electropositive, reactive, and silver-coloured like other actinide metals, and should have a density of about 14 g./cc.

Californium seems to exist exclusively in the III oxidation state in acidic aqueous solution, although it is expected that the V oxidation state, as the ion CfO_2^{2+}, may be found. As with the other actinide elements, the oxalate and fluoride are insoluble in acid solution, while the other halides, nitrate, sulfate, perchlorate, and sulfide are all soluble.

Californium can be separated from the other actinide elements through the use of ion-exchange resins, and from the rare-earth elements by using its tendency to form strong complex ions with species such as chloride ion in connection with ion-exchange and solvent extraction separation methods.

The isotope Cf^{252}, because of its decay by spontaneous fission, is important as a point source of neutrons for industrial and medical applications.

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CALIGULA (GAIUS CAESAR) (A.D. 12–41), Roman emperor from A.D. 37 to 41 in succession to Tiberius. He was handsome, popular, intelligent and well-educated, but with no administrative experience when he became emperor. In under four years he squandered Tiberius' accumulated savings and lost all his popularity. The accounts of his reign by ancient historians are so biased that the truth is almost impossible to disentangle.

Named Gaius Caesar, his nickname "Caligula" (little boot) was given him in childhood by the soldiers of his father Germanicus. The deaths of his father in A.D. 19, of his mother, Agrippina, in 33 and his two elder brothers, Nero Caesar in 31 and Drusus Caesar in 23, were popularly ascribed to the malevolence of Tiberius. Gaius and his three sisters survived. Adopting his father's distinguished name, he became Gaius Caesar Germanicus.

He was severely ill seven months after his accession; after this he restored treason trials, showed great cruelty and indulged in wild despotic caprice, *e.g.,* he bridged the Bay of Naples with boats from Baiae to Puteoli in summer 39. In 38 he executed Naevius Sertorius Macro, prefect of the praetorian guard, to whose support he owed his accession, and Tiberius Gemellus, grandson of Tiberius, whom he had supplanted in the succession. He made pretensions to divinity, and showed extravagant affection for his sisters, especially Drusilla who, on her death in 38, was consecrated as Diva Drusilla, the first woman in Rome to be so honoured. This relationship has prompted the suggestion that he aimed at establishing a Hellenistic type of monarchy, on the example of the brother-sister marriages of the Ptolemies. Others have thought that after his illness he was mad; but much so-called evidence of his madness—*e.g.,* that he made his horse consul—is untrue.

Appearing unexpectedly on the upper Rhine in Oct. 39, he suppressed an incipient revolt, executing Drusilla's widower M. Aemilius Lepidus and Gnaeus Lentulus Gaetulicus, the commander of the upper Rhine armies, and restored discipline by stiff maneuvers, travestied in the accounts of ancient historians. In 40 he was in Gaul, and probably raised two new legions and planned to invade Britain in spring 40. Possibly the troops refused to go on board: on this occasion, instead of ordering them to embark, Gaius allegedly commanded them to pick up shells. A pogrom in Alexandria in Aug. 38 and trouble in Palestine in winter 39 led Gaius to order the governor of Syria to erect his statue in the temple at Jerusalem in summer 40. Under the suave persuasion of Herod Agrippa at Rome Gaius countermanded the order. A conspiracy was formed (A.D. 40–41) and Gaius was murdered by Cassius Chaerea, a tribune of the guard, at the Palatine games on Jan. 24, A.D. 41. (J. P. V. D. B.)

CALIPHATE, a term restricted, in general historical usage, to the history and rule of the successors of the prophet Mohammed in the government of the Muslim community and of the territories occupied or subjugated by the Arabs. These comprise: (1) the first four caliphs, the immediate successors of Mohammed at Medina; (2) the Omayyad caliphs of Damascus; (3) the Abbasid caliphs of Baghdad. To these three groups the present article is confined. For the western caliphs *see* ABD-AL-RAHMAN; ALMOHADS; and SPAIN: *History.* For the Egyptian caliphs *see* EGYPT: *History;* and FATIMIDS. The history of Arabia proper will be found under ARABIA.

THE FIRST FOUR CALIPHS

Mohammed died at Medina on June 8, 632, without leaving any instructions for the future government of the Muslim community. In the confusion that followed several parties began to form, notably among the Medinian tribes, and a meeting of the Khazraj tribe was convened to choose a leader. Several of the Meccan companions, including Abu Bakr and Omar, joined in the meeting. After lengthy argument, it was agreed to recognize Abu Bakr as leader of the community, and the choice was ratified on the following day by the people as a whole, except for Mohammed's son-in-law Ali, who made submission only some months later. Abu Bakr adopted the title of *khalifat rasul-Allah* ("successor of the Messenger of God"), whence the term "caliph."

Abu Bakr (632–634).—Abu Bakr was confronted immediately by the revolt of several tribes in Hejaz and Nejd against the government of Medina. In face of his uncompromising attitude the Hejaz tribes submitted without fighting, but the Nejd tribes, excited by the appearance of "false prophets," had to be subjugated by military forces under the command of Khalid ibn al-Walid. After a desperate struggle against Musailima in Al Yamamah (Al Kharj, eastern Nejd) in May 633, minor expeditions secured the submission of the rest of the Arabian peninsula. Meanwhile Khalid, with support from the tribe of Bakr, raided the borderlands of Iraq and captured Hira (*q.v.*). In the same year, the tribesmen were summoned by Abu Bakr to join in expeditions into Palestine and Transjordan, under Amr ibn al-As (*q.v.*) and other leaders. In face of the Byzantine counteroffensive, Khalid made a hazardous march across the Syrian desert, rejoined the combined Arab forces in southern Palestine and defeated the Greeks at Ajnadain (July 30, 634).

Omar (634–644).—The first steps toward a regular conquest of Syria had thus been taken before the death of Abu Bakr (Aug. 23, 634) and the immediate and uncontested succession of Omar, under whom the conquests were extended to Iraq, Mesopotamia and Egypt. On his accession Omar took the title of amir al-mu'minin ("commander of the faithful"; *i.e.*, of the believers), which became the formal title of all later caliphs.

For the history of the Arab conquests scarcely any contemporary annals have survived, and their progress has to be largely reconstructed from the traditions preserved by the Arabic chroniclers about two centuries later. Though confused in part by the growth of tribal sagas and heroic legends, the core of these traditions proves to be remarkably accurate and consistent in its presentation of the main events. Many details still remain obscure, particularly in regard to the conquest of Egypt and to the strategy and tactics of the opposing forces. The Greek chronicles which describe the campaigns are, unfortunately, no earlier than the Arabic and contain only curt mentions of battles and sieges.

The armies of the Arabs were formed entirely of tribesmen mounted on camels and horses, whose traditional method of fighting was to charge in a long line, cast a shower of javelins on the opposing force, wheel back to a prearranged base line, repeat the tactics until the enemy line showed signs of breaking and then engage in hand-to-hand combat. In arms (lance, bow and sword) they were little inferior to their enemies, whose tactics were familiar to the frontier tribes from centuries of warfare as allies or as opponents of Roman and Persian armies. But, having no siege equipment, they were unable to besiege cities and fortresses, which they could capture only by storm, treachery or blockade. Their greatest advantage (besides their mobility) was that, as the aggressors, they were able to choose their ground and to fight their chief battles on the edge of the desert, where they were safe from attack in the rear and their communications were fully protected. The forces engaged on both sides are often greatly exaggerated, but it is probable that in numbers of fighting men the Arabs were seldom inferior to their opponents in pitched battles.

Khalid, following up the retreating Greek army, defeated it again at Fihl (Pella), near Beisan (Jan. 23, 635), surrounded Damascus, which surrendered on Sept. 4, and pushed northward. Early in 636 he withdrew south of the Yarmuk river before a powerful Greek force which advanced simultaneously from the north and from the coast of Palestine. But the Greek armies were composed mainly of Arab, Armenian and other auxiliaries, who felt little loyalty to the empire; the treasury and the provinces were exhausted by the long Persian wars and the Persian invasions; and the populations were apathetic, if not actively hostile. When a rebellion broke out in the Greek camp, Khalid, reinforced from Medina and possibly from the Syrian Arab tribes, attacked and destroyed the Greek forces in the precipices of the Yarmuk valley (Aug. 20, 636). Damascus was regained in the same year; and three Arab armies occupied, against little resistance, the northern cities, Palestine and the coastal region. Jerusalem held out until the caliph Omar received its surrender in person in 638; and Caesarea and Gaza fell in 640. The last Greek strongholds, Ascalon and Tripoli, capitulated only in 644 and 645. The Arab troops were established in military cantonments (called *jund*) in Damascus, Jabiya, Homs (ancient Emesa) and Kinnasrin; and in 639 the Omayyad Mu'awiya ibn Abi Sufyan was appointed governor of all Syria.

After Khalid's withdrawal, the tribesmen of Bakr, defeated by the Persians, withdrew to Hira, but on the arrival of Yemenite reinforcements drove back a Persian counterattack at Buwaib (Oct. 635). Only after the victory of the Yarmuk did Omar feel free to organize a full-scale invasion, under the command of Sa'd ibn Abi Wakkas; the main Persian army, commanded by Rustum, was broken at Kadisiya (June 637), the Sasanian capital Ctesiphon (al Mada'in) fell in the following month, and the remaining Persian forces were again defeated at Jalula (near Hulwan) in December. Two new garrison cities (*misr*) were founded for the Arab troops at Kufa and Basra, from which annual expeditions were organized, each tribe being allotted its own quarter in the city.

Syrian troops had already begun to occupy Mesopotamia from the west in 638–639; in 640 Iraqi troops conquered Mosul and Kurdistan and pushed into Azerbaijan, while the Syrians raided Armenia for several years in succession.

The conquests made by the Arabs hitherto had been in the relatively flat and familiar area of the fertile crescent. But their possession of Iraq remained insecure so long as the Persians were at liberty to reorganize their forces in the Iranian plateau. Undeterred by the difficulties of the terrain and of adapting their methods of fighting to mountain warfare, the Arab generals in Iraq set out to effect the systematic conquest of Persia. While the troops of Basra were engaged in the task of reducing Khuzistan (638–644) and Fars (644–650), those of Kufa began to penetrate the highlands through the Hulwan gap. After a fresh Persian army had been defeated in a hard-fought battle at Nehavand (641), the western edges of the Persian plateau were conquered piecemeal, but the Arabs continued to encounter obstinate resistance both in Rayy and in the province of Fars. It was only on the final subjugation of Fars in 650 that the troops of Basra were able to sweep across the plateau to occupy Kerman and Khurasan.

The last Sasanian king, Yazdegerd III, fleeing before them, perished miserably near Merv in 651; and in the following year the campaigns were rounded off with the occupation of Merv, Balkh and Herat.

In 639, Amr ibn al-As, on his own initiative, led his 4,000 Yemenite troops down into Egypt on an extensive raid. Reinforced from Medina in 640, he concentrated his forces on the edge of the delta at 'Ayn Shams (Heliopolis). The Greek forces advancing from the fortress of Babylon to engage him were severely defeated in July, and during the following siege of the fortress Amr negotiated the submission of the Coptic population. On the surrender of Babylon (April 641), he advanced on Alexandria, which surrendered after a truce of 11 months. In 643 a permanent encampment was founded at Al Fustat (modern Misr al Qadimah); in the same year expeditions were sent into Nubia and westward into Cyrenaica; and Tripoli was captured after a siege in 643. A last attempt at reconquest was made by the Greeks in 645 with a sudden naval attack on Alexandria, but Amr regained the city by assault. (*See* also EGYPT: *History: Medieval Period.*)

The part played by the caliph in these conquests was a far from passive one. Though the details of strategy were necessarily left to the discretion of the commanders, Omar maintained a remarkable measure of general control over their objectives and policy. Their government of the provinces was closely supervised and any delinquency sharply reprimanded or punished. The most difficult problem that confronted the Arab rulers was the administration of the newly conquered territories. The method generally adopted was to leave the land in the possession of its existing owners and taxation in the hands of existing officials, in return for fixed annual payments in money and kind. The conquests constituted a perpetual endowment for the upkeep of the Arab garrison troops, who received four-fifths of the provincial revenues and of war booty; the other fifth, together with crown lands and sequestrated estates, was at the caliph's disposal for distribution at Mecca and Medina.

Othman (644–656).—On the death of Omar, who was stabbed by a Kufan workman in the mosque at Medina (Nov. 3, 644), a conclave of Meccan nobles at Medina elected the already aged Othman as caliph. For six years or more the conquests proceeded steadily and Syrian armies began to probe Asia Minor. A notable new development was the organization of Syrian and Egyptian fleets, which occupied Cyprus and in 655 defeated the Greek fleet near Phoenix in Lycia. But with the removal of external dangers the tribesmen began to resent the control exercised by the caliph and his governors, the economic exploitation of the conquests by the commercial aristocracy of Mecca and the favours shown to his kinsmen of the Omayyad family by Othman. Encouraged by the caliph's weakness and by preachers who denounced his errors and innovations (notably his issue of an official text of the Koran and order to destroy all others), the troops in Kufa and Al Fustat rebelled. A party from Egypt, headed by the son of Abu

Bakr, marched to Medina, besieged Othman in his house and killed him (June 17, 656).

Ali (656–661).—The mutineers and Medinians then recognized Ali (*q.v.*), Mohammed's son-in-law, as caliph. Two Meccan nobles, Talha and Al-Zubayr, joined by Mohammed's widow Aisha, escaped to Iraq and gained the support of the garrison at Basra. The rival garrison at Kufa now joined Ali, who defeated his opponents in the "battle of the camel" (ridden by Aisha), and established himself in Kufa.

When Mu'awiya, governor of Syria, calling for vengeance for the blood of his kinsman Othman, refused to recognize Ali, the Kufans invaded Syria; the armies met at Siffin and, after long and indecisive negotiations and skirmishes, agreed to submit the case to arbitration (Aug. 657). In the surviving accounts of the meeting of the arbitrators there is more legend than history, but it seems to have turned out unfavourably for Ali.

A group of fanatical dissidents at Kufa moved out to Nahravan (hence their name *khawarij*, sing. *khariji*, "outgoers," whence Kharijites) and openly rebelled; although Ali severely defeated them (July 658), similar, if smaller, risings broke out in various quarters, while Khurasan was lost through a Persian revolt, and Egypt regained for Mu'awiya by Amr ibn al-As. The Syrian raids on Ali's territories in Iraq and Arabia grew bolder and more effective; Mu'awiya could count on the obedience of loyal and disciplined troops, while Ali, having risen to power on a wave of revolution, was rendered powerless by the insubordination, on the one hand of the zealots who held him guilty for agreeing to arbitration, on the other of the ordinary tribesmen of Iraq who refused to engage the Syrians again, while he had lost the sympathies of Medina by transferring the capital to Kufa.

The zealots attempted to assassinate both Mu'awiya and Ali, but succeeded only in killing Ali (Jan. 661). His son Hasan, in face of an invasion by Mu'awiya and discord among his troops, abdicated a few months later and retired to Medina, where he died in 669.

THE OMAYYAD CALIPHS

Mu'awiya (660–680).—On his entry into Kufa, Mu'awiya, who had been proclaimed caliph in Jerusalem in July 660, received the submission of all Iraq, contested only by the *khawarij*, whose local revolts continued to disturb the peace for many years. His first care was to re-establish Arab rule in Khurasan, and several years later new garrison cities were founded at Merv and in Seistan, from which expeditions were directed into central Asia and northwestern India.

The Egyptian armies under Okba ibn Nafi' began the invasion of northwest Africa and founded another garrison city at Kairouan. His expeditions culminated in a triumphal march to the shores of the Atlantic (681), followed by a Byzantine and Berber rising which drove the Arabs back to Cyrenaica. But the main Arab offensive was directed against the Byzantine empire. With the support of the fleet, Constantinople was attacked in 669, but in the following winter the Arab army was destroyed at Amorium. A fresh campaign was mounted in 673, and for four years Constantinople suffered an annual siege of several months. The invaders were repeatedly driven off by Greek fire, and their heavy losses compelled them to withdraw in 678.

Mu'awiya was a typical Arab *sayyid* ("gentleman"). He governed not by force but by superior intelligence, self-control, mildness and magnanimity. But behind him stood the disciplined army of Syria, with the most powerful tribe in which, the Kalb, he had allied himself by marriage. Well aware that the allegiance of this army was now the sole guarantee of the unity of the Arab empire and that the old Arab method of election to the caliphate was no longer practicable, he secured during his lifetime a general oath of allegiance to his son Yazid as his successor. The introduction of the hereditary principle was, however, an offense to Muslim ideas and especially disliked in Iraq, already restive over the transference of the capital to Damascus and the predominance of the Syrian army. Mu'awiya had had the good fortune to find an excellent governor for Iraq in Ziyad, a former partisan of Ali, said to be a bastard of Mu'awiya's father and publicly acknowledged by the caliph as his brother. During his firm but just government Iraq remained quiet, but after his death in 673 the old tensions began to revive in the garrison cities and were further complicated by the gradual combination of groups of tribes into tribal and political factions.

Yazid I (680–683).—The opposition in Kufa flared into action on Mu'awiya's death, when the faction favourable to the house of Ali (the *Shi'a* or Shi'ites) invited Ali's second son Husain from Mecca to Kufa, to claim the caliphate. Yazid, informed of the threatening behaviour of the Shi'ites at Kufa, sent Obaidallah, the son of Ziyad, and governor of Basra, to restore order. Using the same tactics as his father before him, Obaidallah summoned the chiefs of the tribes and made them responsible for the conduct of their men.

Meanwhile Husain had set out with all his family, expecting to be received with enthusiasm at Kufa. Though warned on reaching Iraq of the change that had taken place, he persisted in his journey and at Karbala was confronted with a Kufan force commanded by Omar, a son of Sa'd ibn Abi Wakkas. He gave battle and fell, with most of his family and followers, on Oct. 10, 680.

No other issue of this rash expedition could have been expected. But the tragic death of the prophet's grandson, with so many of his house, caused a strong revulsion of feeling, not only among the Shi'ite partisans at Kufa, who were the principal authors of the disaster, but among devout Muslims everywhere; and the facts soon acquired a wholly romantic colouring. This event, rather than the misfortunes of Ali, became the emotional root of Shi'ism; Omar ibn Sa'd and his officers, Obaidallah and Yazid himself, came to be regarded as murderers and their names to be held accursed by all Shi'ites, who have ever since observed the tenth day of Muharram, the day of *'Ashura*, as a day of public mourning (*see* HASAN AND HUSAIN). Among the Sunnis also it cast a cloud over the Omayyads and gave a handle to all their enemies.

Another of these enemies saw his own claim to the caliphate facilitated by the removal of Husain. Abdullah ibn al-Zubayr, the son of Ali's rival al-Zubayr, obtained the allegiance of Medina and Mecca. After prolonged negotiations Yazid sent a Syrian army against Medina; the forces of the citizens were easily overcome and, according to tradition, the city was given up to plunder for three days. The Syrians then marched on Mecca in Sept. 683 and found Abdullah ibn al-Zubayr ready to defend it. The siege had lasted 64 days (during which the Ka'ba was damaged by bombardment) when the news came of the death of Yazid (Nov. 10, 683), whereupon the army returned to Syria.

Mu'awiya II (683).—Yazid's young and sickly son succeeded him, but died within two or three months. Abdullah ibn Zubayr was recognized throughout Arabia, Iraq and Egypt; but Marwan ibn Hakam of another branch of the Omayyads, proclaimed caliph at Damascus by the Kalb or Yemen faction in June 684, defeated the Kais (Qays) or northern Arab (Mudar) faction, who had declared for Abdullah, at Marj Rahit in the vicinity.

Marwan I (684–685).—Marwan immediately reconquered Egypt (Dec. 684) and installed as governor his second son Abd-ul-Aziz. Shortly after his return to Damascus he died (April 685) and was succeeded by his eldest son Abd-al-Malik.

Abd-al-Malik (685–705).—Meanwhile, in the provinces nominally subject to Abdullah ibn al-Zubayr also, the tribal factions were in open or latent hostility to one another, especially in the east, where the recently conquered populations revolted and drove the Arabs back upon Khurasan. In eastern Arabia, the province of Basra and Khuzistan, the Kharijites maintained a reign of terror and isolated Abdullah in the Hejaz. In Kufa the Shi'ites, defeated in their first engagement with Obaidallah, found a leader in Mukhtar, who organized the *mawali* ("clients"; *i.e.*, freed slaves and non-Arab freemen) and with the aid of the Yemenite Shi'ites crushed the Arab opposition and defeated and killed Obaidallah in Mesopotamia (Aug. 686).

Abdullah's brother Mus'ab Zubayr, governor of Basra, sent the troops of Basra under the Yemenite general Muhallab to regain control of Kufa, and the Shi'ites, after a desperate resistance, were put down with great slaughter.

For several years Abd-al-Malik was wholly occupied in Syria, first against the Mardaite tribes in Lebanon, who had received Byzantine support, and then against the Kais tribes in the north. His major task was to reunite the factions in a reformed Syrian army; when this was accomplished in 692 he had little difficulty in defeating Mus'ab's forces and reoccupying Iraq, wearied by the Kharijite ravages.

In the same year a force of 2,000 Syrians, commanded by al-Hajjaj ibn Yusuf, after investing Mecca for six months, killed Abdullah ibn al-Zubayr, sword in hand, in the final assault. The Kharijite bands still held out; those in Arabia were broken up in 694 by Muhallab, but the troops of Basra and Kufa showed little enthusiasm for a further campaign in Khuzistan. At length, in 696, Abd-al-Malik committed the government of Iraq to al-Hajjaj. Within three days of his arrival the tribesmen of Kufa, overawed by his personality and biting eloquence, were on the march, and those of Basra soon followed.

After dispersing the Kharijites Muhallab was appointed in 697 to the government of Khurasan under al-Hajjaj. He restored Arab control over the Oxus frontier, but the large contingent of his Yemenite fellow tribesmen who accompanied him introduced into the factional tensions of the province a new and powerful force, which was subsequently to play an important role in its history. The governor of Seistan likewise attempted to reimpose Arab control over Afghanistan (then called Zabulistan), but was caught at a disadvantage in the difficult passes by the king of Kabul and held to ransom. Al-Hajjaj dispatched the troops of Kufa and Basra in 699 to exact retribution, under a Yemenite chief, Ibn al-Ash'ath, but after their arrival in Seistan, resenting the peremptory commands of al-Hajjaj, they revolted and marched back on Iraq. The governor's weak forces were brushed aside and the rebels occupied first Basra and then Kufa. Al-Hajjaj, reinforced by Syrian troops, held his ground at Dair al Jamajim, outside Kufa, until the Kufan army broke, when he re-entered the city, but the rebellion was put down only after a violent battle at Maskin, on the Dujail (701). The defeated Iraqians fled to Seistan, pursued by the Syrians, and eventually surrendered to Muhallab's son at Herat. Ibn al-Ash'ath took refuge with the king of Kabul and on the demand of al-Hajjaj for his surrender either was killed or committed suicide.

Ibn al-Ash'ath's rebellion was primarily a bid by the tribesmen of Iraq to throw off the government of Syria. The proud tribal chiefs smarted under the iron control of the plebeian al-Hajjaj and his demand for instant obedience; the troops resented the higher rates of pay enjoyed by the Syrian troops and the transfer to Syria of the surplus revenue from the province; the cultivators, who had streamed into the cities during the disturbed years of the civil war and had become Muslims, were embittered by their forcible resettlement on the land and by al-Hajjaj's insistence on their payment of the full land tax; and the growing body of religious leaders, called "Koran reciters" (*kurra*), took offense both at the administrative measures of the governor and at his imposition of Othman's official recension of the Koran to the exclusion of their own provincial text. The failure of the rebellion marked an epoch in the evolution of the Arab empire. The Syrian hegemony was reimposed and maintained by the foundation in 702 of a new city on the Tigris for the Syrian troops, then permanently garrisoned in Iraq; lying halfway between Kufa and Basra, it was called Wasit (middle).

The Iraqi forces were never again called out on campaign en masse, and Kufa and Basra gradually became rival centres of sedentary pursuits.

After the reoccupation of Iraq Abd-al-Malik resumed the war with the Byzantine empire on the northern frontiers and in Africa. In Asia Minor annual raids gave the Syrian army continual military exercise, but no conquests were made; in Africa, on the other hand, the Egyptian troops, with the support of a fleet, recaptured Kairouan and, after defeating the Greek fleet, expelled the Greeks from Carthage. A new naval base was established in Tunis, Pantelleria was captured, and naval raiding was extended to Sicily and Sardinia.

Abd-al-Malik also reorganized the administration of the empire in several directions. More effective centralization was attained by a regular post service from Damascus to the provincial capitals for government dispatches and the appointment of postmasters to keep the caliph informed of events and economic conditions in their areas. The financial administration, which had hitherto remained in the hands of the former cadres of Greek and Persian officials, was partially reformed and ordered to be conducted in Arabic.

A new Islamic coinage, with gold dinars and silver dirhems, was instituted in 693 to replace the former Greek and Sasanian type coinage.

Al-Walid I (705–715).—Thanks to the organization and order established by Abd-al-Malik, the reign of his son al-Walid was, next only to that of Omar I, the most brilliant in the history of the caliphate. The Syrian army, commanded by the caliph's brother Maslama, captured Tyana in 708 and ranged with impunity over Asia Minor and Armenia, while the Byzantine empire was distracted by military revolutions. From its new headquarters at Kairouan the African army under Musa ibn Nusair (himself under the orders of the caliph's uncle Abdul-Aziz, still viceroy of Egypt) swept to the far west in 708, and his freedman Tarik was set up as governor in Tangier.

Three years later, after a trial raid on the Spanish coast, Tarik, in command of an army of 7,000 Berbers, and freedmen, crossed the strait to the mountain which still bears his name (Gibraltar-Jabal Tarik) and, reinforced by 5,000 Arabs, defeated the Gothic king Roderic on the Rio Barbate and overran the greater part of Spain. In 712 Musa himself took command and subdued the remaining fortresses, until from the coast of Galicia he was recalled to Damascus.

In the east also the Arab armies, under the general control of al-Hajjaj, gained spectacular successes. The Khurasanian garrisons, commanded by Qutaiba ibn Muslim, conquered Bukhara Samarkand, Khwarizm (modern Khiva) and Fergana and Tashkent beyond the Jaxartes (Syr-darya) from their Sogdian and Turkish princes. Meanwhile an army from Basra under Mohammed ibn al-Kasim, a cousin of al-Hajjaj, invaded Makran and Sind, took the port of Daibul, defeated the Indian king Dahar and after a prolonged siege captured Multan, with immense booty.

But it was not only in warfare that al-Walid's reign stands out. It was a time of intensive agricultural development, especially in Iraq under the direction of al-Hajjaj; new canals were constructed marshes drained, uncultivated lands brought under the plough Roads were cared for, wells dug for the convenience of travelers and pilgrims.

The Omayyad mosque in Damascus, converted by the caliph from the Church of St. John Baptist, and the Dome of the Rock in Jerusalem (begun by Abd-al-Malik and completed by al-Walid are among the architectural glories of Islam; and al-Walid also enlarged and beautified the Aqsa mosque in Jerusalem and the Prophet's mosque in Medina.

Suleiman (715–717).—Al-Walid was succeeded by his self-indulgent brother Suleiman, under whom the rhythm of conques slackened in the east, except for the capture of Jurjan. Suleiman was an implacable enemy of al-Hajjaj (who had died in 714) and of his adherents. Qutaiba had attempted to revolt but was killed by the hostile Arab factions; Mohammed ibn al-Kasim was recalled and put to death. Abdul-Aziz, the son and successor of Musa in Spain, was murdered, and the Christians of the Asturias rose in revolt against the Arabs.

Meanwhile the Byzantine war was energetically pressed. The Syrian reserves were called up, a fleet of 2,000 vessels manned and Constantinople was blockaded by land and sea (717). Leo III the Isaurian, who had in fact been proclaimed emperor by Maslama, conducted a brilliant defense of the city; and the besiegers after suffering from a severe winter, were compelled to make disastrous retreat through Anatolia, while the fleet was destroyed by storm.

This shattering disaster was the climax and turning point of th Arab conquests. Apart from the loss of prestige, the destructio of the Syrian army removed the main prop and stay of the Omayyad dynasty. At this critical moment, however, a precious respit was gained by Suleiman's fortunate and unexpected nominatio as his successor of a cousin, Omar, the son of Abdul-Aziz, whose simple and universally respected piety brought a brief relaxation of tensions.

Omar II (717–720).—The main object of Omar's administration was to reform the system of taxation and finance. In addition to the grievances of the troops of Iraq at the privileges enjoyed by the Syrians, the Muslim converts in every province resented the continuance of Omar I's regulation by which the Arab troops alone (with few exceptions) received stipends from the public revenue, besides paying preferential rates of taxation on their estates. Omar II's principle was that all Muslims should be placed on the same footing, without respect of nationality. Although the existence of established rights and the necessity of maintaining cultivation prevented the thoroughgoing application of this principle, he reversed the policies enforced by al-Hajjaj, allowed the immigration into the cities of converted *mawali* (who thereby became in principle eligible for stipends) and strictly forbade the imposition of poll tax upon converts, and other illegal imposts. These and other measures made serious inroads on the public revenue; but Omar went on uncompromisingly to dismiss non-Muslim employees from the public services and to issue severe regulations (known as the "ordinance of Omar") for the conduct and dress of Christians and Jews.

The effect was to throw the financial administration into disorder in several provinces, especially in Egypt, but also to encourage mass conversions to Islam; to the remonstrances of his governors the caliph replied, "God sent Mohammed to call men to the Faith, not to collect taxes."

Although in principle, again, Omar discouraged frontier raiding for the sake of booty, warfare was still carried on at both extremities of the empire. He had at one time thought of ordering the Arab armies to evacuate Spain, but sent a new governor, Samh, with instructions to distribute certain reserved lands among the troops, in 719; and both Samh and his predecessor Hurr made expeditions across the Pyrenees into southern Gaul.

Omar died in Feb. 720, leaving a reputation for piety and sanctity such as no other caliph of the Omayyad or Abbasid houses attained or even approached.

Yazid II (720–724).—His successor, by the nomination of Suleiman, was a son of Abd-al-Malik and a daughter of Yazid I, who thus united temporarily the two branches of the Omayyad family. He was at once faced with serious difficulties. The state of the public finances called for urgent stopgap measures which, as they inevitably reversed some of Omar's relaxations, caused discontent and some outbreaks of violence. But the most dangerous rising had no connection with this. The caliph was a partisan of al-Hajjaj, whose niece he had married; his namesake, Yazid ibn Muhallab, who had been prominent in the hunt against al-Hajjaj's associates, fled to Basra and stirred up a general revolt of the Yemenite faction in Iraq and southern Persia. Defeated by Maslama with a reformed Syrian army near Babylon, the leaders of the rebellion fell in battle or were pursued into India and there killed.

This violent outburst of the Yemenite faction set in train among the Arabs a sequence of factional struggles which grew in intensity and finally pulled down the Omayyad dynasty. For the moment Yazid had no alternative but to confide the government of Iraq to Kaisite officers, who revenged themselves upon the Yemenites; in Syria, on the other hand, he showed equal favour to both the Kais and the Kalb (Yemenite) tribes, and the latter even took a prominent part in suppressing the Iraqi rising. In the chronicles he is represented, perhaps unjustly, as a frivolous and pleasure-seeking prince.

Hisham (724–743).—Yazid II nominated as his successor his brother Hisham, the fourth of Abd-al-Malik's sons to mount the throne, with his own son Walid as second heir. Whatever Yazid may have been, Hisham was severe in morals and manners, earnest though with little imagination, just but heavy-handed. The Arab empire had now for a century been organized for expansion; Hisham was confronted with the problems of stabilization that arise when such an organism reaches or overreaches the limits of expansion. The military problem was met in part by the organization of frontier defenses; the internal problems were beyond his powers to solve. But his most remarkable achievement was to lay the foundations of the bureaucratic system which (after the turmoil of the civil war and destruction of his house) was taken over and developed under the Abbasid caliphs.

During the early years of his reign the Syrians resumed, with some success, the attack on Asia Minor, and the Spanish Arab forces penetrated into central France. But on the central Asian front the Arabs were already on the defensive against the attacks of Turkish forces from the steppes, aided by discontent among the subject population of Sogdiana. In 730 or 731 they were disastrously defeated near Samarkand; and simultaneously the Khazar Turks from the southern steppes of Russia destroyed the Arab armies in Azerbaijan.

In northern India also a revolt drove the Arabs back on Sind, where they founded the two strong garrison cities of al Mahfuza and al Mansurah. In 732 Charles Martel put an end to the advance into France at the battle of Poitiers (Tours), and in 740 Leo III destroyed the main Arab forces in Asia Minor at Akroinos (Afion Karahisar). The two latter defeats were decisive, but the more serious Turkish threats in the east and north were energetically countered. The Khazars were driven back beyond Derbent and forced to pay tribute; the central Asian Turks, defeated near Balkh in 737, evacuated Sogdiana, which was reoccupied by the Arabs under Nasr ibn Sayyar and pacified by a just redistribution of taxation. But both victories were gained by the Syrian troops, and the frontiers were guarded by Syrian garrisons at Derbent and Balkh.

Shortly afterward, when the African army was destroyed by a Berber revolt in Morocco (741), a large force of Syrians was sent to restore order; these too were cut to pieces on the river Sebou (742), and Kairouan was saved only by the dispatch of a fresh army from Egypt and Syria. The Arab empire had thus ended by becoming a Syrian empire, maintained by Syrian troops dispersed in garrisons from central Asia to Kairouan; and the strain which this involved was too great to be borne indefinitely, even after cutting the losses in Asia Minor.

For 14 years Hisham maintained the Yemenites in power in Iraq. The Kais chafed under the rule of his governor Khalid al-Kasri, but had their revenge when the Kaisite Yusuf replaced him in 738. For the moment, however, the factional spirit was kept within bounds; when Zaid, a grandson of Husain ibn Ali, headed a Shi'ite revolt at Kufa in 740 he found little support; Yusuf's Syrian troops easily suppressed the movement; and Zaid's son Yahya fled to Balkh, where he was killed several years later. For about two centuries, nevertheless, the Zaidis remained the most active of the Shi'ite parties, and the sect still predominates in the highlands of Yemen.

Al-Walid II (743–744).—Hisham had intended to nominate his son Mu'awiya to succeed him, setting aside the nomination of his nephew al-Walid, but Mu'awiya was killed in a hunting accident. Al-Walid's dominating passion became a hatred for Hisham and all that Hisham stood for; and after his accession he withdrew to his desert castle in Transjordan, neglecting the duties of his office. In order to pay for his new castle of Mshatta he sold Khalid al-Kasri to Yusuf, the governor of Iraq, whose cruel murder of his opponent roused Yemenite anger to fever pitch in every province. When the caliph proclaimed his two young slave-born sons as his heirs, the sons of al-Walid I revolted in Syria with Yemenite support, and one of them, Yazid, was proclaimed caliph in Damascus. A Yemenite force was sent to deal with al-Walid and killed him with little opposition.

Yazid III (744).—By this action, the moral authority of the Omayyad caliphate, already undermined by the frivolous character of al-Walid II, was all but destroyed. Dying less than six months after his proclamation, Yazid nominated his brother Suleiman to succeed. But Hisham's cousin, Marwan ibn Mohammed, who had, as governor of Azerbaijan, built up a powerful army of Mesopotamian Kaisites, marched into Syria in the name of Walid's sons, defeated the Yemenites and, since the young princes had in the meantime been put to death, was proclaimed caliph.

Marwan II (744–750).—Marwan's first task was to pacify

Syria, but when he transferred his capital to Harran in Mesopotamia the Syrians rebelled (745). Scarcely had he put down this revolt and assembled an army to march into Iraq when a fresh revolt broke out, led by Suleiman ibn Hisham. This time Marwan took decisive measures, demolished the walls of Homs, Damascus and other towns, and left Syria utterly crushed and defenseless (746), thus destroying the bulwark of Omayyad power.

While this struggle was in progress the other provinces of the empire were left to themselves. A Shi'ite rising in Kufa, led by a distant relative of Ali named Ibn Mu'awiya, had after a brief success been put down by the Omayyad governor, a son of Omar II (744). Ibn Mu'awiya retired to Isfahan and within a short time had become master of all southern Persia. Immediately afterward the Kharijites rose near Mosul; Ibn Omar and the rival governor appointed by Marwan, making common cause against them, were defeated, and the whole of Iraq joined in the revolt. Only in 747 was Marwan able to break their hold on the province. The remains of their army joined Ibn Mu'awiya in Fars, but in 748 both were dispersed by the new governor of Iraq, Yazid ibn Hubaira. In the same year another Kharijite band, which had occupied the holy cities in Arabia, was destroyed, and Marwan might well have felt satisfied that his authority was securely established in the central and most important provinces of the empire.

But the decisive challenge to Omayyad rule was to come from another quarter. In Khurasan, during the struggle in Syria, the governor Nasr ibn Sayyar had persuaded the Arab chiefs to accept him as amir until a caliph should be universally acknowledged. It was not long, however, before the Yemenites, naturally opposed to a Kaisite governor and inflamed by the murder of Khalid and by the general hostility of their faction toward Marwan, rose against Nasr. The Kais faction, split by internal divisions, gave him inadequate support; and, abandoning Merv to the Yemenites, he retired to Nishapur (746). In the next year, the Kais split having been healed, he marched again on Merv, after sending vain appeals to Marwan for reinforcements, but the struggle between the factions ended in a stalemate, which opened the way to the intervention of a third party.

About 40 years earlier a great-grandson of Mohammed's uncle Abbas had acquired control of a secret missionary organization, operated by and among the non-Arab *mawali* of Kufa, on behalf of a Shi'ite party known as the Hashimiya. This had grown out of the revolutionary party led by Mukhtar in the time of Abd-al-Malik, which recognized as its imam a son of Ali known by the name of Mohammed ibn al-Hanafiya. Under this Mohammed's son Abu Hashim the propaganda organization was strengthened, and on his death the majority of the Hashimiya acknowledged the Abbasid Mohammed ibn Ali as their imam. The tenets of its adherents varied from an ultra-Shi'ite gnosticism to a simple non-doctrinal hatred of the Omayyads, and the task of the missionaries was to preach the infidelity and injustice of the Omayyads and the coming of a saviour from the house of the Prophet, the mahdi (*q.v.*) who would "fill the earth with justice, as it is now filled with violence and iniquity."

Mohammed ibn Ali, realizing that no revolutionary hopes could be placed on Kufa, sent out missionaries to Khurasan, still populated thinly by Arabs but with a virile and warlike Iranian population. Though directed mainly to the non-Arabs, the propaganda gained over also the Arab Shi'ite in Khurasan, who came mostly from among the Yemenite tribes.

Ibrahim, who succeeded his father Mohammed as imam in 743, sent as his personal representative to Khurasan a freedman from Kufa named Abu Muslim. In the general confusion of the times Abu Muslim gained a wide success, especially among the Iranian landowners, converting, among others, Khalid ibn Barmak, the son of the hereditary high priest of an influential Buddhist sanctuary near Balkh (*see* BARMECIDES).

There were some difficulties with the leaders of the Arab Shi'ite, but they were eventually overcome, and by general agreement Abu Muslim unfurled in 747 the black banner which, in popular belief, was the symbol of the precursor of the mahdi. His Iranian partisans gathered round him at Sikadanj, near Merv, and Shi'ite risings broke out at Herat and other cities. For several months little more happened on either side, but when Nasr appeared to be on the point of reconciliation with the Yemenites Abu Muslim appealed to the Yemenite Shi'ite, who broke the truce and gave Abu Muslim the opportunity to enter Merv (748).

The union of the Abbasid partisans with the Yemenites of Merv compelled Nasr to flee again to Nishapur. This was a crucial error, for it split the anti-Abbasid forces in Khurasan, and left the burden of opposition to the Syrian garrison at Balkh, to overcome which the Abbasid party had to wage a severe campaign. On the orders of the imam Ibrahim, the command of the Abbasid army was entrusted to the Yemenite general Kahtaba; the struggle against Nasr and the belated reinforcements from Iraq thus took on the character of a conflict between Yemen and Kais, and Kahtaba's success roused an empire-wide revolt of the Yemenites. The Yemenite governor of Kufa revolted and, with the support moreover of the Syrian garrison, opened its gates to the Abbasid forces in Sept. 749. There, after some hesitations—probably resulting from the fact that, since the Abbasid leadership of the revolt had been kept secret, the Kufans saw in it a Shi'ite revolt on behalf of the house of Ali—the Khurasanian leaders, instructed by Abu Muslim, forced the issue. Ibrahim had recently died in prison at Harran, but his brother Abu'l-Abbas, with other members of the family, had arrived in Kufa; and on Nov. 28, 749, Abu'l-Abbas, declaring himself to be al-*Saffah,* the precursor of the mahdi, was proclaimed caliph.

Marwan had still to be reckoned with, but at this point a wave of enthusiasm, nourished by popular predictions and aspirations for the reign of the mahdi, turned the scale. The Khurasanian army had at last furnished the instrument of power which could match the hitherto invincible Marwanid army; the moment of destiny was come, and from all sides volunteers flocked to join the Khurasanians. The final defeat of Marwan's depleted forces on the Great Zab (Jan. 750) was due largely to the conviction that the Shi'ite movement (as it was still believed to be) owed its success to divine agency and that there was no longer any hope of stemming the tide.

Marwan retreated to Harran, thence to Syria, pursued by the Khurasanian forces. When the citizens of Damascus opened their gates he fled to Egypt and was killed at Busir in Aug. 750. The members of the Omayyad house were hunted down and put to death; only a few escaped, among them a grandson of Hisham, Abd-al-Rahman, who fled to Africa and thence to Spain, where he founded a few years later the Omayyad dynasty of Cordoba (*see* SPAIN: *History*).

THE ABBASID CALIPHS

The transfer of the caliphate from the Omayyad to the Abbasid house meant at first no more than the transference of the capital to Iraq and the substitution of a standing army based on Khurasan for one based on Mesopotamia. The Syrian hegemony had already been broken by Marwan, and the general lines of administration laid down by Hisham. The Khurasanian army was still predominantly Arab in composition; the armies of Egypt and Africa were still composed of tribal units, and those of Syria and Mesopotamia were soon reconstituted for frontier warfare against the Byzantines. In the latter provinces the tribal feuds which had destroyed the Omayyad caliphate still flared up from time to time; in the more professional Khurasanian forces, on the other hand, they were rapidly extinguished.

The fact, however, that the power of the dynasty rested upon the two provinces, Iraq and Khurasan, in which the mingling o Arab and Persian had gone furthest and continued with increasing momentum, favoured the development of a common Muslim civilization in which the Arab no longer predominated. While the Arab religion and Arab language maintained themselves and spread ove the whole empire (the revival of Persian as a cultural languag began only in the 10th century), in the court and the administration, on the other hand, the traditions of the Persian Sassanian empire set the tone. In keeping with this tendency, the Abbasi caliphs devoted much attention to strengthening and emphasizin the religious basis of their rule, insisting, particularly against th Shi'ite opposition, upon the claim of the house of Abbas to be th legitimate heirs of Mohammed. Their patronage of religion, while marked by a demand for conformism and persecution of heresy, created also favourable conditions for the expansion of religious learning, out of which the new Muslim Arabic literary culture developed.

At the same time, the growth of luxury and the cessation of wars of conquest gave an impulse to industry and commerce, both within the empire and overseas.

In these conditions the Abbasid capital at Baghdad rapidly became the centre of a brilliant intellectual and material civilization which spread over the entire Muslim world and reached its height in the 10th century, when the Abbasid caliphate itself was already far in decline.

Abu'l-Abbas (750–754).—Since the Abbasids had seized the caliphate in a wave of revolutionary enthusiasm that temporarily united all the enemies of the Omayyads, their first task was to convert a local and precarious act of usurpation into a valid, because universally recognized, claim. The revolutionary unrest continued for many years and found expression in risings and rebellions on behalf of rival parties and groups, not only in Syria and Mesopotamia, Libya and Oman, but also among the Arabs in Khurasan. The reign of Abu'l-Abbas was filled largely with campaigns against a succession of rebels; and the governorships of the provinces were given almost exclusively to the caliph's uncles and brothers, except for Khurasan, which remained under Abu Muslim.

Al-Mansur (754–775).—On the death of Abu'l-Abbas the succession of his brother Abu Ja'far—who took the "mahdist" title of al-Mansur ("the divinely aided")—was challenged by his uncle Abdullah, the governor of Syria. In order to defeat Abdullah's argely Syro-Mesopotamian army, al-Mansur was forced to call n the assistance of Abu Muslim. The continued influence of Abu Muslim over the Khurasanian troops (combined, perhaps, with the discontent of the Arabs in Khurasan with Abu Muslim's government and Abu Muslim's own sense of importance) held such dangerous possibilities that al-Mansur summoned him to the court before he returned to Khurasan and had him murdered. The result was a violent reaction of the original Iranian converts of Abu Muslim in Khurasan against the Abbasids; under the name of Muslimiya, venerating Abu Muslim as the true imam, they broke out in a succession of revolts.

Though these were put down without great difficulty by the ocal troops, the existence of this discontent among the Iranians was too much for the loyalty even of some of the Arab governors, and Khurasan was only restored to order when al-Mansur's eldest on, significantly entitled al-Mahdi, was appointed to its government in 759. In 761, a considerable body of Arab Khurasanian evies was transferred to Kairouan, in order to restore Abbasid uthority in Africa, shaken by Berber and Kharijite revolts; but n Spain all al-Mansur's efforts to dislodge the Omayyads by supporting local rivals came to nothing.

In contrast to the Muslimiya, the ultra-Shi'ite Hashimiya of Kufa still remained loyal to the Abbasids, but their importunities nd payment to him of divine honours became so embarrassing hat al-Mansur took the opportunity of a demonstration in 758 o root them out and thus give public proof of the orthodoxy of he Abbasid house. This was the more urgently necessary since he true Shi'ites, hitherto quiescent for lack of an active leader, ad now found one in Mohammed, a grandson of Hasan. Al-Mansur, well aware of the danger of a widespread Shi'ite rising, ook stringent measures against the Hasanids in the holy cities, ut Mohammed eluded him and in 762 seized Medina and Mecca. A Khurasanian force, commanded by the heir presumptive Isa ibn Musa, easily defeated and killed Mohammed, but in the meantime is brother Ibrahim had occupied Basra, Khuzistan and Fars. l-Mansur himself, with a small force, held his ground at Kufa ntil the Khurasanians returned from Arabia and in a severe enagement at Bakhamra, 48 mi. from Kufa, killed Ibrahim.

Thanks to the disunity of its opponents and the fighting qualities f the Khurasanians, the Abbasid dynasty was now established. l-Mansur signalized the event by founding a new capital, comleted in 766, on the Tigris at the old market town of Baghdad (*q.v.;* officially renamed Medinat al Salam, "City of Peace"), close to the former Persian capital at Ctesiphon, which served as a quarry. Built in the first place as a fortified garrison city, it rapidly grew into the great metropolis which, in spite of riot, flood and siege, remained the centre of Islam until the end of the Abbasid caliphate. At the same time he took in hand the reorganization of the administration.

Under the general control of the *wazir* (vizier), an office introduced by him, a number of *diwans* (divans) or ministries were set up for the chancery, finance, army, posts, etc., staffed largely by Khurasanians, Persians and other *mawali* (although this term was now beginning to fall out of use). The most notable of his ministers was Khalid ibn Barmak, for a time minister of finance.

Al-Mahdi (775–785).—Isa ibn Musa had been nominated by Abu'l-Abbas as successor of al-Mansur and had taken the leading part in suppressing the Alid revolt. But al-Mansur, determined to secure the succession for his own son Mohammed al-Mahdi, gained the army's interest on his behalf and persuaded Isa to renounce his immediate right of succession; and on al-Mansur's death a dispute was averted by the prompt action of the vizier in installing and obtaining the oath of allegiance to al-Mahdi.

The year after his accession was marked by a revolt of the Muslimiya in Transoxiana under al-Mukanna' (the veiled prophet). From his stronghold at Sanam, near Kish, he attacked the Arab governments at Bukhara and Samarkand; and during the eight years which elapsed before the rebellion was crushed there were several risings of the Iranians in other parts of Khurasan. The caliph devoted his interest largely to the war with Byzantium which, after some inconclusive raiding during the reign of al-Mansur, had taken an unfavourable turn when the Greek general Michael captured Mar'ash. In 779 al-Mahdi led a powerful army of Khurasanians, Syrians and Mesopotamians into Cilicia; and an expedition commanded nominally by his second son Harun, under the guardianship of his tutor, the Barmecide Yahya ibn Khalid, captured the fortress of Semalouos in the interior (780). In the following year the Arabs fell back before a fresh Greek offensive. Harun was again dispatched with orders to march on Constantinople and, after defeating the Greek commander at Nicomedia, forced the empress Irene to conclude a truce for three years, on payment of an annual tribute of 70,000 or 90,000 dinars (782). This success gained for Harun the nomination as second heir after his elder brother Musa al-Hadi and the title of al-Rashid. Three years later al-Mahdi set out for Khurasan, on Musa's refusal to obey his order to return to Baghdad, but died suddenly on the way at the age of 43.

During his reign the zeal of the Abbasids for religious orthodoxy was signalized by a vigorous persecution of freethinkers and crypto-Manichaeans (*zindiks*). The administrative services were expanded and improved, and the taxation in Iraq was reformed. With increasing prosperity there was a marked development of intellectual and cultural pursuits, which laid the foundations of the brilliant Islamic civilization of the next century.

Al-Hadi (785–786).—Shortly after al-Hadi's succession a fresh Alid revolt broke out in Medina. Though it was put down with little difficulty, two Alids, brothers of the earlier rebel Mohammed, escaped; one, Yahya, made his way to Dailam, in the Elburz range in northern Persia, the other, Idris, to Morocco, and both founded independent kingdoms in due course. Al-Hadi also intensified the persecution of *zindiks*. By his efforts to set aside Harun's nomination as his successor he alienated his mother Khaizuran and the Barmecide Yahya, but before he could take definite action he fell sick and died, in circumstances which created some suspicion.

Al-Rashid (786–809).—Harun succeeded his brother without opposition and appointed his former tutor Yahya ibn Khalid as vizier with full powers. Under the prudent government of Yahya and his son Fadl, the Abbasid empire reached its highest degree of power and prosperity; the armies and frontiers were well manned and controlled, the public treasury, in spite of the magnificence of the court, carefully safeguarded. Yet even at its height there was seldom peace throughout the empire. An Omayyad revolt and tribal indiscipline in Egypt, a protracted outbreak of the Arab factions in Syria, a succession of Kharijite insurrections in Mesopotamia, and the Dailamite following of the Alid Yahya, all gave evidence of the strains and stresses which accompanied the readjustment of populations and gradual regrouping of social and economic forces among the widely diverse peoples and diversified terrains of the vast empire, and which no administration, however skilful, could do much to alleviate.

A further cause of weakness was the growth of rivalries and jealousies at court. The power of the Barmecide Yahya and of his sons Fadl and Ja'far, the caliph's boon companion, raised up a host of enemies, among whom the chamberlain Fadl ibn Rabi' was the most active. Through his influence the important government of Khurasan was given in 796 to a certain Ali ibn Isa ibn Mahan, whose violence and extortions created general discontent and a widespread revolt of the Iranian schismatics in the northern provinces. Externally, however, the power of the dynasty was vindicated against the Greeks in a series of campaigns.

Harun, who had transferred his residence to Rakka, on the Euphrates, led an army in person to Ephesus and Ancyra in 797 and reimposed terms of truce on Irene; and when her successor Nicephorus broke the treaty in 803 he again marched to Heraclea. On a later campaign in 805 he occupied Heraclea and Tyana and increased the tribute by a personal impost on the imperial house. Cyprus was overrun in 807. An interchange of embassies with Charlemagne, motivated probably by common enmity to the Omayyads of Spain and the Greeks, resulted in increased facilities for Christian pilgrims to Jerusalem. In 799, on the other hand, the Khazars from the Volga broke through into Armenia, causing severe losses; and at the end of Harun's reign the tide of war had begun to turn in Anatolia.

In 803 the rivals of the Barmecides succeeded in winning the caliph's favour. Without warning Ja'far was seized and beheaded, Yahya and Fadl imprisoned and their property confiscated. Whatever the reasons for their overthrow may have been, the suddenness of this action could only intensify the internal strains; and when, two years later, the caliph confirmed Ali ibn Isa in his government of Khurasan, a serious revolt broke out in Transoxiana under Rafi' ibn Laith, a grandson of Nasr ibn Sayyar (806). In spite of the efforts of the Khurasanian guard the rebels held out, and in 808 Harun himself marched from Baghdad with the remainder of the Abbasid troops, but died on the way at Tus, in March 809.

In 802, during a pilgrimage to Mecca, Harun had formally divided the territories of the empire between his heirs and assigned the government of Khurasan outright to his second heir, Abdullah, surnamed al-Ma'mun. On his last journey to the east, moreover, he willed that the whole of the Khurasanian guard should fall to the lot of al-Ma'mun and took an oath from the troops to that effect.

Al-Amin (809–813).—On Harun's death, however, the troops returned to Baghdad, either of their own accord or at the instigation of Fadl ibn Rabi'. Relations between the new caliph al-Amin and his brother al-Ma'mun were thus strained from the beginning and causes of dispute rapidly multiplied. When al-Ma'mun gained a strong following in Khurasan and enrolled a new Khurasanian army under the Iranian general Tahir, open war followed (811). Al-Amin's old Khurasanian guard was repeatedly worsted, and he was finally besieged in Baghdad. For nearly two years the city put up a desperate resistance, but at length the caliph's troops gave way, and he himself was captured and killed while attempting to escape, leaving a reputation of frivolity and incompetence as a ruler.

Al-Ma'mun (813–833).—For several years al-Ma'mun continued to reside at Merv, under the influence of his Persian vizier Fadl ibn Sahl, whose brother Hasan was appointed governor of Iraq, while the western provinces of the empire were assigned to Tahir. But the civil war had weakened the authority of the caliphate, and most of Syria and Egypt remained for more than a decade beyond its control. In Iraq a Shi'ite movement, beginning in Kufa, gained the support of the Bedouins and for a year (814–815) held all southern Iraq and the holy cities in Arabia. Scarcely had the Khurasanian garrison of Baghdad put down this rising than it in turn rebelled against the Persian government of Hasan.

To add to these dissatisfactions there came in 817 orders from the caliph designating as his successor the Alid imam Ali al-Rida. Al-Ma'mun's reasons for this step are not clear: the common assumption that it was intended to give satisfaction to the supposed Shi'ite sympathies of the Persians has no substantial foundation; and it is indeed more probable that it was the Shi'ites of Iraq whom he had in view. But the population of Baghdad, always hostile to Shi'ism, rose almost to a man under the leadership of the Abbasid family and, joined by the Khurasanian garrison, proclaimed Ibrahim, a son of al-Mahdi, caliph. Ibrahim, however, proved incapable of maintaining order either in the city or in the provinces and his supporters rapidly dwindled. On receiving news of the revolt al-Ma'mun at last realized the facts of the situation and set out himself for Baghdad. The journey occupied a year and a half during its course Fadl ibn Sahl was murdered and Ali al-Rida died where his shrine now stands at Meshed. His Khurasanians reoccupied Baghdad against little opposition in 819, and a few months later al-Ma'mun proclaimed a general amnesty and made his ceremonial entry into the city.

During the remainder of his reign al-Ma'mun showed himself to be possessed of a strong practical sense and independence of judgment. He gave his patronage to science and literature, founding at Baghdad a kind of academy where Greek works on mathematics, astronomy, medicine and philosophy were translated; and he extended official patronage to the rationalizing Mu'tazilite school of theology. At the same time the restoration of order and imperial control in the outer provinces was vigorously pursued Syria was easily regained; but the suppression of the disorders in Egypt required several expeditions, the last (832) led by the caliph in person after a particularly dangerous rising of both Arabs and Copts. In Media a local Arab dynasty came to terms with the caliph only in 829. The most serious military problem was the re volt of the Persian schismatics (*khurramis*) under Babak in Azer baijan, which was not put down until after al-Ma'mun's death The repercussions of this revolt on Khurasan compelled the caliph unwillingly to confide the government of Khurasan in 821 to hi general Tahir, combining his governorship with the office of mili tary commander at Baghdad. In the following year Tahir dropped al-Ma'mun's name from the public prayers and died immediatel after. But al-Ma'mun, aware that the power of the Abbasid cal iphate now rested on a close alliance with Khurasan, could no afford to risk a breach with the Tahirids. Tahir's son Talha wa appointed to his father's posts both in Baghdad and Khurasan and was succeeded on his death in 828 by another son, Abdullah. Th Tahirids thus became to all intents independent, though tributary in Khurasan, and their alliance with the caliphate continued unt the extinction of the dynasty toward the end of the century.

In the last years of his reign al-Ma'mun reopened hostilitie with Byzantium. Expeditions in 830, 831 and 832 under his ow command achieved such successes that the emperor Theophilu sued for peace, which the caliph haughtily refused to grant. I June 833, a further expedition commanded by his son al-Abba occupied Tyana, but shortly afterward al-Ma'mun caught a fever of which he died in August. He was buried in Tarsus.

Al-Mu'tasim (833–842).—Although al-Abbas was proclaime caliph by the troops, he quickly yielded to the claim of al Ma'mun's brother Abu Ishak, surnamed al-Mu'tasim. The firs task was to deal with the rebel Babak, who was now co-operatin with the Greeks. A formidable force, commanded by the Sogdia general Afshin, took the field in 835 and finally broke the revo in 837. In the same year Theophilus attacked the Muslim frontie and laid waste the town of Zibatra, with a ferocity which rouse a wave of indignation. Assembling the most powerful army eve conducted by a caliph, al-Mu'tasim penetrated into Asia Mino defeated Theophilus and captured and destroyed the two stron fortresses of Ancyra and Amorium (Aug. 838).

To al-Mu'tasim, who had a passion for the army, was due th introduction of a new element in the Muslim forces. Al-Ma'mun Khurasanian guard already differed from its predecessor i composition by the enrollment of troops from the inner dis tricts of Transoxiana and the Turkish frontier regions. To thes al-Mu'tasim added large numbers of Turkish slaves, acquired b capture or purchase, from central Asia, who were formed in regiments of light horse, equipped with sword, lance and bow. The officers of the new Turkish guard rapidly distinguished themselves in war and rose to influential positions. Since the excesses of these troops created a dangerous state of tension in Baghdad, al-Mu'tasim in 835 moved his residence to a new garrison city at Samarra, about 70 mi. N. of Baghdad. This policy, however, by putting the caliph almost wholly at the mercy of his guards, was to have serious consequences for his successors.

Al-Wathik (842–847).—Under his son Harun, entitled al-Wathik, the increasing power of the Turks was shown by the appointment of two generals, Ashinas and Itakh respectively, to the titular but lucrative government of the eastern and western provinces. He intensified state support of the Mu'tazilite doctrine to the point of persecution of the orthodox, thereby arousing violent discontent in Baghdad. But the only event of importance in his reign was a combined rising of Arab tribes in Nejd and Hejaz, which was put down by the imperial guard under the Turkish general Bogha only with much difficulty, after a campaign lasting three years (844–847).

This revolt marks the definitive alienation of the Arab tribes from the caliphate and paved the way for the Shi'ite and Bedouin risings in the next generation.

Al-Mutawakkil (847–861).—Harun was succeeded by his brother Ja'far, entitled al-Mutawakkil, whose whole reign was occupied by the effort to regain control over the Turks. In order to conciliate the orthodox Muslims, he abjured the Mu'tazilite doctrine, persecuted not only the Mu'tazilites but also the Shi'ites and imposed severe restrictions on Jews and Christians, compelling them to wear distinctive dress. In 858 he attempted to remove the capital to Damascus, but immediately returned to Samarra and there built a new residence farther to the north. The financial stability of the Abbasid state, already burdened by the upkeep of the vast military establishments of Samarra and threatened by revolts in Azerbaijan, in Armenia (Bogha had to penetrate to Tiflis before the rebels were subdued), in Syria and n the east, was undermined by this new extravagance. The fact hat the imperial treasury was in difficulties probably contributed argely to the disorders of the next two decades.

The Byzantine war, which had ceased for a time under al-Wathik, was renewed in 851 by the frontier troops. A Greek fleet burned Damietta in 853, but in 856 the Muslim armies were reinforced by the immigration of the heterodox Paulicians, following n a violent persecution of the sect by the orthodox authorities. The annual raids by both sides were attended with alternate successes, the chief events being the restoration of Ancyra by the Greeks in 859 and the surrender of Lu'lu'a to the Muslims in 60, followed by a truce and exchange of prisoners.

Early in his reign al-Mutawakkil had divided the empire between his three sons, nominating them as his successors in order f seniority. The eldest, Mohammed, called al-Muntasir, gradually became estranged from his father and finally conspired with he commanders of the Turkish guard to murder him in Dec. 861.

Al-Muntasir, al-Musta'in, al-Mu'tazz and al-Muhtadi.—The murder of the caliph played straight into the hands of the Turkish generals, who became the real rulers and already began o form dynasties, handing on their power to their sons and sons-n-law. The disorder in the central government was extreme. When al-Muntasir died six months after his father's assassination, the generals selected as his successor a cousin, who took the tle of al-Musta'in (862–866). His attempt to check the Turks with the aid of the citizens and Tahirid forces in Baghdad led to siege of the city (865) and his forced abdication and murder. l-Mu'tazz (866–869), the brother of al-Muntasir, unable to find he money to pay for the troops, was seized and starved to death. l-Muhtadi (869–870), a son of al-Wathik, and a man of firm nd upright character, was chosen to succeed, but became entangled n the rivalries which had broken out between the Turkish generals nd their troops, and was similarly put to death.

Such conditions of anarchy in the capital made it impossible maintain ordered government in the provinces. Although the aliphs continued to be recognized from Tunisia to Turkistan, local chiefs and Turkish generals had gained the substance of independence over most of their nominal dominions. In the east a popular movement in Seistan led by the Saffar brothers broke the power of the Tahirids in Khurasan (*see* SAFFARIDS) coupled with a similar movement in the northern provinces of Persia under an Alid leader, Hasan ibn Zaid. In Transoxiana the Samanids (*q.v.*), the lieutenants of the Tahirids, assumed the responsibility of government and concentrated all political authority in their own hands. In Mesopotamia a powerful revolt of the Khawarij broke out, and in Arabia the tribesmen were ready to support any Shi'ite rising. In Egypt, the deputy governor Ahmad ibn Tulun, appointed in 868, set his hand to the task of restoring the prosperity of the ruined countryside and of creating a powerful Egyptian principality (*see* EGYPT: *History: Medieval Period*). On the Greek frontier, after a bold raid on Amisus (Samsun) in 863, the Muslim garrisons were severely defeated and forced on the defensive. Finally, in 870, a rising of the Negro slaves in southern Iraq, under an Alid leader, had begun to assume serious dimensions.

Al-Mu'tamid (870–892).—This desperate situation was slowly retrieved during the reign of al-Mutawakkil's son Ahmad, entitled al-Mu'tamid. The real ruler was, however, his brother Abu Ahmad, known as al-Muwaffak, who had already distinguished himself as a soldier and who, aided by the exhaustion of the rival Turkish families, regained control over the guard. With immense effort he restored order and discipline in Iraq, defeated a Saffarid attempt to march on Baghdad (876) and finally, after many reverses, overcame the Negro rebels in the marshes above Basra (883). The dangerous isolation of the caliphs at Samarra was ended in 883, by removing the seat of government back to Baghdad.

In the outer provinces, al-Muwaffak had to rely on diplomacy. Against Ibn Tulun he was practically powerless; Ibn Tulun's son and successor Khumaruya not only added Syria and Mesopotamia to his dominions, but forced a formal investiture from the caliph. In Persia, the system of private wars and seizure of provinces had to be tolerated, and in Arabia the Shi'ites firmly established themselves in Yemen.

Al-Mu'tadid (892–902).—The fruits of al-Muwaffak's labours were, however, reaped by his son Ahmad, entitled al-Mu'tadid, who began by forcing al-Mu'tamid to disinherit his son. By a wise choice of officers he secured unexampled harmony in the administration, which was reorganized and the financial system reformed. The Tulunids were conciliated by the caliph's marriage with Khumaruya's daughter; the Saffarids were left in peace until they challenged the Samanids and were utterly defeated (900); the Mesopotamian Arabs and Kurds were subdued. But the last years of his reign were darkened by a sinister shadow. During the long period of disorders, the missionaries of the extreme Shi'ites or Ismailis had gained a ready following among the oppressed cultivators of lower Iraq and the Bedouin tribes of the Euphrates and northeastern Arabia.

In 899 the long-prepared revolt broke out. The leader of the Karmatians (*q.v.*) or Karmatis, as they were called, Abu Sa'id al-Jannabi, defeated the imperial troops, and withdrew to al-Hasa, where he founded a Karmatian state.

Al-Muktafi (902–908).—Shortly after the accession of al-Mu'tadid's son Ali, entitled al-Muktafi, the Bedouin tribes on the Syrian border rose under Karmatian leaders and, though defeated in their assault on Damascus, swept over all northern Syria. An imperial army defeated them in 904 and, taking advantage of the weakening of the Tulunid house, reoccupied Egypt in 905. The Bedouins of Mesopotamia were kept in order by the chiefs of the Hamdanid family who, though Shi'ite in sympathies, now laid the foundations of their future fortunes by alliance with the caliphate. A second Karmatian rising on the Syrian border, followed by the massacre of a pilgrim caravan in lower Iraq, led to fresh military operations against them, but the headquarters of the sect in northeastern Arabia remained inviolate.

In the last year of al-Muktafi's reign the Arab princes of Tunisia were driven out by Berber forces organized by Ismaili missionaries in the name of the rival caliphate of the Fatimids (*q.v.*).

Al-Muktadir (908–932).—The restoration of imperial control over the western provinces under the three previous caliphs was a tour de force, which had imposed an immense strain on the resources of the caliphate. The forces of disruption had only been temporarily checked by a succession of resolute and vigorous rulers. The accession of al-Muktafi's younger brother Ja'far, a boy of 13, who was saluted with the ironical title of al-Muktadir (the powerful through God), allowed the resumption of the internal rivalries and seizures of authority which preluded the rapid and fatal decline of the Abbasid house. Al-Muktadir himself was twice deposed and reinstated, and met his death, sword in hand, in combat outside Baghdad.

The mainstay of the caliphate for most of his reign was the general Mu'nis, who defeated the first Fatimid attempts to seize Egypt (915 and 921) and rectified the deteriorating situation on the Byzantine frontier. But against the Karmatians of Arabia the imperial arms were unavailing. After sacking Basra in 923 they created turmoil and dismay in Iraq for many years: Kufa suffered the same fate in 925 and Baghdad was itself threatened. In 929 a band of Karmatians raided Mecca and carried off the sacred Black Stone to their capital, where it remained for about 20 years.

Al-Kahir, al-Radi, al-Muttaki and al-Mustakfi.—The short reign of al-Muktadir's depraved brother Mohammed al-Kahir (932–934) was notable only for the execution of the loyal Mu'nis. On his deposition the troops elected al-Muktadir's son Ahmad al-Radi (934–940), and al-Kahir was blinded. A pious and well-meaning man, al-Radi lacked the force of character needed for the times. He was succeeded on his death by his brother Ibrahim al-Muttaki (940–944), whose attempt to use the Hamdanid princes of Mosul against the Turks led to his deposition and blinding in turn, with the complicity of his cousin Abdullah, son of al-Muktafi, who succeeded him with the title of al-Mustakfi (944–946).

During this troubled period the authority of the caliphate scarcely extended outside Baghdad, and its external history consists of little more than the successive attempts of powerful generals to take possession of the city. In 936 al-Radi conferred on the victor of the moment, Ibn Ra'ik, the title of amir al-umara or generalissimo (*see* AMIR), and henceforth the administration was in his hands and those of his successors. Egypt and Damascus were held by an independent Turkish governor, the Ikhshid; northern Syria and Mesopotamia by the Arab Hamdanids; Armenia and Azerbaijan by the Transoxanian Sajids. Meanwhile the mountaineers of Dailam, unified under the banner of Shi'ism, had begun from about 920 to expand over western Persia. Led by three brothers of the house of Buya or Buwayh, they constituted between 933 and 937 a powerful group of allied principalities from the Caspian sea to the Persian gulf (*see* PERSIAN HISTORY). It could only be a matter of time before they crushed the petty rival amirates of Iraq; and after some preliminary probing the Buyid Ahmad marched on Baghdad and entered it without a blow in Jan. 946. The caliph al-Mustakfi conferred on him the title of Mu'izz al-Dawla, but was immediately seized and blinded. For a moment the Shi'ite conqueror thought of abolishing the Abbasid caliphate altogether, but for reasons of state reversed his decision and appointed another of al-Muktadir's sons, al-Fadl, to the vacant office, with the title of al-Muti'.

Al-Muti', al-Ta'i' and al-Kadir.—During the century of Buyid rule Baghdad was a provincial capital; and after an attempt by Ahmad's son Bakhtiyar to make himself independent there (977) it was generally held by the ruling prince of Fars. The administration which the Buyids inherited was already politically and financially bankrupt and few of them showed any administrative ability; rivalries between the younger princes and feuds between their Dailamite infantry and Turkish cavalry troops aggravated the general disorder. In all this the caliphs had little part or say, and their long and generally uneventful tenures tell their own tale. They no longer had viziers, but merely secretaries, and received a modest pension for their household needs. Al-Muti' (946–974) was compelled to abdicate by reason of paralysis in favour of his son Abd-al-Karim al-Ta'i' (974–991), who was in turn deposed by a Buyid amir wishing to loot his palace and replaced by his cousin Ahmad al-Kadir (991–1031). But they still exerted a certain influence upon the Sunnis bureaucracy, and as the Buyid power weakened through internal disputes and the general disorganization, the growing revulsion of feeling against Shi'ism invested them with a symbolic significance. Al-Kadir was able to utilize this in order to reassert in some degree the prerogatives of the caliphate, the more so that his reign coincided with the career of the great Turkish conqueror Mahmud (*q.v.*) of Ghazn in Afghanistan, who acknowledged his authority and threatened the Buyid dominions from the east.

Al-Ka'im (1031–75).—In the reign of his son Abdullah, entitled al-Ka'im, the Sunnis revival came to a head and the caliphate was liberated from Shi'ite control. The agents of this revolution were the Seljuk Turks (*see* SELJUKS), whose chief, Togrul Beg defeated Mahmud's successor in 1040 and established himself in Khurasan. With the aid of the Sunnis Persian bureaucracy Togrul Beg built up a powerful administration which enabled him to control the nomadic forces under his command and make an orderly advance to the west. Summoned by the caliph to put an end to the anarchy of the later Buyid regime, Togrul Beg marched on Iraq, entered Baghdad in Dec. 1055 and was formally invested with the title of sultan. In 1058, however, during a revolt of the Seljuk tribes, a Dailamite officer occupied Baghdad in the name of the Fatimid caliph of Egypt and forced al-Ka'im to swear allegiance to his rival, who was quickly driven out again by Togrul Beg, under whose nephew Alp Arslan (1063–72) and the vizier Nizam-al-Mulk the administration was reformed and order restored. As symbol of the restoration of his authority the caliph now had his own vizier again, but his sphere of activity remained confined to religious matters.

Al-Muktadi (1075–94).—The reign of al-Ka'im's grandson Abdullah, entitled al-Muktadi, coincided with that of Al Arslan's son Malik Shah (1072–92), under whom the Selju empire reached its zenith. The Abbasid caliphate was now again acknowledged throughout Muslim Asia, although the caliph had in reality little more power than his predecessors. In spite o al-Muktadi's marriage with a daughter of the sultan, the first rift began to disturb the harmony of their relations, but Malik Sha died before an open breach ensued. His last years were shadowe by the menace of a new Ismaili organization, the Assassins (*q.v.* who had established themselves in Dailam and had begun to creat a reign of terror in northern Persia.

Al-Mustazhir (1094–1118).—Al-Muktadi's son Ahmad, entitled al-Mustazhir, succeeded during a conflict between Mali Shah's sons, in which he was a passive onlooker. When order was restored under the strong hand of Sultan Mohammed (1105–18 and appeals for help against the crusaders came from the Muslims of Syria, the caliph showed little concern. He left, however, great reputation for uprightness and fair-dealing.

Al-Mustarshid (1118–35) and al-Rashid (1135–36).—Afte Sultan Mohammed's death the Seljuk power in Iraq began to b challenged with increasing boldness by provincial governors an the Arabs of lower Iraq. Since the task of defending Baghda against their attacks often fell to the caliph, he was enabled to form again an army of his own, to intervene in the conflicts betwee local rivals and even, on occasion, to take the offensive. A Mustazhir's son al-Fadl, who succeeded his father as a Mustarshid, after several military exploits of this kind, ended h organizing a coalition against Sultan Mas'ud (1133–52) an marched out against him, only to be deserted by his troops, captured and subsequently killed by assassins. His allies recognize his son Mansur as his successor, with the title of al-Rashid, bu deserted him on the sultan's approach to Baghdad. After a brie resistance, al-Rashid fled to Azerbaijan and was formally depose

Al-Muktafi (1136–60).—Al-Mustarshid's brother Mohamme was installed in his place, with the title of al-Muktafi. It was th caliph who, after the death of Sultan Mas'ud, succeeded at last regaining the independence of the caliphate. The Seljuk arm was defeated by the caliph's forces in 1155, and the sultan's a tempt to capture Baghdad two years later failed ignominiousl By the end of his reign, the temporal power of the caliph extende over most of Iraq to the borders of Mosul.

Al-Mustanjid (1160–70) and al-Mustadi (1170–80).—A Muktafi's son Yusuf al-Mustanjid and grandson al-Hasan a

Mustadi successfully maintained their control of Iraq against the Seljuks and the Arabs, but their government suffered from internal ivalries, in the course of which the former was assassinated. Alhough the suppression of the Fatimid caliphate in Egypt by Saladin (*q.v.*) in 1171 and the substitution of the Abbasid alegiance seemed to restore the position of the Abbasid caliphs as he only recognized caliphs in Islam outside northwest Africa nd Spain, their reassertion of temporal power in Iraq had rather he contrary effect of depressing them to the status of rulers of ne among many petty kingdoms.

Al-Nasir (1180–1225).—Al-Mustadi's son Ahmad, who on suceeding his father took the title of al-Nasir, made it his constant im and ambition to emerge from this equivocal position and to evive the universal empire of the early caliphs. Through an lliance with the shahs of Khwarizm (then the rulers of eastern Persia) the Seljuk sultanate was finally destroyed, and the caliph was able to add part of its Persian territories to his dominions (1190). But the result was only to bring him into conflict with is former allies, and these local interests distracted him from iving effective support to Saladin (of whom he was, in any case, ealous) in the desperate struggle of the third crusade. The breach went so far that in 1215 the shah of Khwarizm had al-Nasir delared deposed, and in 1217 sent a force against Baghdad, which was turned back, however, by snowstorms and Kurdish attacks in he mountains.

The caliph, on his part, incited the shah's eastern neighbours nd rivals against him; but there is little evidence for the story hat he invoked the help of Genghis Khan (*q.v.*), whose Mongol rmies invaded Transoxiana and Khurasan in 1220, leaving a trail f burned cities and depopulated countryside.

Al-Zahir (1225–26), al-Mustansir (1226–42) and al-Musta'sim (1242–58).—Under al-Nasir's son Mohammed and randson al-Mansur the presence of the Mongols in Persia prevented further attempts at expansion, except within the boundaries f Iraq. Al-Mustansir's son Abdullah, entitled al-Musta'sim, by efusing to ally himself with the Mongols against the Assassins, rovided a pretext for the final attack. Hulagu, a grandson of Genghis Khan, had crossed the Oxus at the head of fresh Mongol orces and, after destroying the Assassin strongholds, summoned he caliph to appear before him and to dismantle Baghdad. On is refusal the city in 1258 was invested, surrendered and sacked, nd al-Musta'sim put to death.

Later Abbasids.—The Abbasid caliphate had played, for all ts pretensions, so small a part in the real political life of the Muslim world for so many centuries that the fall of Baghdad, ensational as it was, made no change in the general structure of ts political institutions. The defense of Islam against the menace f the Mongols passed to the Mameluke sultans of Egypt (*see* GYPT: *History*). After the defeat of the first Mongol invasion of yria, Sultan Baybars, with the aim of securing for Egypt both the olitical and the religious leadership of Islam, proclaimed the efugee Ahmad, a brother of al-Mustansir, caliph, with the same tle, in 1261. His pretensions proved irritating, and Baybars, havng accompanied him as far as Damascus on an expedition to reover Baghdad, allowed him to proceed by himself with what orces he could collect; and he was defeated and killed at Hit 1262). In the next year a new Abbasid caliph from a cadet ranch was installed, but with diminished and purely formal owers; and this shadow caliphate continued in his line until the Ottoman conquest of Egypt in 1517. Except for a brief moment, n 1412, when a caliph occupied the sultanate, they had little inuence and less power and only exceptionally enjoyed the recogition of a foreign prince. The last of the line, al-Mutawakkil III, as taken to Constantinople by Sultan Selim I, but returned to Cairo, where he died in 1538. The supposed transfer of his preogatives to the Ottoman sultan is not confirmed by any conemporary Arabic or Turkish sources.

OTTOMAN CLAIMS

The old Sunnis orthodox, or classical, theory of the caliphate hich, based upon the history of its first two centuries, assumed hat all Muslims would always live under the government of one Muslim ruler, who should be descended from the prophet's tribe of Quraish (Koreish) had, in fact, long been discarded, though independent princes, moved by antique piety or uneasy consciences, might still from time to time apply to the caliphs for a diploma of investiture or title of honour. Later jurists, particularly after the Mongol conquests, held that the true caliphate had come to an end with the four original caliphs of Medina and that subsequent holders of temporal power, by whatever name they might be called, derived their authority directly from God. In the diplomatic styles of most princes, from the 13th century onward, the terms "sultanate," "imamate" and "caliphate" became interchangeable in their local application. This, or a parallel theory, underlay the usage of the early Ottoman sultans also and was continued by them after the conquest of Egypt; in the public prayers, the title applied to them was always sultan, not khalifa.

But in course of time the vast dominions and long rule of the Ottoman sultans endowed their line with something of the prestige which had formerly been associated with the Abbasid caliphs of Baghdad; and in the 19th century Turkish diplomatists found it convenient in their relations with Christian powers to make use of the false analogy current in Europe between the caliph and the pope and to claim for the sultan spiritual authority over all Muslims, even if these were not actually his subjects.

Abdul-Hamid II (1876–1909) especially emphasized this claim, and from the outset of his reign endeavoured to obtain recognition of himself as caliph by sending emissaries to Egypt, Tunis, India, Afghanistan, Indonesia and China. This was the basis of the "pan-Islamic" policy, which was continued even after his deposition in favour of his successors. The attempt to implement this policy when Turkey entered World War I in 1914 by the proclamation of a *jihad*, or "holy war," summoning all Muslims to fight in defense of the caliphate, showed up the unreality of the Ottoman claim, although many Muslims, especially in India, were distressed at the fact of hostilities between Turkey and the governments to which they gave their loyalty. The abolition of the caliphate by the Turkish grand national assembly in March 1924 caused even greater perturbation among Muslims. An attempt by King Husain of the Hejaz (*see* HUSAIN IBN ALI) to fill the vacuum met with little support outside Arabia and Syria, and an international Caliphate congress held at Cairo in 1926 decided in effect that until all the Islamic peoples could join in establishing a new caliphate the office remained in abeyance. *See* also references under "Caliphate" in the Index. (H. A. R. G.; X.)

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CALISTHENICS, bodily exercises done without the use of apparatus or with light hand apparatus, used to develop grace and co-ordination or to "loosen up" muscles before participating in other strenuous activities, particularly body contact sports such as football or boxing. For competitive calisthenics *see* GYMNASTICS.

CALIXTUS (CALLISTUS), the name of three popes and one antipope.

CALIXTUS I (d. 222), pope from 217 or 218 to 222, was little known before the discovery of the book of the *Philosophumena*. From this work which is in part a pamphlet directed against him, we learn that Calixtus was originally a slave. Falling on evil times, he was brought into collision with the Jews, who denounced him as a Christian and procured his exile to Sardinia. On his return from exile he was pensioned by Pope Victor. Later he was associated with Pope Zephyrinus in the government of the Roman Church. After the death of Zephyrinus (217) he was elected in his place and occupied the papal chair for about five years. His theological adversary Hippolytus (*q.v.*), the author of the *Philosophumena,* accused him of having favoured the modalist or Patripassian doctrines (*see* MONARCHIANISM) both before and after his election. Calixtus, however, condemned Sabellius, the most prominent champion of modalism. Hippolytus accused him also of certain relaxations of discipline. It appears that Calixtus reduced the penitential severities applied against fornication and adultery, which the church had previously regarded as irremissible except by God Himself. Under Calixtus and his two immediate successors, Hippolytus was the leader of a schismatic group, organized by way of protest against the election of Calixtus. In the time of Constantine the Roman Church reckoned him officially among the martyr popes. (L. D.; X.)

CALIXTUS II (Guy of Burgundy) (d. 1124), pope from 1119 to 1124, was a son of William I, count of Burgundy. Appointed the archbishop of Vienne in 1088, he rose to fame as the fearless spokesman of the reform party and critic of imperial policy. When Gelasius II died at Cluny, the cardinals there elected Guy to succeed him, on Feb. 2, 1119. He made his way to Reims, where he held a synod in which lay investiture was again condemned and the emperor Henry V and the antipope Gregory VIII were again excommunicated. In 1120 Calixtus was able to enter Rome in triumph. The German princes now forced the emperor to come to terms with the pope, and the concordat of Worms was negotiated (1122) to terminate the contest over the investiture. For the conclusion of peace, Calixtus called a general council (the 9th). This, the first Lateran council, met on March 18, 1123, ratified the concordat and published important reforming canons. On Dec. 13 or 14, 1124, Calixtus "died in the peace of the Church which he, by God's help, had established." His bull *Etsi Judaeis* (1120) afforded a considerable measure of protection to the Jewish community in Rome.

See U. Robert, *Histoire du pape Calixte II* (1891); A. Fliche, *La Réforme grégorienne et la reconquête chrétienne* (1946); C. J. Hefele, *Histoire des conciles,* trans. by H. Leclercq, vol. v, pt. i (1912).

CALIXTUS III (John of Struma), antipope from 1168 to 1178, was elected as Paschal III's successor in opposition to Alexander III. He was the protégé of the emperor Frederick I Barbarossa until the treaty of Anagni (1176). This ended the schism in Alexander's favour, with the proviso that Calixtus should have an abbacy to compensate him for his deposition. Calixtus nevertheless ignored the treaty and remained obstinate even after the conclusion of the peace of Venice (1177) between Frederick and the Lombards. In Aug. 1178, however, he submitted to Alexander, who treated him generously.

CALIXTUS III (Alfonso de Borja, or Borgia) (1378–1458), pope from 1455 to 1458, was born near Xativa, in Valencia, Spain, on Dec. 31, 1378. As professor of law at Lérida, he won a great reputation for juristic learning and austerity of life. He attached himself to Alphonso V, king of Aragon and Sicily, and his services in reconciling his master with the pope gained him the bishopric of Valencia in 1429 and the cardinalate in 1444. After a struggle in the conclave between the Colonna and Orsini, he was chosen pope on April 8, 1455, as a compromise candidate who was unlikely to last long in view of his advanced age. The master idea of his pontificate was the organization of a crusade to recover Constantinople from the Turks. In this he failed, despite heroic efforts, but he raised a pontifical fleet which did good work in relieving many of the Aegean islands. The repulse of the Turks from Belgrade on Aug. 6, 1456, marked the turn of the tide, and Calixtus commemorated it by instituting the feast of the Transfiguration (1457) and ordering that it be observed on that day. His personal life was blameless, but he followed the fashion of his time in showering favours on his nephew, Rodrigo Borgia, whom he made cardinal and generalissimo of the papal forces. He died on Aug. 6, 1458. (C. H. LE.)

CALIXTUS (CALIXT), **GEORG** (1586–1656), German Protestant theologian who tried to develop a theological system that would permit reunion of Lutherans, Calvinists and Roman Catholics, was born at Medelbye, Schleswig, on Dec. 14, 1586 After studying philology, philosophy and theology at Helmstedt Jena, Giessen, Tübingen and Heidelberg he traveled through Holland, France and England, where he became acquainted with the leading reformers. In 1614 he was appointed professor of theology at Helmstedt, and he held this post for 40 years, making Helmstedt a centre of reasonableness in an age of bitter theological controversy.

Calixtus constantly pressed for a milder treatment of confessional differences, and thought that a basis for the reunion of all the churches could be found in the study of the Christian fathers His ideas were those later advocated (also fruitlessly) by Leibniz In 1613 he published a book, *Disputationes de praecipuis religionis christianae capitibus,* which provoked the hostile criticism of orthodox scholars; in 1619 he published his *Epitome theologiae* and several years later his *Theologia Moralis* (1634) and *De Arte Nova Nihusii.* Statius Buscher charged the author with a secret leaning to Romanism. Calixtus refuted the accusation of Buscher but after the conference of Thorn (1645) a charge of a secret attachment to Calvinism was preferred against him, principally at the instance of Abraham Calovius. The disputes on the possibilities of the reconciliation desired by Calixtus—known in the church as the syncretistic controversy—lasted during the whole lifetime of Calixtus, and distracted the Lutheran Church, until a new controversy arose with P. J. Spener and the Pietists of Halle

Calixtus died on March 16, 1656.

See E. L. T. Henke, *Georg Calixtus und seine Zeit,* 2 vol. (1853-60).

CALLA, a genus of plants of the arum family (Araceae, *q.v.*) comprising only one species (*C. palustris*), known as arum lily water arum or wild calla, found widely in wet places in cool north temperate and subarctic regions. It is a handsome plant, with heart-shaped leaves, showy white flowering spathes and a fruit cluster of brilliant red berries. The juice of *C. palustris* is violently poisonous.

The well-known calla, or calla lily, of the gardeners comprises several species of *Zantedeschia,* the chief of which is *Z. aethiopica* of South Africa, a stout herb with a brilliantly white corolla and arrowhead-shaped leaves, widely grown for the florist trade. The golden or yellow calla lily is *Z. elliottiana,* also of South Africa as is the pink or red calla lily *Z. rehmannii. Z. aethiopica* is grown outdoors in mild climates but all calla lilies are best grown in the greenhouse where they need a rich soil, plenty of water and a temperature of about 60° Dormant fleshy roots or tuber are planted in 7-in. pots filled with 2 parts cow manure, 1 par sand, 2 parts loam and 2 part leaf mold. When through flowering the pots should be plunged outdoors for the summer. (N. TR.)

J. HORACE MCFARLAND CO.

HORTICULTURAL VARIETIES OF CALLA LILY (ZANTEDESCHIA)

CALLANDER, a small burgh of Perthshire, Scot., 16 mi N.W. of Stirling by road. Pop. (1961) 1,654. It is mainly on the north side of the Teith, there crossed by a three-arched bridge It owes much of its prosperity to its position on the road from Edinburgh to Oban and Fort William and to its proximity to the Trossachs, Loch Katrine (*qq.v.*), and Lochs Achray and Vennachar. This romantic and scenic region was described in Sir Walter Scott's *The Lady of the Lake.* Ben Ledi (2,873 ft.) is 4 mi. W.N.W., and 1½ mi. N.E. are the Bracklinn falls.

Northwestward road and railway enter the Pass of Leny, 4 mi beyond which is Loch Lubnaig ("the crooked lake"), 4½ mi. long and divided into two reaches by a picturesque rock. Little Leny ancestral burial ground of the Buchanans, is nearby.

CALLAO, the principal seaport and warehouse centre of Peru, lies on the central coast of the republic at 12°05′ S and 77°08′ W. Although it is the seaport for the capital city of Lima, about 8 mi. inland, Callao is a constitutional province (Provincia Constitucional del Callao). Pop. (1966 est.) of the province 279,500; of the city 219,250. Occupying an area of 28 sq.mi. (74 sq.km.) with an inner harbour of 250 ac., the province ncludes the Port of Callao; its suburbs, La Punta, Bellavista, and Chucuito; and several islands, notably San Lorenzo, Frontón, and Las Palominas. In addition to its maritime role, Callao, in onjunction with Lima, is part of Peru's chief industrial and commercial district. San Lorenzo Island, a submarine and naval station, protects the roadstead from the south. The green Rímac Valley stretches inland. Callao is connected with Lima by three major highways, a railroad, and an electric interurban line.

The average annual temperature is about 66° F (19° C) and here is little seasonal variation. The annual rainfall seldom exceeds 2 in., but overcast, misty days are common. The northlowing Humboldt Current helps produce sea and air temperatures many degrees colder than is usual for this latitude.

In selecting the Lima-Callao site for his capital in 1535 (acually founded in 1537), Francisco Pizarro recognized that the area afforded two advantages: it was suitable for irrigation, with an abundant supply of water from the Río Rímac; and it had fine anchorage protected by a large offshore island and by a ong promontory of land pointing toward the island from the mainland. The harbour was given further protection from the ea in recent times by breakwaters; its entrance and channels have depth of 37 ft. A modern maritime terminal was opened in 935 and shipping facilities were improved by the construction of a 570-ft. dry dock in 1938; a naval arsenal was completed the ame year.

As the leading shipping point for the gold and silver taken by he Spanish conquerors from the Inca Empire, the port was freuently assaulted by pirates and the European rivals of Spain. It was pillaged by Sir Francis Drake in 1578. A tidal wave, following an earthquake, inundated Callao in 1746, and the city was rebuilt about three-quarters of a mile from the original site. The extensive fortification called Castillo del Real Felipe was uilt after the disaster. It withstood a number of sieges by Spanish forces during the wars of independence. Simón Bolívar anded at Callao in September 1823, and three years later it was he scene of the final surrender of Spain. The city was bombarded y a Spanish fleet in 1866 in a vain effort by that country to egain its lost colonies. In 1881, during the War of the Pacific, was occupied by Chilean forces. Chile restored the port to Peru in 1883 by the Treaty of Ancón. Further rebuilding of the ity and port was necessary after a severe earthquake in 1940.

The railway to Lima, opened May 17, 1851, was the first in South America. The built-up area of Lima has spread in three uccessive phases. Until the latter part of the 19th century most of the population was still within the limits of the walls, which were razed late in the century, but new railways and tramways were built in that period in three directions—toward Callao, Magdalena, and Miraflores—and development began to spread along these transport axes. By the 1930s these had been supplemented y good roads, and in the early 1950s a Greater Lima region was recognized by planners to fill the triangle of Lima-Callao-Chorrillos, though some agricultural land remained within this triangle. Meanwhile, there developed an industrial zone extending most of the length of one of the avenues between Lima and its ort. A third phase of growth began in the 1960s partly planned, artly unplanned, of a still Greater Lima, an urban area extending along the coast from Callao and San Lorenzo Island, inland up the Rímac Valley.

In 1958 the International Bank for Reconstruction and Development made a loan of $6,575,000 for the improvement and expanon of the Port of Callao. The new installations included cargo erths, storage sheds, and improved accommodations for passengers which have enabled it to cope with the general growth of passenger, cargo, and refined-metals traffic.

As the Port of Callao serves the mining and agricultural areas of the Central Sierra and Lima, about 75% of the nation's imports and 25% of its exports pass through the port; it handles a significant volume of coastal traffic as well. In terms of tonnage, the leading exports are minerals, refined metals, and general cargo such as wool, cotton, hides, and fish meal; the chief imports include items such as wheat, machinery, lumber, newsprint, and automobiles. The industrial establishment of the city of Callao comprises metallurgical industries, lumber mills, flour mills, soap and candle factories, sugar refineries, breweries, and meat-packing plants. Many fish-meal factories are found on the road from Callao to Lima. Agricultural products grown in the province, chiefly for the local market, include vegetables, fruits, corn, and sugarcane.

The suburb of La Punta, site of the naval academy, is a popular seaside resort. (J. L. Tr.)

CALLENDAR, HUGH LONGBOURNE (1863–1930), British physicist best known for his work in heat and thermodynamics, was born at Hatherop in Gloucestershire. Educated at Marlborough and at Cambridge, he was professor of physics at McGill university, Montreal (1893–98); at University college, London (1898–1902) and at the Imperial College of Science.

Callendar was successful in devising and carrying out accurate methods of heat measurement and in designing new apparatus. The electrical resistance thermometer, with the Callendar-Griffiths bridge and various recording devices used with it, was the subject of papers published in 1886–87. This was followed by his work on the electrical continuous flow calorimeter, giving a new method of measuring specific heats of liquids, which eliminated the water equivalent of the apparatus and simplified the radiation correction; the full description was given in 1902. In addition, Callendar was responsible for a compensated air thermometer (1891) and a radio-balance (1910).

His researches on steam (*q.v.*) led to the formulation of the Callendar steam equation and the publication of *Callendar Steam Tables* (1915); *Properties of Steam and Thermodynamic Theory* (1921); *Abridged Callendar Steam Tables C. and F. Units* (1922 and 1927), and *Callendar Steam Diagram C. and F. Units* (1922).

In 1925 he presented a report to the Electrical Research association on the continuous flow method of measuring the total heat of steam at high pressures. Callendar was the author of a number of papers on various subjects such as internal combustion engines, thermometric scales, radiation, vapour pressure, osmotic pressure of solutions, absolute expansion of mercury and the boiling point of sulfur. He was also responsible for Air Ministry reports and memoranda on work carried out by himself and colleagues on *Dopes and Detonation* (1926) and on the effect of antiknock compounds on engine knock (1927). He died in London on Jan. 21, 1930.

Callendar was a member and officer of many societies; he was awarded the Rumford Medal of the Royal Society in 1906 and the first Duddell Memorial Medal of the Physical Society in 1924; he received the C.B.E. in 1920.

CALLES, PLUTARCO ELÍAS (1877–1945), president of Mexico, was born at Guaymas, Sonora, Sept. 25, 1877. Of humble origin, he was a schoolteacher before entering politics as a member of the revolutionary movement. He served the cause of constitutionalism in the successive struggles against Victoriano Huerta and Pancho Villa. In 1917 he became governor of Sonora and sponsored notable labour and agrarian legislation. In 1919 Calles was appointed secretary of commerce, labour and industry under Pres. Venustiano Carranza, but resigned to support Álvaro Obregón's candidacy.

A member of the Sonora triumvirate that overthrew Carranza in 1920, Calles served in the provisional government of De la Huerta and as secretary of interior under Obregón. His own term as president, 1924–28, was marked by a continuation, if somewhat modified, of the agrarian, labour and educational program of the Mexican revolution. Programs of irrigation, agricultural credit and road building were initiated.

The stability of the regime was threatened by controversy with the United States over the passage of alien land and petroleum laws and by a Catholic rebellion precipitated by application of the religious and educational provisions of the constitution.

The assassination of President-elect Obregón in 1928 created a political vacuum that only Calles could fill. For the next six years he remained the power behind the president. Cynicism prevailed as the agrarian program was slowed and labour's power curbed. In 1936 Lázaro Cárdenas, although elected with the support of Calles, successfully asserted his independence. Forced into exile, Calles lived in California until 1941, when he returned to Mexico City. He died there on Oct. 19, 1945. *See* also Mexico: *History*. (S. R. R.)

CALLIAS AND HIPPONICUS, names borne alternately by the heads of a noble and wealthy Athenian family in the 5th and 4th centuries B.C. The office of *daduchus* (torchbearer) at the Eleusinian mysteries, which was hereditary in the clan Ceryces, was held by all those listed below.

Callias (5th century B.C.), second of the name, an influential figure who won three victories at Olympia and married Elpinice, sister of Cimon. He distinguished himself at Marathon (490), but his best-known activities came at the end of his life, his embassy to Susa and the negotiation of peace between Athens and Persia in 449 (this last has been doubted, but on insufficient grounds), and his part in the Thirty Years' peace between Athens and Sparta in 446.

Bibliography.—Herodotus, vii, 151; Diodorus, xii, 4, 7; Plutarch, *Cimon*, 13; Demosthenes, *On the Embassy*, 273; H. T. Wade-Gery, *Essays in Greek History*, pp. 201–232 (1958); E. M. Walker, *Cambridge Ancient History*, v, pp. 469–471 (1927).

Hipponicus (5th century B.C.), son of the above, with Nicias and Eurymedon commanded the Athenian forces which won a minor victory near Tanagra in 426, and was killed at the battle of Delium in 424 (*see* Peloponnesian War). He was the first husband of the wife of Pericles.

Bibliography.—Thucydides, iii, 91; speech wrongly attributed to Andocides, *Against Alcibiades*, 13; Plutarch, *Pericles*, 24; Isocrates, *On the Team of Horses*, 31.

Callias (5th–4th century B.C.), son of the above-mentioned Hipponicus, was ridiculed by the comic poets for his extravagance in youth; he also quarreled with Andocides who attacked him violently in his speech *On the Mysteries*. But he was friendly with the philosophers, and his house is the scene of Xenophon's *Symposium* and Plato's *Protagoras*. In 390 during the Corinthian War he commanded the Athenian hoplite force at Corinth, on the occasion when Iphicrates' lighter-armed troops destroyed a Spartan regiment. In 371 he headed the embassy which made peace with Sparta shortly before the Spartans were defeated by the Thebans at Leuctra; in the speech which Xenophon attributes to him on this occasion, caricaturing his vanity, he asserts that he had led two such embassies successfully before.

Bibliography.—Aristophanes, *Frogs*, 429, *Birds*, 283; Andocides, *On the Mysteries*, 110–131; Xenophon, *Symposium*, 1; Plato, *Protagoras*, 311a; Xenophon, *Hellenica*, iv, 5, 13–15; vi, 3, 2–6. (A. As.)

CALLIÈRES, FRANÇOIS DE (1645–1717), French diplomat, famous for his exposition of the principles of diplomacy, was born at Torigny in Normandy. Having been sent on diplomatic missions to Poland (three times), to Savoy (twice), to Holland and to Bavaria in the period 1670–93, he went as French plenipotentiary to Holland in 1695 and 1696 for the preliminaries of the peace of Ryswick (1697). His success there was rewarded by Louis XIV with the post of cabinet secretary (1698). After a mission to Lorraine (1700), he spent the rest of his life at Versailles or in Paris, where he died on March 5, 1717.

Callières had been elected to the Académie Française in 1689 for a panegyric of Louis XIV (1688). This and most of his other writings (guides to courtly behaviour and polite conversation) are now rarely remembered; but his treatise *De la manière de négocier avec les souverains* (1716; modern Eng. trans., *The Practice of Diplomacy*, London, 1919) remains a model introduction to its subject, covering the qualifications, duties, conduct and methods of the ideal negotiator and showing sound psychological insight in its assessment of the proper use of flattery and bribery and in its condemnation of trickery as prejudicial to the confidence that an envoy must inspire. (J. G. R.-S.)

CALLIGRAPHY is writing as an art. The term derive from the Greek words for good or beautiful and for writing o drawing, and means what writing masters called the art of fai writing. It implies a sure knowledge of the correct forms of letters *i.e.*, the conventional signs by which language can be communicated, and the skill to inscribe them with such ordering of the various parts and harmony of proportions that the cultivated, knowin eye will recognize the composition as a work of art. In the Fa East, especially China, calligraphy by long and exacting traditio ranks above all other arts. In Western culture the simpler Latin derived alphabets and the spread of literacy tend to make handwriting theoretically "everybody's art," though in few instance does it either aspire to or attain the status of calligraphy.

Reports, inferential reconstructions, and the pitifully sparse remains of volumes intended for display and artistic enjoyment i Greek and Roman collections betoken the calligrapher's presenc throughout literary history, though most manuscripts came fro the hands of copyists who produced books of various qualitie primarily to be read. An attractive early habit among Gree bibliophiles of adding to their private libraries by personall making copies of admired texts gave way to having educate slaves make the transcriptions, probably not to their calligraphi detriment. Athens offered a luxury market before the Roma occupation, as witness Plato reportedly paying three Attic talent for three books of Philolaus, the 5th-century Pythagorean, an Aristotle, whose library ranked as the most comprehensive in private hands, acquiring out of the way items at a similar rat Rarity more than sumptuous book making was doubtless account ble for such prices; the standard work of literature was writte on one side of a papyrus roll and unadorned.

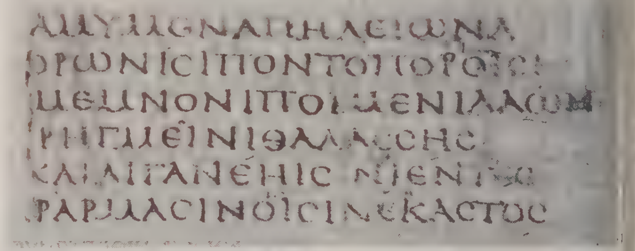

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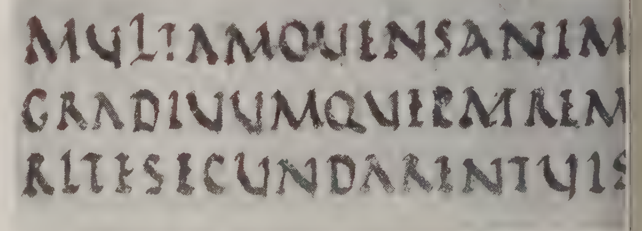
FIG. 1.—HOMER'S "ILIAD," 2ND CENTURY A.D., GREEK PAPYRUS (MS. G CLASS. A.1/8 [P])

Along with the management of other cultural affairs for thei Roman masters, the Greeks naturally took charge of the makin of books. The books put out by Cicero's intimate friend Titu Pomponius Atticus, whose surname announces his origins, wer principally noted for correctness of text, but this implies carefu writing too. From the 2nd century the codex form and the allurement of parchment as a surface for calligraphy and painting encouraged artistic exploitation of the smooth rectangular page, including the use of dyes, paints, and gold (chrysography). Th major Roman contribution was in the perfection of its epigraphi art under the empire, as seen in the monuments of Claudius, Trajan, etc., which set almost indestructible models of the noblest so to inspire and guide calligraphers.


MVLTAMOVENSANIM
GRADIVVMQVEPATREM
RITESECVNDARENTVIS

BY COURTESY OF THE BIBLIOTECA APOSTOLICA VATICANA

FIG. 2.—RUSTIC CAPITALS ON PARCHMENT; VIRGIL'S "AENEID," 4TH CENTURY A.D. (COD. VAT. LAT. 3225)

Among the forms with which the calligrapher works, the greatest division is between the brush-and-chisel-formed capital letters or majuscules which come down from Greco-Roman classical inscriptions and the pen-formed "small letters" or minuscules which were stabilized toward the end of the 8th century under Charlemagne's cultural renascence, and then rediscovered and refined by 15th-century Italian humanists. Roman capitals properly have a dignity befitting their imperial background. By nature they are rather to be constructed, drawn, or built up than written straight off with a stroke or two of the pen as can be done with the minuscules. The calligrapher looks to them for opulent effects, for textual emphasis and glorification, including ornamental initial letters, versals, and titles, often adorned with colours and metals. He places them in a field of orderly, well-shaped script, depending on balanced proportions, even spacing, and expert rhythmical movement to deliver the text to the reader agreeably and without unintended interruptions. The distinction between majuscules and minuscules in calligraphic practice is generally the difference between lettering and writing.

The general history of writing is outlined and illustrated in Paleography, where supplementary material relating to black-letter and medieval script will be found. The reader may also wish to refer to related articles such as Bookbinding and Illuminated Manuscripts, and pertinent topics, *e.g.*, parchment, epigraphy, etc. The present article traces the principal sources of traditional forms in the calligraphy of the Western world, China and Japan, and the Islamic world, describes their development as materials for the artist, and discusses the achievements of some of the more eminent schools and masters.

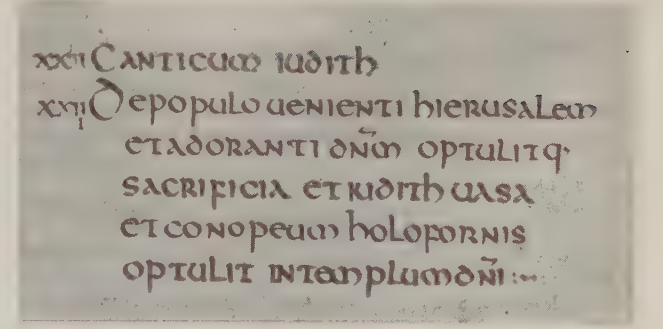
CALLIGRAPHY IN THE WEST

The Anglo-Celtic or Insular and Other "National" Styles

From the 5th century the relaxation of imperial Roman authority brought on a reassertion and growth of native cultures; that is, wherever the people were not wholly occupied in a savage struggle against barbarians for mere existence. The most isolated places such as the province of Britain responded strongly to this opportunity and at the same time were able to conserve important elements of the Roman civilization. With Ireland, which was never under occupation by the legions, it offered during Europe's darkest age comparative peace and shelter for the development of the richest and most original of book styles.

The insular manuscripts were produced at monasteries that were often on a barren rock in the sea or at an equally inaccessible site. According to tradition the earliest centre of Christian learning in Ireland was established by the Romano-British apostle St. Patrick (fl. 5th century A.D.). A great successor, St. Columba or Columcille (*c.* 521–597), whom legend credits with divine scribal powers, founded monastic houses at Derry and Durrow and then journeyed to the Inner Hebrides to found one on the lonely island of Iona in 563. St. Columban (543–615), another Irish missionary, in much the same period was founding monasteries on the continent: *c.* 590 in Gaul the Burgundian centre Luxeuil, from which Corbie in Picardy was organized, and St. Gall in Switzerland, and Bobbio in Italy about the years 612 to 614.

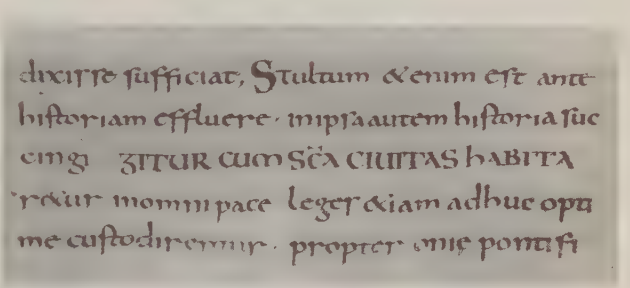
From Iona a daughter house was founded in 635 on St. Cuthbert's holy isle of Lindisfarne just off the coast of Northumbria. To the south the Northumbrian monk, later abbot and saint, Benedict Biscop (*c.* 628–690) established the twin monasteries of St. Peter at Wearmouth in 674 and St. Paul at Jarrow in 682. He endowed them with splendid collections of books and pictures gathered during repeated visits to Rome, so that in the late 7th and early 8th centuries they comprised the most flourishing centre of Christian scholarship in western Europe, and the meeting place of Hiberno-British and continental influences.



xxvi Canticum iudith
xxvii De populo uenienti hierusalem
et adoranti dn̄m optulitq·
sacrificia et iudith uasa
et conopeum holofornis
optulit in templum dn̄i :--

BY COURTESY OF THE BIBLIOTECA MEDICEA-LAURENZIANA, FLORENCE

FIG. 3.—CODEX AMIATINUS, 8TH CENTURY, NORTHUMBRIA (MS. LAUR. AMIAT. 1, C. 709)

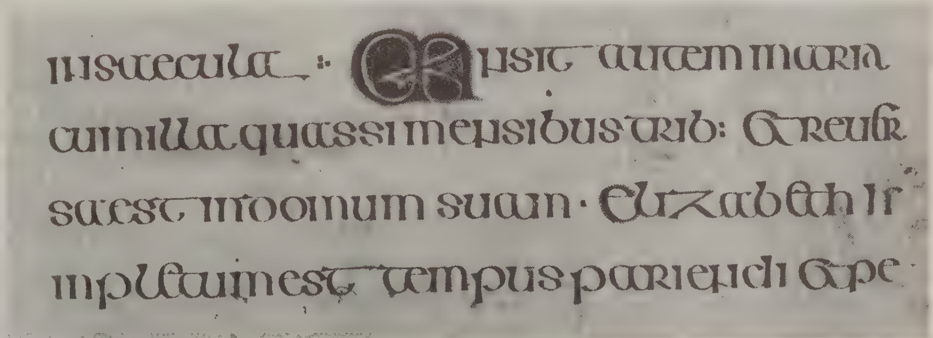


dixiſſe ſufficiat, Stultum &enim eſt ante
hiſtoriam effluere · in ipſa autem hiſtoria ſuc
cingi gitur cum sc̄a ciuitas habita
retur in omni pace leges &iam adhuc opti
me cuſtodirentur · propter oniȩ pontifi

BY COURTESY OF THE BIBLIOTHEQUE MUNICIPALE, AMIENS

FIG. 4.—MAURDRAMNUS BIBLE, BETWEEN 772 AND 781, CORBIE, FRANCE

For the fine books made in the Anglo-Celtic centres the majuscular script called Insular half-uncial was deemed suitable rather than the pointed, more cursive Irish minuscule used for documents and vernacular texts. There is a high degree of conformity, attesting to their stylistic maturity, among masterpieces such as the Book of Kells and the Lindisfarne Gospels, individual as they are in detail and ornament. After all, there is room for infinite variation where in one-quarter of a square inch 158 interlacements have been traced unerringly—by angels, we are told. That is in the Kells book, *Codex Cenannensis* to paleographers, who tend to give it a birthplace at Iona and a date around 800. It has 339 leaves, 13 × 10 inches of noble script in single column, jet black on well-made parchment, through which runs the most spirited and colourful of ornamentation ranging from the red-dotted outlining of letters, which is as much a feature of the style as the wedge-topped ascenders, to the wildly extravagant full page incipit initials at the opening of Gospels. The other, *Codex Lindisfarnensis*, was written in honour of St. Cuthbert shortly after his death in 687. It displays the same lively inventiveness, the love of fantastic animal and bird forms (zoomorphs), intricate interlacing, and even, rhythmic script, set off by generous margins.



in saecula :· Mansit autem maria
cum illa quassi mensibus trib: & reuer
sa est in domum suam · Elizabeth ır
impletum est tempus pariendi & pe

BY COURTESY OF THE BOARD OF TRINITY COLLEGE, DUBLIN

FIG. 5.—INSULAR HALF-UNCIAL SCRIPT ON PARCHMENT; THE BOOK OF KELLS, *c.* 800, IONA OR NORTHUMBRIA

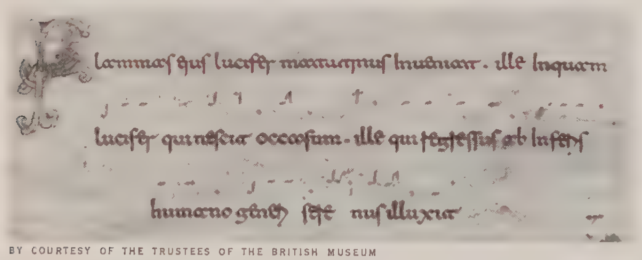
The earliest of all extant manuscripts of the Insular style is the *Cathach* ("battler") of St. Columba, who according to legend wrote it himself and, in the judgment of scholars, may actually have done so. Housed in its *cumhdach* (a sort of ark), it was carried into battle to ensure victory.

Besides the proud witness of such books as these to the Anglo-Celtic contribution, there were also the productions of continental centres influenced by St. Columban and his disciples, as well as books mainly in the Roman tradition but carrying the unmistakable signs of Insular influence. For instance, there are three that scholars believe were written in the 7th century at Bobbio, at the monastery of St. Columban. There is another, *Codex Amiatinus*, of 1030 leaves measuring 20 × 13½ inches, made in Northumbria in the 8th century. It is continental Roman in style with no concession to the Insular habit of ornamentation. This is understandable, for Benedict Biscop's successor abbot, Ceolfrid, designed it for presentation to the pope.

Though the Insular minuscule was ready to hand, the majuscular half-uncial as the senior script was always given the place of honour and the preference for the fine Latin books of the Anglo-Celtic monasteries. Nevertheless, by the 8th century the minuscule was developing into a disciplined book hand, as seen in the copy of Bede's *Historia Ecclesiastica* (*c.* 731; Cambridge University Library). The spiky, ligatured (*i.e.*, with letters frequently tied together), compactly written style migrated early to the continent and by the beginning of the 8th century was at home in the Anglo-Saxon foundation of Echternach, in Luxembourg. Fulda and Würzburg were other important centres of Insular culture and book production abroad in this style.

The Merovingian, in France, and the Visigothic, in Spain, are two more varieties of minuscular script that grew out of Latin cursive after the withdrawal of the Roman authority. In the Luxeuil monastery the minuscule attained in the 7th century the characteristics of a fine book hand, but for only a short period, when the reforms under Charlemagne took effect. Beyond the Pyrenees the Visigothic style was in use from at least the 8th to the 12th century. It has the verticality of emphasis that is common to the other hands out of the same cursive background, when deliberately written, with weighted ascenders carefully topped by flat serifs.

The South Italian script of the style called Beneventan, nurtured in the mother house of the Benedictine order at Monte Cassino, was the "national" hand that rose to the status of calligraphy and held its position well into the 13th century, an active literary life of more than 500 years. It has a peculiar jerky rhythm and retains individual cursive forms which together with the abundance of abbreviations and ligatures make reading difficult.

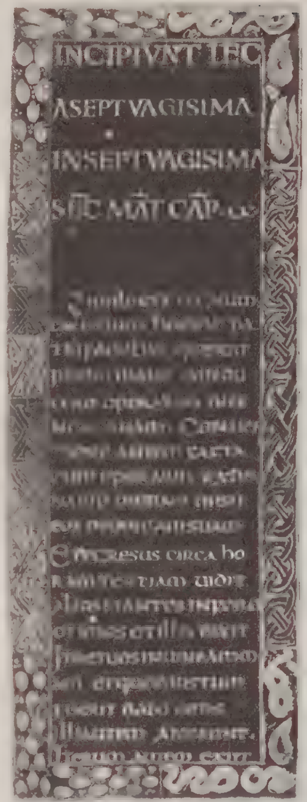


BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

FIG. 6.—BENEVENTAN EXULTET ROLL, LATE 11TH OR EARLY 12TH CENTURY, MONTE CASSINO, ITALY, (ADD. MS. 30377)

Carolingian Reforms in the Scriptorium

The literary reforms carried on in the latter part of the 8th century and early 9th century by order of Charlemagne set the highest of standards for the making of books throughout his Western empire. The extensive educational program, looking forward to new authorized versions of the Vulgate, the Missal, and other liturgical works, he placed in charge of the learned English cleric Alcuin of York. The emperor persuaded Alcuin to leave his position at the head of the cathedral school of York and the excellent library he had gathered there, first to become master of the palace school at Aachen, then at Tours as abbot of St. Martin's to conduct the literary activities centred at the well-established scriptorium there.



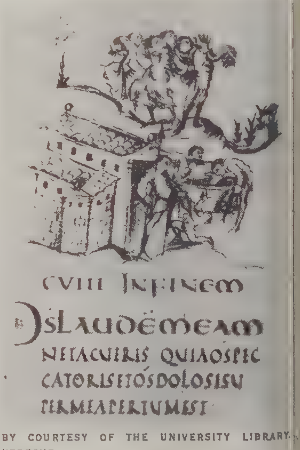
BY COURTESY OF THE BIBLIOTHEQUE NATIONALE, PARIS

FIG. 7.—UNCIAL SCRIPT BY GODESCALC: EVANGELARY FOR CHARLEMAGNE, BETWEEN 781 AND 783, MAINZ, GER. (MS. NOUV. ACQ. LAT. 1203, FOL. 23)

Before taking up the abbacy in 796 Alcuin was responsible for, or at least inspirer of, the most precious of Carolingian codices, the so-called Golden Gospels. These were a series of illuminated masterpieces mainly written in gold and often on purple-stained vellum. The most famous is the *Godescalc Evangeliarium* written before 783, the body of the text in uncials and the dedication in Carolingian minuscule. (*See* also ILLUMINATED MANUSCRIPTS: *Pre-Romanesque Illumination: Carolingian Renaissance.*)

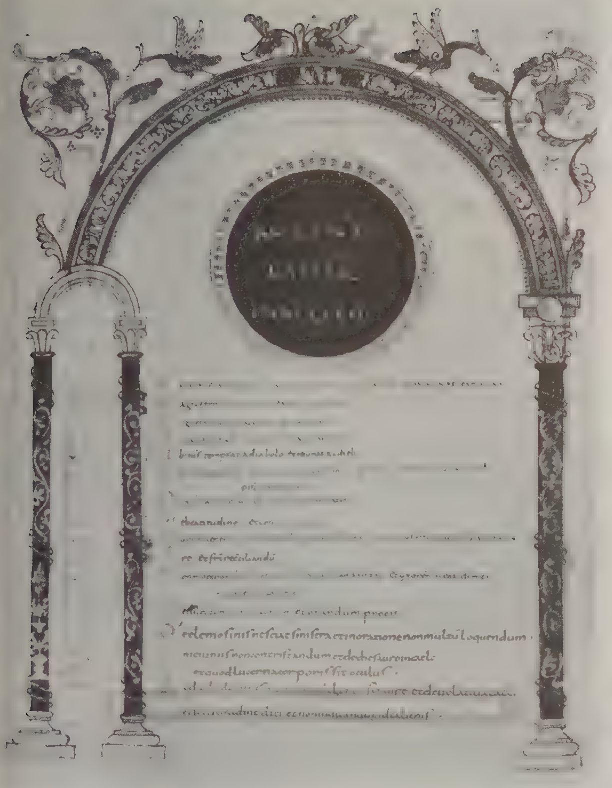
Alcuin carried forward the work of the St. Martin scriptorium in the spirit of a true classical renascence. Each variety of traditional letter form was studied with a view to finding its norm by careful comparison with archetypes in ancient monuments and books. Thus, the square capitals, at the top of the hierarchy of scripts, were modeled on Augustan inscriptions. For rustic capitals (*capitales rusticae*) the reformers adopted the style of those used for the text of such fine old codices as the Virgil fragment now in the Vatican. The Roman uncial was restored to its simple dignity as in well-made books of the 6th century, and the minor or half-uncial likewise to the plain elegance of that earlier period, after the degeneracy of the 7th century.

The model for the most valuable and characteristic of all the Alcuinian contributions, the Carolingian minuscule, has never been precisely determined. It may well have been a local variety of cursive or, more probably, mixed half-uncial and cursive, in which Alcuin discerned the possibilities of his clear, round, flexible but disciplined script, comfortable to both scribe and reader. For as regularized at the scriptorium of St. Martin the minuscule was written with the shaft of the pen pointing somewhat to the right instead of straight back over the shoulder; though the letters were formed deliberately, even and round, stroke by stroke the same way every time by rule, the writing brought relative ease for the hand and eye. With the years some cursive features became more prominent, *e.g.*, a tendency nearly to join certain letters and an occasional hint of "italic" in the slightly sloping, even, well-spaced lines. The incipits were celebrated by means of display letters and a decorative initial that might come from any one of a number of sources, including Insular, Byzantine, and Merovingian. Otherwise, the classic calm



BY COURTESY OF THE UNIVERSITY LIBRARY, UTRECHT

FIG. 8.—THE UTRECHT PSALTER, 9TH CENTURY, REIMS, FRANCE (MS. 32, FOL. 64R)



COURTESY OF THE BIBLIOTHEQUE NATIONALE, PARIS

G. 9.—GOSPELS OF LOTHAIR, *c.* 850, TOURS, FRANCE (MS. LAT. 266, OL. 19)

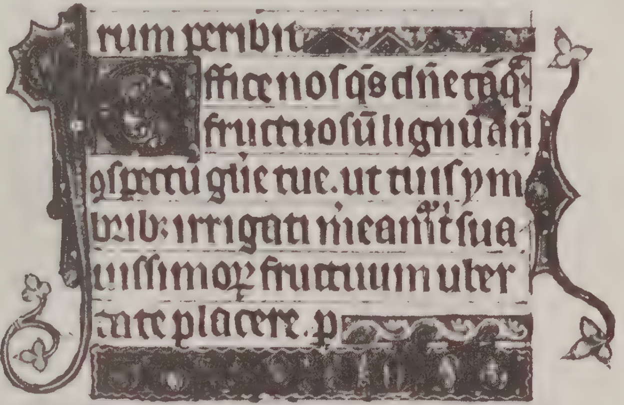
as maintained, supported by the superb arrangement of material the pages and the excellence of the craftsmanship in carrying rough every detail from the manufacture of the skins to the strained illumination. The crowning achievement of the Tours hool of scholars, scribes, and artists was reached in the mid-9th ntury under Alcuin's successors in the Gospels of Lothair.

There are observable variations among the different Carolingian hools but these are generally in small details. The most surrising departure is the Utrecht Psalter written at Reims in rustic apitals and illustrated with fluent pen-drawings in the Hellenistic ashion. Apparently, the whole work was devotedly copied in the h century from an old model.

The Black-Letter or "Gothic" Style

Carolingian minuscule remained the unrivaled book hand of Vestern Europe through the 9th century, or nearly so. Then a end away from the official imperial standards set in. It can be bserved progressing in the manuscripts written at St. Gall toward he close of the 9th century and during the 10th. There is a endency toward lateral compression of the letters. This begins s the natural result of an easier motion of the pen held in a slantg position, *i.e.*, with the shaft out to the side rather than pointg back over the right shoulder. At such an angle of holding he pen, a nib cut straight across does not deliver body strokes of ll thickness to the letters. However, the scribes learned to adjust his matter by cutting the pen's writing edge obliquely so that it ould be parallel to the top of the page anyway; even though the haft was held in the slanting position, the nib so cut would yield perpendicular stroke of maximum width. They were led on by he attractive novelty of bolder and bolder contrasts that evenually were to appear to the eyes of the Italian humanists so brutal s to deserve the bad name of Gothic. Nevertheless, the more ondensed, compact writing made for important economies in the mount of time taken in writing the books and the quantity of aterials used, and therefore in the cost of finished manuscripts.

Black-letter of increasing density deepened the "colour" of the page and imparted to the northern, advanced, formal variety of book hand a matted aspect, or fanciful likeness to woven fabric, that gave rise to the name Textura. It is called by paleographers *littera textualis formata* or *lettre de forme*. As the script developed through the 11th and 12th centuries in Germany, France, and England its curves broke into angles. During the 13th and 14th centuries the size of writing was generally reduced. It became stiffer and though in the following century, its last of undisputed sway, the script regained size, the proportions were disagreeably narrowed and the letters, in lines as rigid and mechanically perfect as a picket fence, have angles sprouting hairlines apparently added with a crowquill afterward. Of this species of formal black-letter book hand two kinds are distinguished by paleographers. One stands flat and unseriffed on the base line and is known as *textus prescissus*. The other is completed with square or diamond-shaped feet and is called *textus quadratus*. Though the former, and earlier, has superior claims for the calligrapher, the latter is the variety that was carried into printing types and hence into much wider use.



SPENCER COLLECTION, THE NEW YORK PUBLIC LIBRARY; ASTOR LENOX, AND TILDEN FOUNDATIONS

FIG. 10.—*Textus prescissus* BY BROTHER TICKHILL; "BEATUS" PAGE FROM THE TICKHILL PSALTER, 1310–15, NORTHUMBERLAND, ENG.

In Italy the writing during the same period took on weight, but the curves of comparable book script never became angles. The senior script there was the Rotunda, heavy but not pointed. The form persisted for liturgical work both as writing and printing type until late in the Renaissance.

The north and the south had of course their other kinds of writing for court and business or personal uses. A cursive hand that literally flourished in France, Flanders, and England rose to favour in the 15th century as a vernacular book script. This *littera bastarda*, or *lettre bâtarde* as it is termed in the vexed nomenclature

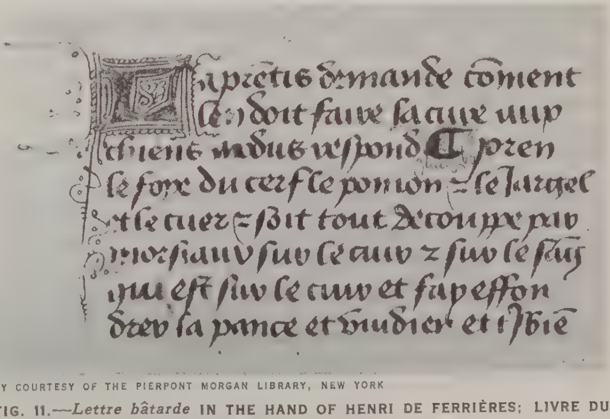


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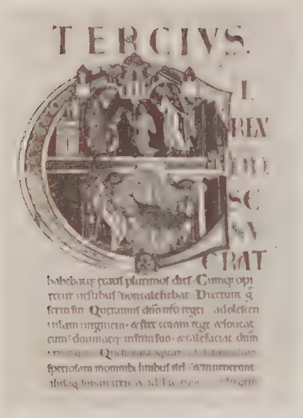
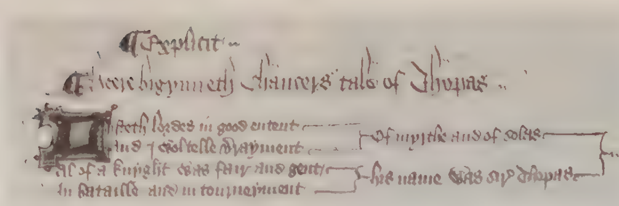
FIG. 11.—*Lettre bâtarde* IN THE HAND OF HENRI DE FERRIÈRES; LIVRE DU ROY MODUS ET DE LA REINE RATIO, *c.* 1430–40, NORTHERN FRANCE (MS. 820, FOL. 16V)



BY COURTESY OF THE DEAN AND CHAPTER OF WINCHESTER CATHEDRAL

FIG. 13.—*Textus quadratus;* WINCHESTER CATHEDRAL BIBLE, 3RD QUARTER OF 12TH CENTURY, WINCHESTER, ENG.


Explicit.
Heere bigynneth Chaucers tale of Thopas.
Listeth lordes in good entent
And I wol telle verrayment
Al of a knyght was fair and gent
In bataille and in tourneyment
Of myrthe and of solas
His name was sir Thopas

BY PERMISSION OF THE HUNTINGTON LIBRARY, SAN MARINO, CALIFORNIA

FIG. 12.—*Lettre bâtarde;* ELLESMERE CHAUCER, *c.* 1410, ENGLAND (EL 26 C9)

of paleography, for all its high style as attained in fashionable books, was close kin to the epistolary "running secretary" commonly written by northern Europeans and early American settlers till it grudgingly yielded in the 17th century to italic script.

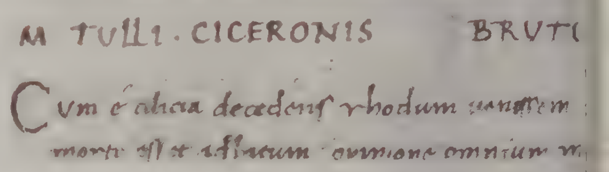
The Scripts of Humanism

Under the inspiration of Petrarch (Francesco Petrarca, 1304–74), who started the collecting of old manuscripts, coins, medals, and other "antiques," the essentially literary movement called humanism engaged a group of scholars at Florence in the latter part of the 14th century and opening decades of the 15th. Their growing enthusiasm for antiquity led them on an ever widening search for Latin books and ancient monuments, in order that they might restore the lost heritage of Rome. Classical authors written in the clear Carolingian minuscule with display lines in lapidary style (*i.e.,* in the style of ancient inscriptions cut on stone) appealed to them as though straight from the time of Cicero instead of from the 10th to 12th centuries. Reverently Coluccio Salutati (1331–1406), chancellor of Florence who followed Petrarch as leader of the movement, and his fellow humanists imitated the old script, which they spoke of as the *lettera antica* to distinguish it from the ordinary *moderna* that belonged to the black-letter style.

Two protégés of Salutati are credited with developing, on the basis of these studies and experiments among old manuscripts, the two fundamental scripts of humanism. Poggio Bracciolini (1380–1459), at the very beginning of the 15th century, produced the round, formal writing that, after further polishing by a generation of scribes, served the new art of printing as prototype of "Roman" fonts. He promptly followed up this achievement by introducing into his manuscripts the square capital letters as used on ancient monuments. Later in the century the rage for epigraphic inscriptions brought such enthusiasts as Cyriacus of Ancona (1391–1452), Felice Feliciano of Verona (*c.* 1432–80), and his fellow townsman Giovanni Giocondo (*c.* 1433–1515) into the field, and from Padua, Giovanni Marcanòva, Bartolomeo Sanvito, and Andrea Mantegna. They compiled the fruit of their researches in great *sillogi* or anthologies which, among other uses, served calligraphers with precious, authoritative patterns for letter forms, ornament, and the correct spacing and placing of all display elements in their books.

Feliciano, a calligrapher fond ornament and fertile in inve tion, about 1460 demonstrat for the first time how to constru the monumental Roman capit according to geometrical rules.

The second style of humanist script appears earliest in t writing of Poggio's friend Nicco Niccoli (*c.* 1364–1437), w was also an accomplished scri His slightly inclined cursi written with a fairly narrow rounded nib at a good rate of spee was to be to the printers' "italic" what the Poggian hand beca to their "Roman." Niccoli's innovation employed movements a rhythms close to those of the ordinary black-letter cursive famili in everyday affairs. Indeed the script contains a sprinkling of c rent black-letter mannerisms and lends itself similarly to the joi ing or tying together of letters. The special character of t *antica corsiva* results from the narrowing of the bodies of lette due to the rapid up and down movement of the pen, facilitated its being held with the shaft pointing at an angle away from t shoulder instead of straight back, producing this ×, not +. in italic fonts to this day, the form of *a* is distinctive; and *f*, *g*, and ſ (long *s*) are all more or less reminiscent of Gothic current habits. For his headings Niccoli preferred Roman capitals "italicized" by a slight inclination to the right.


M TULLI · CICERONIS BRUT
Cum ē cilicia decedens rhodum

BY COURTESY OF THE BIBLIOTECA NAZIONALE CENTRALE, FLORENCE

FIG. 15.—NICCOLÒ NICCOLI; "CICERO," *c.* 1423, FLORENCE

Both scripts were at once taken up and spread by other able scribes working at Florence in the first half of the 15th century, of whom the work of Giovanni Aretino, Giacomo Curlo, and Antonio di Mario, among others, is well recognized.

Poggio himself in 1403 had promptly carried his new script to Rome, where he later became papal secretary. Both scripts were equally devoted exclusively to the service of Latin literature. However, there was a

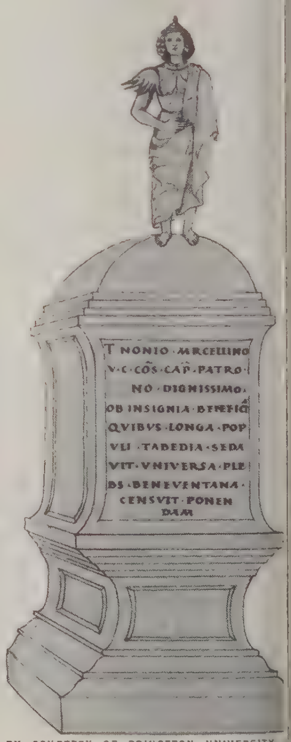


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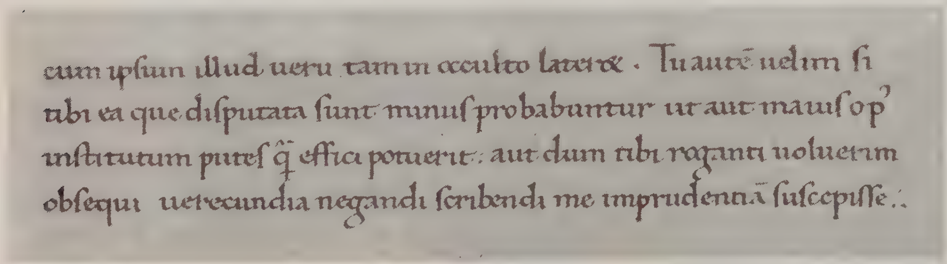
FIG. 16.—GIOVANNI MARCANOV "ANTIQUITATES," *c.* 1465, NORT ERN ITALY (GARRETT MS. 158)

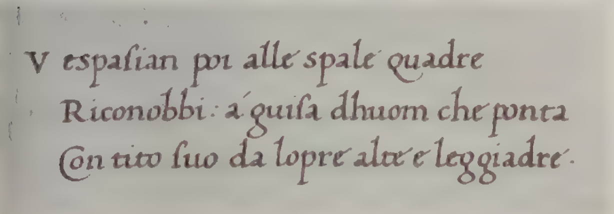

cum ipſum illud uerū tam in occulto lateret. Tu autē uelim ſi
tibi ea que diſputata ſunt minuſ probabuntur ut aut maiuſ op'
inſtitutum puteſ q̄ effici potuerit: aut dum tibi roganti uoluerim
obſequi uerecundia negandi ſcribendi me imprudentiā ſuſcepiſſe.

BY COURTESY OF THE BIBLIOTECA MEDICEA-LAURENZIANA, FLORENCE

FIG. 14.—POGGIO BRACCIOLINI; CICERO'S "DE ORATORE," *c.* 1425, FLORENCE (MS. LAUR. PLUT. 50.31, C.166)

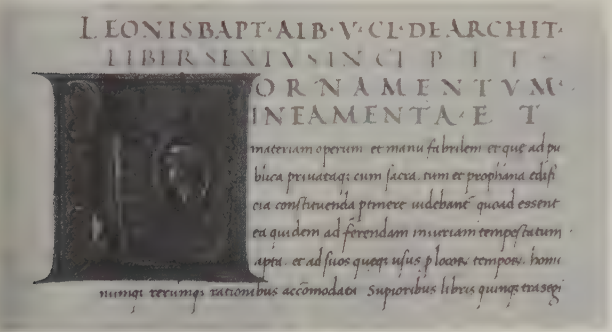
ifference. Poggio used his hand as a calligrapher, Niccoli his as copyist. The former's manuscripts are set forth on fine parchment with meticulous care to formal details such as even lines at he right-hand margin and with handsome embellishment. The atter's are on paper, compactly and rapidly written, with attenion to legibility and textual accuracy above all. There is an ineresting parallel in the printed books of the following century. mbitious Renaissance folios are set in fine roman types while he well-edited but cheap little student books are just as naturally et in italic—though Christophe Plantin (*q.v.*) did at last weary f this Aldine pattern (*see* MANUTIUS).

Typographic printing displaced the copyists. At the same time t gave impetus and new significance to the work of calligraphers. hey accepted the challenge of mechanized writing and for a while esponded by turning out the finest of humanistic masterpieces. he Paduan Sanvito and Pierantonio Sallando (*c.* 1460–*c.* 1540) f Mantua, for instance, not only wrote the round humanistic script n a fashion worthy of the richest miniatures and illumination but hey also honoured the slender proportioned "italic" script by romoting it to a place in some of their most proud and precious anuscripts.


V eſpaſian poi alle ſpale quadre
Riconobbi: a guiſa dhuom che ponta
Con tito ſuo da lopre alte e leggiadre

COURTESY OF THE WALTERS ART GALLERY

IG. 17.—BARTOLOMEO SANVITO; PETRARCH'S "TRIONFI," 1480–90, ROME MS. W. 755, FOL. 43)


LEONIS BAPT·ALB·V·CL·DE ARCHIT·
LIBER SEXTVS INCIPIT
ORNAMENTVM·
INEAMENTA·E T
materiam operum et manu fabrilem et que ad pu
blica priuataq: cum ſacra. tum et prophana edifi
cia conſtituenda ptinere uidebant quoad essent
ea quidem ad ferendam iniuriam tempeſtatum
apta. et ad ſuos queq: uſus p locor. tempor. homi
numq: rerumq: rationibus accōmodata Superioribus libris quinq: trasegi

COURTESY OF THE BIBLIOTECA APOSTOLICA VATICANA

IG. 18.—PIERANTONIO SALLANDO; ALBERTI'S "DE ARCHITECTURA," LATE 5TH CENTURY, MANTUA, ITALY (COD. URB. LAT. 264)

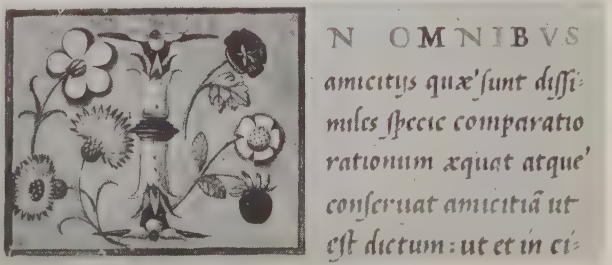
Sanvito's folio and octavo classics in the humanistic cursive re also celebrated for vellum pages stained purple, yellow, reen, or salmon pink and for lines of inscriptional capitals alterating gold, blue, lake, purple, violet, and green. The *antica orsiva* perfected by 15th-century papal scriptors for rapidly inditing briefs issued by the chancery also won its way as the chosen medium of polite correspondence. Thus in the 16th century the ersatile *lettera da brevi* or *cancellaresca* (chancery cursive), ively yet disciplined, responsive to wide variety in cut of nib and peed of movement, attainable by the novice and gratifying to the dept either as book or epistolary hand, became a vehicle of the ew learning throughout Christendom.

As written by the calligrapher and printer Lodovico degli Arrighi f Vicenza (fl. 1510–27), the *cancellaresca* can range from eyerresting contrasts of almost Gothic thick and thin strokes to a elicate, supple monotone tracery. The ascending letters, instead f terminating in serifs as with Sanvito or Sallando, now wave lume-like to the right and the descenders are tending to balance hem with a swing to the left. In 1522 Arrighi published at Rome is modest though revolutionary *La Operina da imparare di scrivere littera cancellaresca.* This, the earliest of printed writing manuals or copybooks, held out to the public clear, simple directions with woodcut examples and invited everyone to learn in a few days how to write this fashionable hand for themselves. In effect it announced the end of the era of the scriptorium and the beginning of the era of the writing master. Dependence upon attracting pupils and gaining a reputation with the public was thereafter reflected in the tendency to exploit novel or flashy scripts and extravagant ornament.

WRITING MANUALS AND COPYBOOKS

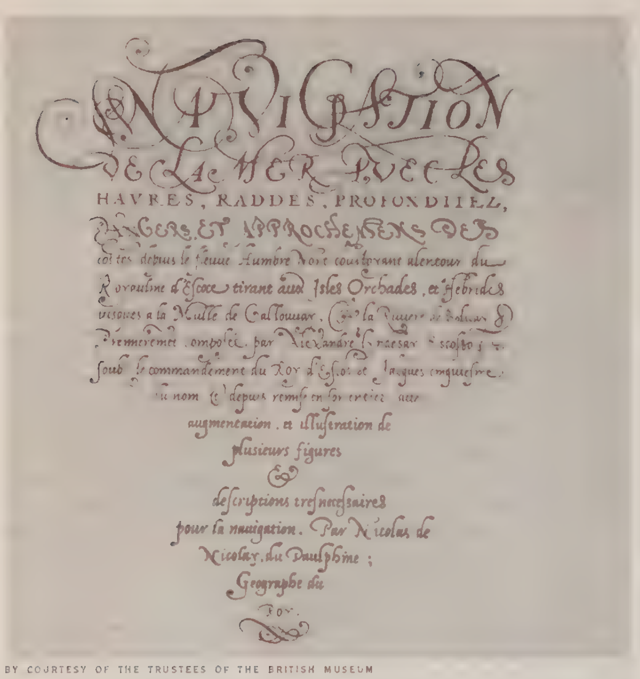
The Arrighi *Operina*'s devotion to the chancery cursive is matched in single-mindedness only by Gerardus Mercator's *Literarum Latinarum, quas Italicas, cursoriasque vocant, scribendarum ratio* (Antwerp, 1540). However, Arrighi's second publication, *Il Modo de temperare le penne* (Venice, 1523), is a more normal performance for the calligrapher, notary, printer, and erstwhile scriptor of apostolic briefs in the role of writing master. Here the scripts and the number of pages assigned to each are as follows: *littera a merchanti*, cursive black-letter mercantile hand, 4; *littera per notari*, small cursive semi-black-letter, slightly inclined, 1; *littera da bolle*, large carefully formed black-letter cursive, 2; *littera da brevi*, chancery cursive, 1; Roman capitals, large humanistic round hand, 1; round Gothic interlaced initials, 2; ribbon initials, 2; large inscriptional Roman capitals, 2; large decorated formal Gothic minuscule, 1; large round outline Gothic, 1; *littera formata*, Gothic black-letter in two sizes, 1. The specimens are completed with another page of smaller interlaced Gothic initials and two pages of type specimens, including the cramped italic as seen in Aldine books and the free calligraphic style first shown here. This book, then, redresses the balance in favour of the more widely used, popular scripts. Here the Goths have it over the humanists about three to one.

Arrighi's elder contemporary, and possible mentor, Giovanni Antonio Tagliente, writing master to the Venetian chancery, published his *Presente libro* in 1524, two years after the *Operina;* and Giovanni Battista Palatino in 1540 at Rome his *Libro nuovo d'imparare a scrivere*. Though Tagliente was master of an elegant *cancellaresca*—his "living hand" is displayed in a supplication to the doge and council of Venice, 1491—as well as of the black-letter hands, he was out of date and prey to the vices of the old professional; *e.g.*, his chancery specimens include a page of script leaning excessively to the right and facing it is a page of similar script leaning away to the left, almost equally hard to read and useless. Unlike the author's own hand in his 1491 supplication, the woodcut models here are acutely pointed. Palatino at the same time exhibits a rigid, sharp-angled *cancellaresca formata* in his excellent manuscript specimen (Bodleian Library, Canon. Ital. 196 fol. 44r), while his popular manuals offer relatively easy-going models for learners. In particular the Palatino *cancellaresca romana* is a normal even-toned script, modest as to bulbed ascenders (*testegiatta*) and angle of inclination, displaying in its forms hospitality for *bastardæ* variations; *i.e.*, gothicizing *g, h, k, r*. The fact that Palatino's *Libro nuovo*, besides being the most complete, was the most widely disseminated of mid-16th-century books on writing, bespeaks certain latitudinarian qualities along with marvelous virtuosity. The summit of absurdity was reserved for


N OMNIBVS
amicitijs quæ ſunt diſſi-
miles ſpecie comparatio
rationum æquat atque
conſeruat amicitiā ut
eſt dictum: ut et in ci-

BY COURTESY OF THE UNIVERSITEITS-BIBLIOTHEEK, AMSTERDAM

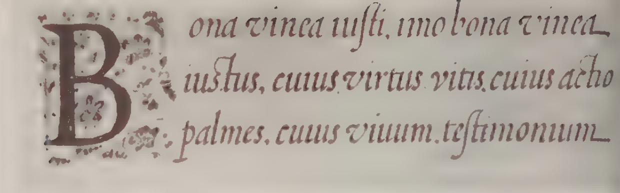
FIG. 19.—LODOVICO DEGLI ARRIGHI; ARISTOTLE'S "ETHICS," FIRST QUARTER OF THE 16TH CENTURY, ROME



NAVIGATION
DE LA MER, AVEC LES
HAVRES, RADDES, PROFONDITEZ,
DANGERS ET APPROCHEMENS DES
costes depuis le fleuve Humbre vers coustoyant alentour du
Royaulme d'Escoce tirant aux Isles Orchades, et Hebrides
voisines a la Mulle de Callouuar. [illegible]
Premierement composee par Alexandre [illegible]
soub le commandement du Roy d'Escosse Jaques cinquiesme
du nom et depuis remise en son entier auec
augmentacion, et illustration de
plusieurs figures
&
descriptions tresnecessaires
pour la nauigation. Par Nicolas de
Nicolay, du Daulphine;
Geographe du
Roy.

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

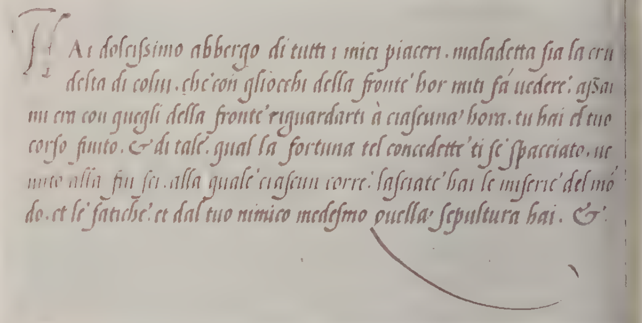
FIG. 20.—ATTRIBUTED TO PIERRE HAMON; "NAVIGATION," c. 1560, FRANCE



Bona vinea iusti, imo bona vinea
iustus, cuius virtus vitis, cuius acho
palmes, cuius vivum testimonium

BY COURTESY OF B. L. WOLPE

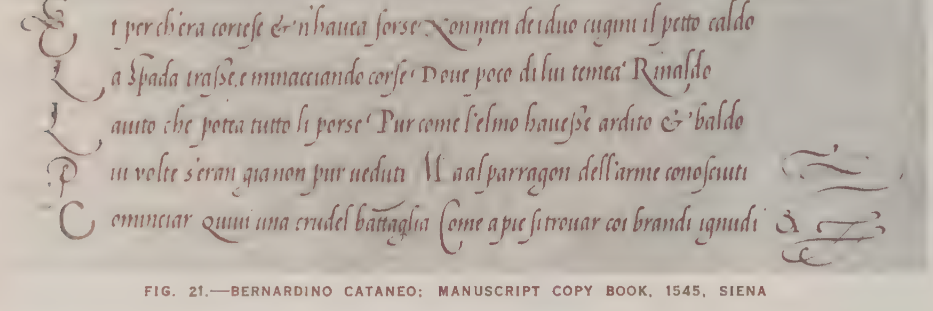
FIG. 23.—JEAN DE BEAUCHESNE; c. 1570



HAi dolcissimo abbergo di tutti i miei piaceri. maladetta sia la cru
delta di colui. che con gliocchi della fronte hor miti fa uedere: assai
mi era con quegli della fronte riguardarti à ciascuna hora. tu hai el tuo
corso finito. & di tale, qual la fortuna tel concedette ti se spacciato. ue
nuto alla fin sei. alla quale ciascun corre: lasciate hai le miserie del mõ
do. et le fatiche: et dal tuo nimico medesmo quella sepultura hai. &

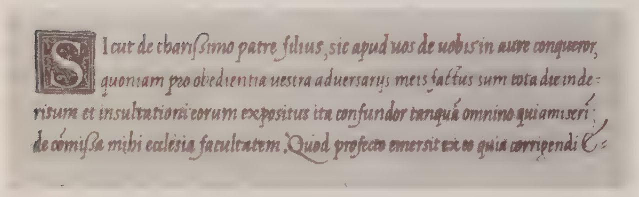
BY COURTESY OF THE BODLEIAN LIBRARY, OXFORD

FIG. 24.—GIOVANNI BATTISTA PALATINO; MANUSCRIPT SPECIMEN BOOK, c. 1550, ROME (MS. CANON. ITAL. 196, FOL. 44R)



Et per ch'era cortese & n'hauea forse Non men de i duo cugini il petto caldo
La spada trasse, e minacciando corse Doue poco di lui temea Rinaldo
Lauuto che potea tutto li porse Pur come l'elmo hauesse ardito & baldo
Piu volte s'eran gia non pur ueduti Ma al parragon dell'arme conosciuti
Cominciar quiui una crudel battaglia Come a pie si trouar coi brandi ignudi

FIG. 21.—BERNARDINO CATANEO; MANUSCRIPT COPY BOOK, 1545, SIENA



SIcut de charissimo patre filius, sic apud uos de uobis in aure conqueror,
quoniam pro obedientia uestra aduersarys meis factus sum tota die in de-
risum et insultationi eorum expositus ita confundor tanquã omnino qui amiseri
de cõmissa mihi ecclesia facultatem. Quid profecto emersit ex eo quia corripendi

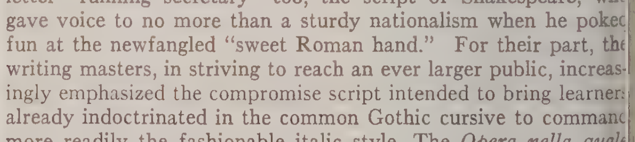
BY COURTESY OF THE BIBLIOTECA APOSTOLICA VATICANA

FIG. 22.—FERDINANDO RUANO; HILDIBERTUS' "EPISTOLAE," 1551, ROME (VAT. LAT. 3841, FOL. 80V)

Ferdinando Ruano, a Spanish scribe working in the Vatican Library, whose *Sette alphabeti* (1553) demonstrated with diagrams how to construct the chancery letters geometrically!

The propagation of the chancery cursive abroad was furthered by native manuals too. The Latin letters called italics, as the Flemish cartographer Mercator had said, were introduced into Germany by Casper Neff's *Thesaurium Artis Scriptoriae* (Cologne, 1549); into Spain by a disciple of Palatino, Juan de Yciar, in his *Recopilacion Subtilissima* (Saragossa, 1548); into France by Pierre Hamon's *Alphabet de l'invention des lettres en diverses escritures* (Paris, 1561); and into England by means of *A Booke Containing Divers Sortes of Hands* (London, 1570) by Jean de Beauchesne and John Baildon. This last was a translation of the French senior author's *Thrésor d'Escripture* believed to have been published at Lyons twenty years earlier; since no copy has been found, first place goes by default to th Hamon book, which has additional interest as illustrating th Plantin didactic dialogue of 156 on calligraphy and printing. I is worth noting that Neff's attractive *cancellaresca* is describe as "A French script, used in Th Chancery."

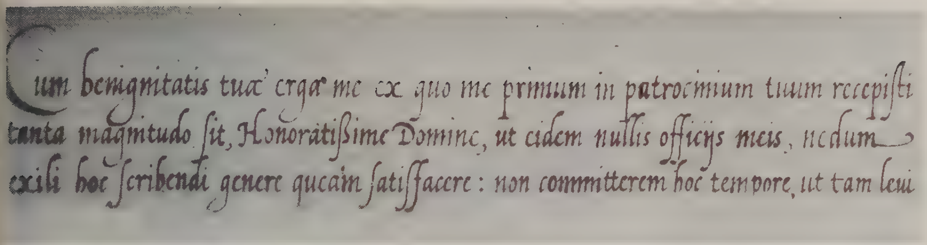
The pure Italian chancery han was the favourite of court circle and humanist scholars throug the second half of the 16th century. In far-off England Roge Ascham (1516–68), schoolmaste to kings and queens, wrote and taught an exemplary *cancellaresca* as did the Cambridge don Bartholomew Dodington (1536–95). These and other educated Europeans generally wrote the black-letter "running secretary" too, the script of Shakespeare, wh gave voice to no more than a sturdy nationalism when he poke fun at the newfangled "sweet Roman hand." For their part, th writing masters, in striving to reach an ever larger public, increasingly emphasized the compromise script intended to bring learner already indoctrinated in the common Gothic cursive to comman more readily the fashionable italic style. The *Opera nella qual si insegna a scrivere* of Vespasiano Amphiareo (Albertacci) ha already offered at Venice in 1554 models that combined the over-disciplined strokes of Palatino with elements of black-letter mercantile hands (*e.g.*, loops and running ligatures); to this hybri *cancellaresca* which he claimed as his own invention Amphiare gave the accurate name of *bastarda*. Then Gianfrancesco Cresc



A a b c d e f g h y l m n o p q r s t u x y
Quuniliano esser ccompagni di roma denno dare questo di xx d'otobre du
Cinquecento cinquantacinque doro in oro quali sono p la ualuta di [illegible]

BY COURTESY OF THE DEPARTMENT OF PRINTING AND GRAPHIC ARTS, THE HOUGHTON LIBRARY, HARVARD UNIVERSITY

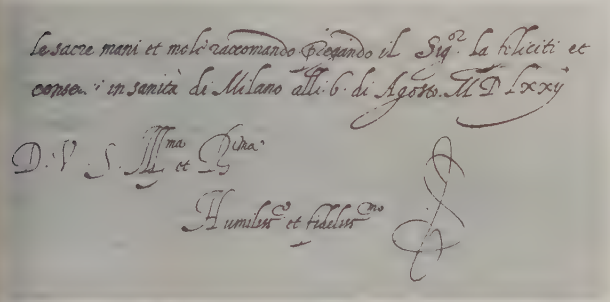
FIG. 25.—VESPASIANO AMPHIAREO; MS WRITING MANUAL, c. 1548



Cum benignitatis tuae erga me ex quo me primum in patrocinium tuum recepisti tanta magnitudo sit, Honoratißime Domine, ut eidem nullis officijs meis, nedum exili hoc scribendi genere queam satisfacere: non committerem hoc tempore, ut tam leui

COURTESY OF THE TRUSTEES OF THE BRITISH MUSEJM

FIG. 26.—BARTHOLOMEW DODINGTON: LETTER TO LORD BURLEIGH, MAY 12, 1590, WESTMINSTER, ENG. (LANSDOWNE MS. 63, FOL. 207)



le sacre mani et molto raccomando pregando il Sig.re la felicita et conser.ne in sanita di Milano alli 6 di Agosto MDLxxij

D. V. S. Ill.ma et R.ma

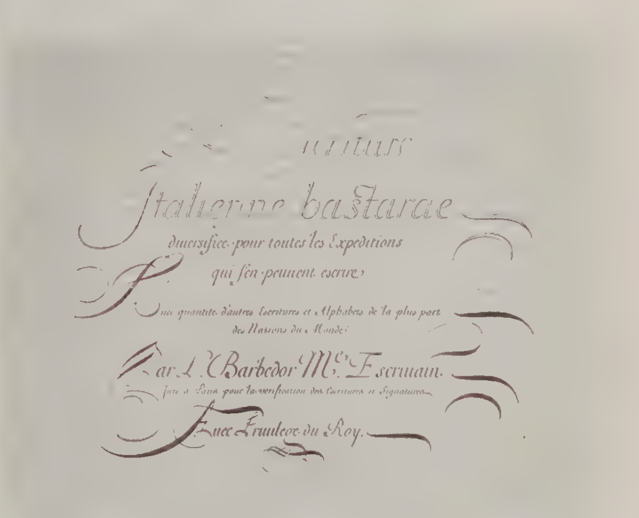
Humiliss.o et fideliss.mo

COURTESY OF THE BIBLIOTECA APOSTOLICA VATICANA

G. 27.—ITALIC *bastarda* BY GIANFRANCESCO CRESCI; LETTER OF AUG. 6, 72, MILAN (VAT. LAT. 6185, FOL. 135R)

' Milan, a Vatican scriptor, published his *Essemplare* (Rome, 560), to herald the oncoming Baroque and to reject vehemently ie works and ways of Palatino and all his academic sort. He reaced their most stylish broad, chisel-beveled nib and meticulous uilding up of disjoined strokes with a narrow, rounded-off pen exible enough to respond to pressure and fluent in dashing off his uch-inclined italic *bastarda* topped off dramatically with bulbous *stegiatta*. It is not too much to say that Cresci's script, with the andsome set of swash capitals (to borrow the typographic term or these free-swinging forms), not only established a revolutionary ont for 17th-century calligraphy but also contained the germs of 8th-century "copperplate" and even Spencerian. Cresci, by the ay, was first in Italy to take advantage of the sleek allurements f copperplate engraving, though iuliantonio Hercolani's *Lo crittor Utile* (Bologna, 1574; ates engraved in 1571) was a ose rival.

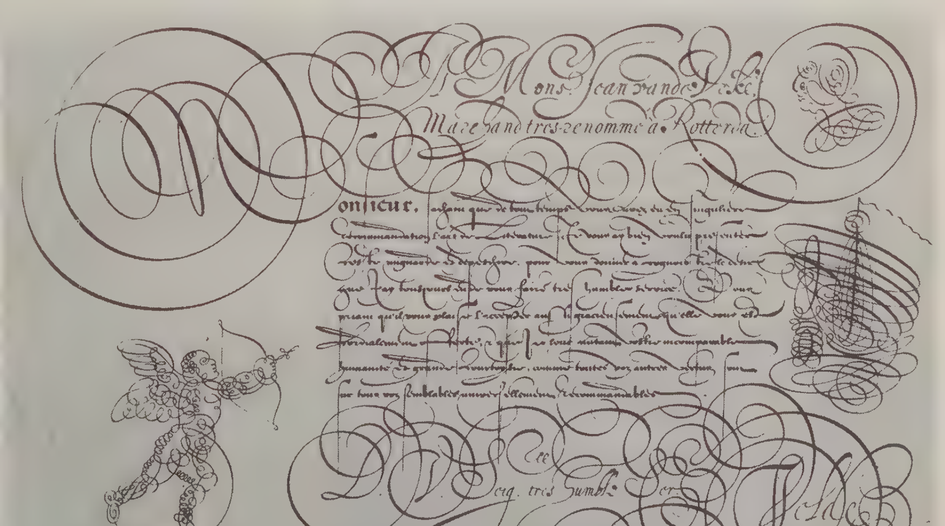
If it is argued that Cresci's reorm swept away calligraphy and ft only handwriting in its place, vidence in rebuttal may be aduced, *e.g.*, from the Spanish asters who followed Yciar: the plendid, ample italic *bastarda* in ie Lucas *Arte de escrevir* (1577) nd Brun's manuals of 1583 and 612. Or the Frenchmen: Lucas Materot's *Oeuvres* (Avignon, 608); Louis Barbedor's *Traité art d'escrire* (Paris, 1640), or s *Escritures financières et itaenne bastarde* (Paris, 1649); ouis Senault's *Livre d'escritures* Paris, 1666); the elder Nicolas uval's *Trésor des nouvelles esritures* (Paris, 1670); and Jean-aptiste Allais de Beaulieu's *Art écrire* (Paris, 1680). (The pelling of titles is normalized and ome publication dates are inferred and therefore only approximate.) The principal French hands of the period were the national black-letter cursive called *lettre françois* or *financière* used in ordinary affairs and the aristocratic *italienne bastarde*. In the Low Countries examples of excellence are provided by Clement Perret, *Exercitatio Alphabetica* (Antwerp, 1569), and by Jan van den Velde, *Spieghel der Schriftkonste* (Rotterdam, 1605), whose fame was carried down through generations of English penmen. It was the period of elaborate and bold "striking" of decorative figures and fanciful shapes by "command of hand." The writing masters did not regard such ornamental work as mere vain show or necessary proof of prowess, though it was important in promoting a



Italienne bastarde
diuersifiee pour toutes les Expeditions
qui s'en peuuent escrire
Par L. Barbedor M.e Escriuain
Fuce Escriuain du Roy.

BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM; PHOTOGRAPH, JOHN R. FREEMAN

FIG. 28.—LOUIS BARBEDOR; "ESCRITURES FINANCIÈRES ET ITALIENNE BASTARDE," 1649, PARIS



A Mons. Jean vande Velde,
Maistre tres renomme a Rotterdam

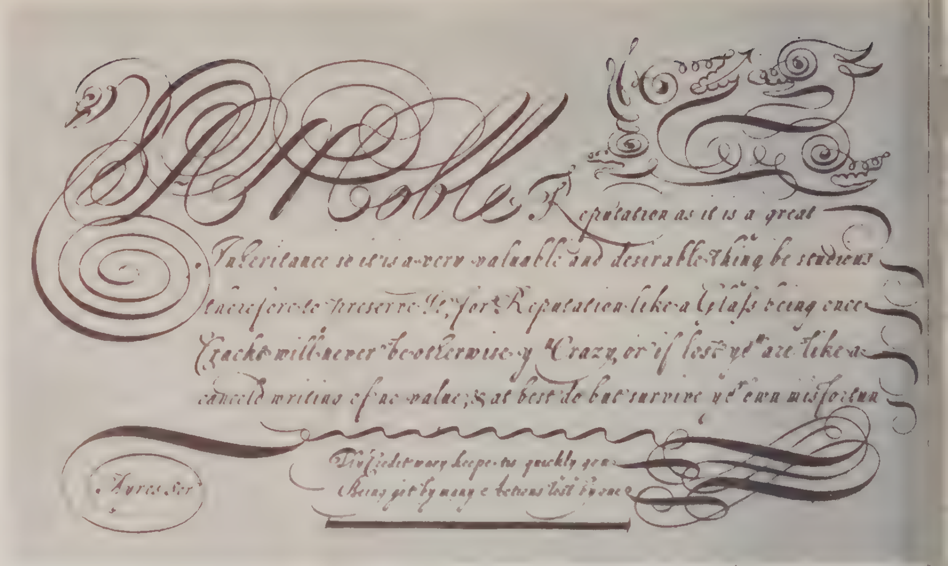
Monsieur,

BY COURTESY OF THE COLUMBIA UNIVERSITY LIBRARIES

FIG. 29.—JAN VAN DEN VELDE; "SPIEGHEL DER SCHRIFTKONSTE," 1605, ROTTERDAM

reputation; they prescribed full-arm flourishing for loosening-up exercises, as teachers later would have pupils perform on mammoth letters or banal push-pulls and oval tunnels.

The *italienne bastarde* spread through Britain and her empire largely through Edward Cocker's engraved copybooks and manuals. Known variously as the "new mixt current" or the "speedy à la mode," its concessions to the black-letter running secretary include the *e* looped at the top like a latter-day Palmer Method *o*, and what has been termed the upside-down *r* which is easily misread as *u* by humanistic eyes. The *d* with a backswept stem and the *h* formed of a loop terminating in a wiggle below the line are other black-letter vestiges that gave up slowly. Nevertheless, in the second half of the 17th century the italic writing won decisively. By the opening of the 18th century a chastened, business-like version was developed in London by John Ayres and his younger contemporary writing masters eager to serve commercial demands. The small, narrow variety of Italian-French script was relegated to ladies' use as something suited to frail capacities, while the robust strain was considered fit to dominate an epoch of trade supremacy. The former came to be known as the Italian hand simply, while the latter took charge of affairs throughout the world as English round hand or "copperplate."



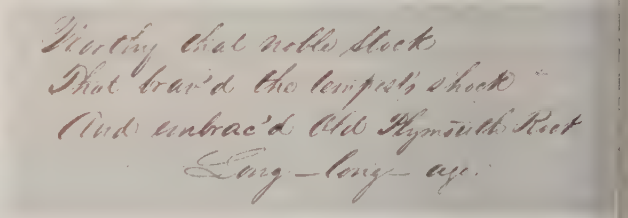
Noble. Reputation as it is a great Inheritance so it is a very valuable and desirable thing be studious therefore to preserve it, for Reputation like a Glass being once Crackt will never be otherwise y Crazy, or if lost yt are like a canceld writing of no value; & at best do but survive ye own misfortun

This fickle wary keeps so quickly gon
Being got by many & betwixt lost by one

Ayres Scr

BY COURTESY OF THE COLUMBIA UNIVERSITY LIBRARIES

FIG. 30.—JOHN AYRES; 1683, LONDON

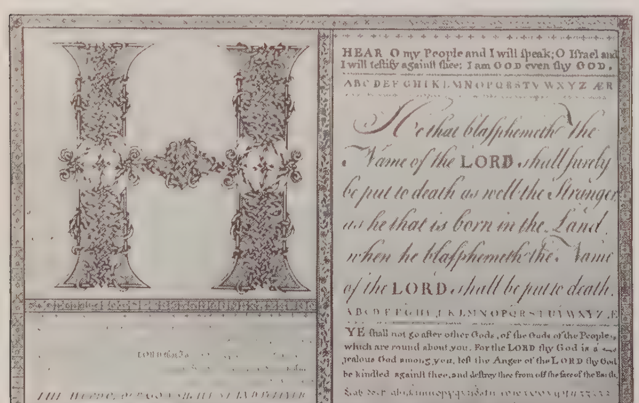


Worthy that noble stock
That brav'd the tempest's shock
And embrac'd Old Plymouth Rock
Long—long—ago.

BY COURTESY OF DARTMOUTH COLLEGE

FIG. 32.—PLATT ROGERS SPENCER; "PIONEER ANTHEM," 1850, GENEV OHIO

Though the transition from black-letter had been even more accelerated in the American colonies, Boston in New England was one of the last bastions of calligraphy in the trend toward counting-house and commercial-college penmanship. The traditional foundations were laid solidly by Abiah Holbrook (1718–69), master of the South Writing School, who raised a group of young proficients and left a fine manuscript in personal testimony. His working library contained 22 identified copybooks of eminent British authors from Thomas Watson's of about 1682 to George Bickham's *Penmanship in its Utmost Beauty and Extent* (London, 1731). He described his own masterpiece, "The Writing Master's Amusement," as "the curious Alphabet containing the Ten Commandments, and other Scripture pieces wrote in all the Hands of Great Britain, in several different colours with neat Borders round the same which I did only for my amusement, though seven years in compleating them. . . ." His Latin scripts are of the varieties called Roman print, italic print, round text, round hand, and Italian hand; there are as many more black-letter scripts, exhibited main for show, since by this time they had only limited ceremonial u and served for decoration and legal mystification. Another sour of inspiration in the neighbourhood was a copy of the senior Geor Bickham's splendid folio anthology of engraved specimens, *T Universal Penman* (London, 1733–41), presented to the Dorchest School Committee "to be exhibited to the School Masters, models; and to the Scholars, for their excitement to fair han writing . . ." and still circulating in the early 19th century. the century advanced, the competition constantly mounted amo systematists emphasizing the plain, practical business hand ar decrying the "ornamental branches." Those who loved to flouri quill pictures of bounding deer or portraits of national heroes we increasingly placed on the defensive. Gifted penmen like N thaniel Duren Gould or Platt Rogers Spencer were almost apol getic when they let their hand go in a moment of profession ebullience.



HEAR O my People and I will ſpeak; O Iſrael and I will teſtify againſt thee: I am GOD even thy GOD.

ABCDEFGHIKLMNOPQRSTVWXYZ ÆR

He that blaſphemeth the Name of the LORD ſhall ſurely be put to death as well the Stranger as he that is born in the Land, when he blaſphemeth the Name of the LORD ſhall be put to death.

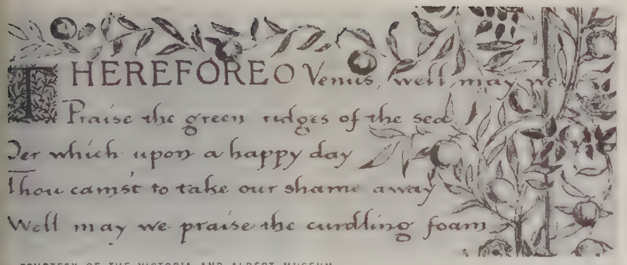
YE ſhall not go after other Gods, of the Gods of the People, which are round about you. For the LORD thy God is a jealous God among you, leſt the Anger of the LORD thy God be kindled againſt thee, and deſtroy thee from off the face of the Earth.

BY COURTESY OF THE HARVARD COLLEGE LIBRARY

FIG. 31.—ABIAH HOLBROOK; "WRITING MASTER'S AMUSEMENT," 1767, BOSTON

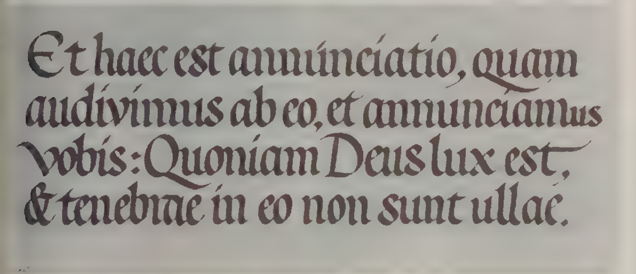
Revival of Calligraphy

The revival of calligraphy at the end of the 19th century w part of an artistic revolt against the mechanization of life. A no talgic sense of the social losses resulting from industrialization w expressed in reformist and arts and crafts movements. About 18 the English poet and artist William Morris (1834–96) had beg to concentrate attention on the ancient practice of scribes and study with pen on parchment the means of achieving similar r sults. In this fashion he wrote out and illuminated a number texts, humanistic and medieval, in the years before he took similarly the study of 15th-century printing prior to establishi the Kelmscott Press. His searching inquiries and patronage l papermakers and ink suppliers, among others, back to forgott standards. His socialist teaching turned attention to the satisfa tion of mastering traditional handicrafts, thus adding to the ide enjoyment of life and the sum of beauty.


THEREFORE O Venus, well may we
Praise the green ridges of the sea
Oer which upon a happy day
Thou camst to take our shame away
Well may we praise the curdling foam

COURTESY OF THE VICTORIA AND ALBERT MUSEUM

IG. 33.—WILLIAM MORRIS; "PRAISE OF VENUS" FROM "A BOOK OF ERSE," 1870, ENGLAND


Et haec est annunciatio, quam
audivimus ab eo, et annunciamus
vobis: Quoniam Deus lux est,
& tenebrae in eo non sunt ullae.

COURTESY OF THE WING COLLECTION OF THE NEWBERRY LIBRARY

IG. 34.—EDWARD JOHNSTON; MANUSCRIPT COPY SHEET, 1918, ENGLAND

Among those who heeded the message was Edward Johnston '1872–1944). He abandoned studies for an intended medical caeer for those of a scribe. On the basis of the Morris investigaions and guided particularly by Sydney Cockerell, Morris' secreary, he rediscovered how to cut and sharpen reeds and quills, how o hold the chisel-nibbed pen so as to produce the kinds of writing hat had become familiar in his study of old manuscripts, and every etail of how to make manuscripts. In 1899 he began teaching, rst at the Central School of Arts and Crafts, and two years later at e Royal College of Art. His early pupils soon became esteemed esigners of lettering and influential calligraphers; *e.g.*, Anna Siions (1871–1951), T. J. Cobden-Sanderson (1840–1922), Eric ill (1882–1940), Noel Rooke (1881–1953), Graily Hewitt (1864–952), Percy Smith (1882–1948). In 1906 he published the basic ianual *Writing and Illuminating, and Lettering,* 500 pages proisely illustrated with his own and Rooke's drawings and with reroductions from historic manuscripts. It contains a chapter by ill on cutting inscriptions in stone, material on gilding by the ecialist Hewitt, etc. In 1910 the book was published in Geriany, where it supported the work independently begun by Rudolf on Larisch (1856–1934) in Vienna and carried on by Rudolf Koch 1876–1934) and Anna Simons. Under the Nazi regime the othics enjoyed a resurgence, but after the war such skilled young erman calligraphers as Hermann Zapf led the way back to Roman nd italic. Jan Tschichold's work has been influential in the appreation of classical letters for present-day uses.

Art schools everywhere gradually followed the Royal College of rt in offering courses in lettering and writing that along with ound forms instilled a sense of responsibility to a rich heritage. ype design passed from the control of engineers into the hands f artists and calligraphical scholars, such as Stanley Morison 1889–1967), Jan van Krimpen (1892–1958), Akke Kumlien 1884–1949), Bruce Rogers (1870–1957), Frederic W. Goudy 1865–1947), Victor Hammer (1882–1967), Berthold Wolpe 1905–), Warren Chappell (1904–). The "freezing" of he alphabets as font material stabilizes them and multiplies their fluence. The effects were not limited to the printed or manuript page, or to book covers and jackets; all kinds of private and ublic markers and memorials, addresses, diplomas, and even the liticians' ubiquitous testimonial "scrolls" were touched by rerm or at least by some consciousness of shortcoming. The stylh lapidary capitals, italics, and sloped letters engraved on boxood by Reynolds Stone for printing, or cut on tablets of wood or stone by John Howard Benson or Will Carter or David Kindersley, are at once distinctively contemporary and lambent with tradition.

Though the United States was a decade behind Britain in organizing an arts and crafts movement, four years before the Johnston bible a Boston architect, Frank Chouteau Brown, brought out a surprisingly sophisticated book, *Letters and Lettering: a Treatise with 200 Examples* (1902). He praised the Morris initiative but wished for more classical balance; he pointed to the neglect of italics and gave them generous space including specimens from the Lucas 1577 *Arte de escrivir,* "letra del Grifo," *bastarda,* etc. In 1905 *The Parable of the Prodigal Son,* fashioned like a humanistic manuscript by William Addison Dwiggins (1880–1956) and printed from photoengraved plates, was offered for sale. Dwiggins, as illustration for a talk on early writing books, copied a page out of the 1542 Tagliente he had picked up in Europe and passed out prints of it at the Dec. 29, 1913, meeting of the Society of Printers —thereby leading the revival of *cancellaresca.* Other graphic artists concerned in the movement included Thomas Maitland Cleland (1880–1964) and Rudolph Ruzicka (1883–).

Edward Johnston's pupils, and their pupils, organized in 1921 the Society of Scribes and Illuminators, "zealously directed toward the production of books and documents" by hand and the advancement of the crafts of member scribes, gilders, and illuminators. The program of this professional group based in London is conducted by means of lectures, publications, and exhibitions. In the 1930s exhibits traveled to five American centres, as well as to Paris and Copenhagen. Members representing the several crafts have collaborated in the making of the rolls of honour for the Royal Air Force and United States Air Force, at St. Clement Danes Church, London. The society has served as a model for similar activities abroad, notably the organization in the Netherlands under the leadership of Jan van Krimpen. In 1952 the British society, with Alfred Fairbank as president, recognized the rising popular interest in italic handwriting by instituting the Society for Italic Handwriting, which soon attracted a large international membership of teachers and amateurs.

In the United States individual enthusiasts and informal groups fostered calligraphy outside the art schools. Ernst F. Detterer in Chicago, who had lessons from Johnston in 1913, headed such a group at the Newberry Library for many years and, when he died in 1947, was succeeded by James Hayes. In Portland, Ore., the instruction and copybooks of Lloyd J. Reynolds, a professor of art in Reed College, had telling effect on the ABC's in use as store posters, school children's writing, etc. For decades Paul Standard in New York practised and preached *cancellaresca corsiva,* and saw the italic reform gain. In 1944 an American calligraphy exhibition at the Grolier Club under American Institute of Graphic Arts auspices offered the first comprehensive view of the subject material in the United States. The Portland Art Museum in 1958 initiated an exhibit of broader scope, "Calligraphy: the Golden Age and Its Modern Revival." A third was organized by the Peabody Institute Library, Baltimore, in 1963, with the title "Calligraphy and Handwriting in America, 1710–1962"; and a fourth, wider-ranging one in 1965, "2000 years of Calligraphy," sponsored also by the Walters Art Gallery and the Baltimore Museum of Art. Duke University also mounted an exhibition in 1965, and there have been displays featuring contemporary and historical calligraphy at Dartmouth College, Harvard University, and the J. Pierpont Morgan Library, among other active centres. As a result of the first exhibition, a bibliographical list of American writing manuals and copybooks was compiled at the Newberry Library; illustrated catalogues were issued in connection with some of the other events. These contain incidental guidance for students seeking further information.

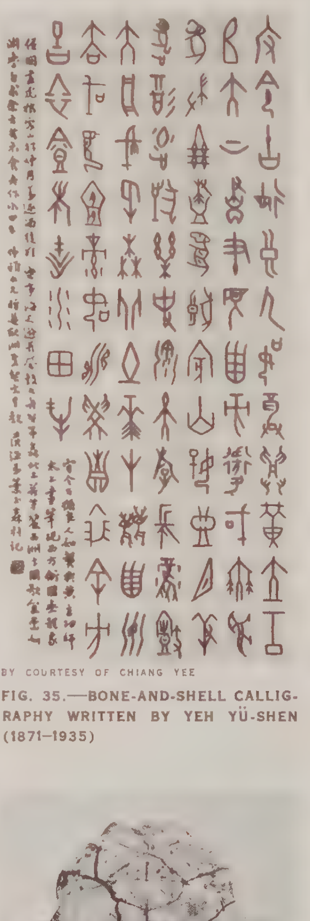
Since Johnston a series of manuals and copybooks centring attention on handwriting improvement have proceeded from the espousal of the rather heavy humanistic hand he admired to an italic which at least implies more speed. Stanley Morison presciently picked out a model for his own hand from Johnston (*Writing and Illuminating, and Lettering,* p. 319, fig. 180) as early as 1913 and James Wardrop called that manuscript "the fons et origo" of his paleographical studies; it is, as Johnston says, a semiformal

16th-century Italian cursive, skilful but a bit colourless to the eye. The fullest and most practical work on the italic is Fairbank, *A Handwriting Manual*. The author places before his book as frontispiece a page of the *bastarda* of Lucas, *Arte de escrivir*, 1577. J. H. Benson's *The First Writing Book* consists of the text and examples of the Arrighi *Operina* translated and admirably written out by the editor and furnished with practical clarifications and notes for the learner. Since Johnston calligraphical research and publishing activities have also produced a handsome and scholarly shelfful of books on related forms, most notably the Renaissance capitals. (RA. NA.)

CHINESE AND JAPANESE CALLIGRAPHY

In China and Japan, calligraphy is a form of pure art. Both Chinese and Japanese calligraphy derive from the written form of the Chinese language, called *kanji* in Japanese. Chinese is not an alphabetical language; each character is composed of a number of differently shaped lines within an imaginary square. The early Chinese written words, like the Egyptian hieroglyphs, were pictorial images, though not so close to the objects they represented as in the ancient Egyptian writing. Rather they were simplified images, indicating meaning through suggestion or imagination. These simple images were flexible in composition, capable of developing with changing conditions by means of slight variations.

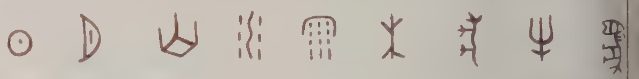
The earliest known Chinese ideographs are engraved on the shoulder bones of large animals and on tortoise shells. Each of the pieces illustrated contains a number of the early ideographs; each seems to have been carefully composed before being engraved on the bones or shells. Although they are not entirely uniform in size, the variations are not great. The figures must have evolved from rough and careless scratches in the still more distant past. This *Chia-ku-wen* or bone-and-shell script (dated *c.* 1766–1123 B.C.) is the earliest stage of development in Chinese calligraphy.



BY COURTESY OF CHIANG YEE

FIG. 35.—BONE-AND-SHELL CALLIGRAPHY WRITTEN BY YEH YÜ-SHEN (1871–1935)

It was said that Ts'ang Chieh, the legendary inventor of Chinese writing, got his ideas from observing animals' footprints and birds' claw marks on the san as well as other natural phenomena. He then started to wor out simple images from what he saw to represent different object such as:

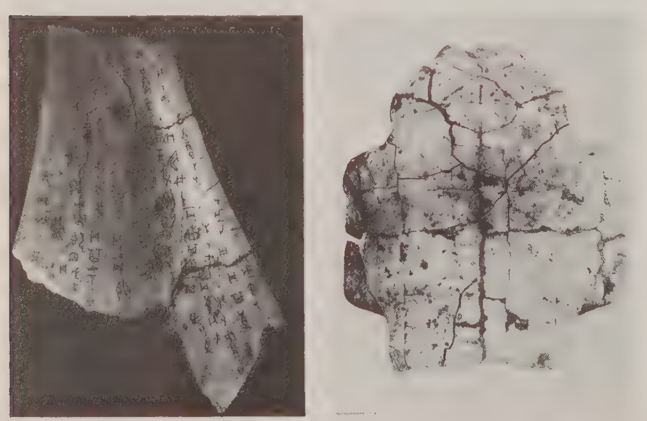


Surely the first images the inventor drew of these few object could not have been quite so stylized, but must have undergon some modifications to reach the above stage. Each image is composed of a minimum number of lines and yet is easily recognizabl Nouns no doubt came first. Later new ideographs had to be invented to record actions, feelings, differences in size, colour, tast etc. Something was added to the already-existing ideograph t give a new meaning. The origin and construction of Chines characters are discussed elsewhere (*see* CHINESE LANGUAGE *Grammar*); here let us examine just one example:

The ideograph for deer is , not a realistic image but a ver much simplified structure of lines suggesting a deer by its horn big eye, and small body, which distinguish it from other animal When two such simple images are put side by side, th meaning is "pretty," "prettiness," "beautiful," "beauty," etc which is obvious if one has seen two such elegant creatures walkin together. But if a third image is added above the other two, thus , it means "rough," "coarse," and even "haughty." The interesting point is the change in meaning through the arrangemen of the images. If the three stags were not standing in an orderl manner they could become rough and aggressive to anyone approaching them. From the aesthetic point of view, three suc images could not be arranged side by side within an imaginar square without cramping one another, and in the end none woul look like a deer at all.

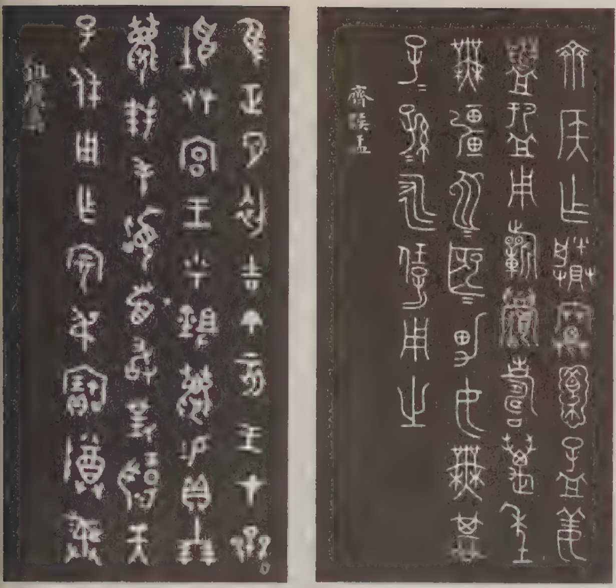
After the bone-and-shell script came writing on bronze vessel known as bronze script. In the early days of divination when th kings of the Shang dynasty (*c.* 1766–*c.* 1123 B.C.) tried to solv their problems by consulting their ancestors and deities, the latter answers were engraved on lasting material for perpetual preserv tion. Later on bronze was used to make cooking utensils and wi vessels in place of common earthenware for the special ceremoni of ancestral worship, raw or cooked food being offered up in ther So sacred were these ancestor-worshiping ceremonies that th best types of bronze utensil were specially designed and cast f such purposes, and in addition, inscriptions, from a few words u to several hundred, were incised inside the bronzes. The words the engravings could not be roughly formed or even just simp images; they had to be well worked out to go with the decorati ornaments outside the bronzes, and in some instances they almo became the chief decorative design in themselves. Though the preserved the general structure of the bone-and-shell script, the were considerably elaborated and beautified. Each bronze or s of them may bear a different type of inscription, not only in th wording but also in the manner of writing. Hundreds of them we created by different artists in different places. All the bronze scri represents another stage of development in Chinese calligraph known as *Chin-wen* or *Ta Chuan* or the big-seal style.

Before long a unification of all types of the bronze script was e forced when China was united for the first time in the 3rd centu B.C. The First Emperor of Ch'in, Shih Huang Ti (259–210 B.C. could be regarded as one of the most terrible dictators in the hi tory of mankind, for he burned Confucian books, buried Confucia scholars alive, and sacrificed thousands and thousands of lives t build the Great Wall to protect himself and his empire; but he d one great thing for the Chinese in unifying their writing, and h



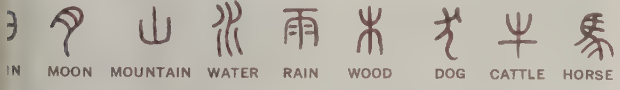
BY COURTESY OF (LEFT) THE EAST ASIAN LIBRARY, COLUMBIA UNIVERSITY, (RIGHT) THE NATIONAL PALACE MUSEUM, T'AI-PEI, TAIWAN, REPUBLIC OF CHINA

FIG. 36.—(LEFT) BONE SCRIPT AND (RIGHT) SHELL SCRIPT, BOTH SHANG DYNASTY (*c.* 1766–*c.* 1123 B.C.)

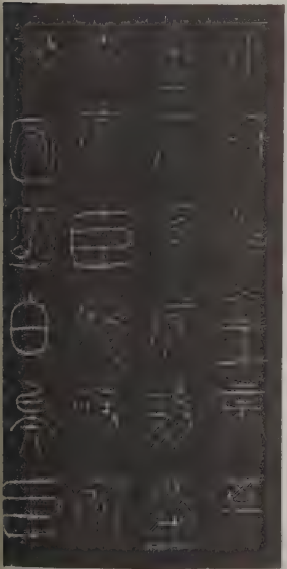


IG. 37.—*Ta Chuan:* INSCRIPTIONS ON (LEFT) A BRONZE CUP OF TSU-LI ND (RIGHT) A BRONZE VESSEL OF DUKE CH'I, BOTH CHOU DYNASTY (c. 22–256 B.C.)

is they have been bound together ever since. The First Emeror's prime minister, Li Ssu (280?–208 B.C.), was given the task working out the new script, and no other type was allowed to be sed. Here are some common words which can be compared with milar words in bone-and-shell script mentioned above:



his was the third step forward in the development of Chinese lligraphy, known as *Hsiao Chuan* or the small-seal style.



COURTESY OF CHIANG YEE

G. 38.—*Hsiao Chuan,* A COPY OF SSU'S WRITING ENGRAVED ON A ONE EPITAPH OF CH'IN DYNASTY 21–207 B.C.). FROM A RUBBING

In the small-seal style of writing all lines are drawn of even ickness and more curves and circles are employed. Each word tends to fill up an imaginary square, and a passage written in small-seal style has the appearance of a series of equal squares neatly arranged in columns and rows, each of them balanced and well-spaced. The Chinese practise the small-seal style when aiming at future attainments in calligraphy. They use only the tip of a long-haired brush, which is almost suspended in the air; no light pencil sketches can be drawn first. It is a hard task and good training.

The uniformity of writing in China was established chiefly for the purpose of meeting the growing demands for documented records. Unfortunately the small-seal style could not be written speedily and was therefore not entirely suitable. Another stage of development was needed—the fourth stage which is called *Li-shu* or official style. The Chinese word *Li* here means "a petty official" or "a clerk"; *Li-shu* means a style specially devised for the use of clerks. If examined carefully *Li-shu* is found to contain no circles and very few curved lines. In other words, all the circles became squares and the curved parts of the lines became angular. Short straight lines, vertical and horizontal, are chiefly used. Owing to the speed needed for writing, the brush in the hand tends to move up and down and an even thickness of line cannot be enforced. As the thickness varied, artist-writers could concentrate more on the artistic shaping of the lines. Thus a door opened for developments in Chinese calligraphy.

Li-shu is thought to have been invented by Ch'eng Miao (240–207 B.C.) who had offended the First Emperor of Ch'in and was serving a 10-year sentence in prison. He spent his time in prison working out this new development which not only facilitated speed in writing but opened up seemingly endless possibilities for later calligraphers. According to their own artistic insight, they evolved new variations in the shape of lines and also in construction. The words in *Li-shu* style tend to be square or slightly rectangular horizontally. Though the even thickness of lines is relaxed, the rigidity in the shaping of them is still there: for instance, the vertical lines had to be shorter and the horizontal longer. As this curtailed the freedom of hand for individual artistic taste, another stage of development came into being—the fifth stage, which is called *K'ai-shu* or regular style. There is no record of who invented this style, but it must have been in evolution for a long time, at least since the 1st century A.D. if not earlier. The Chinese still use this regular style of writing today; in fact, what is known as modern Chinese writing is almost 2,000 years old, and the written words of China have not changed since the first century of the Christian era.

Since about 1950, it has been claimed that the formation of the Chinese written language has changed. This is a serious misunderstanding; the only change is that a certain number of words can now be written and printed with a simplified construction. Most of those simplifications had long been in use in the grass style of writing dating back as far as the regular style, but they were not permitted in documents and records, in books, and in making type for printing. Only those who had never been familiar with the grass style of writing mistook them for newly invented forms.

Before coming to the grass style, the regular style or *K'ai-shu* must be explained. "Regular" here means "proper"—"the proper style of Chinese writing" used by all Chinese for government documents, printed books, public and private dealings in important matters ever since its establishment. Since the regulations for the civil-service examination enforced in the T'ang period (A.D. 618–906), each candidate had to be able to write a good hand in regular style. This imperial decree deeply influenced all Chinese who wanted to become scholars and enter the civil service. This examination was abolished in 1905, but most Chinese still try to acquire a hand in regular style even to the present day.

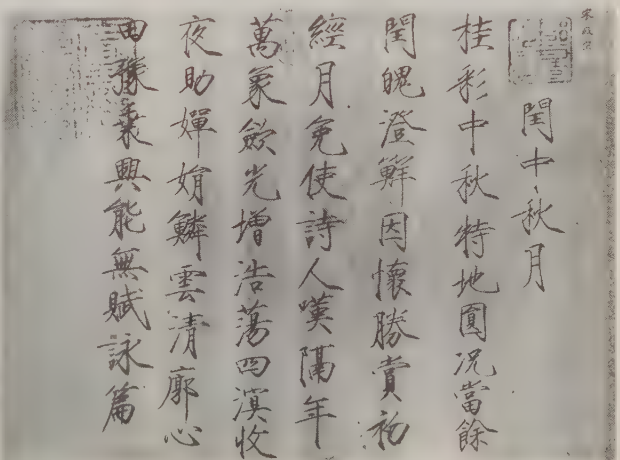

閏中秋月
桂彩中秋特地圓況當餘
閏魄澄鮮因懷勝賞初
經月免使詩人歎隔年
萬象斂光增浩蕩四溟收
夜助嬋娟鱗雲清廓心
田豫乘興能無賦詠篇

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FIG. 39.—*K'ai Shu* BY EMPEROR HUI'TSUNG (1082–1135)

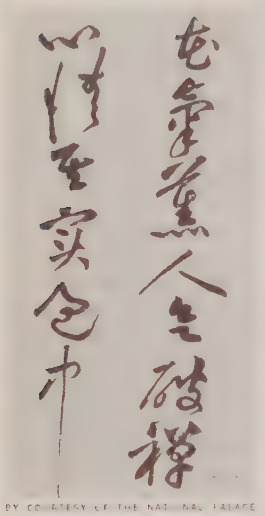

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FIG. 40.—*Ts'ao-shu* BY HUANG T'ING-CHIEN (1045–1105)

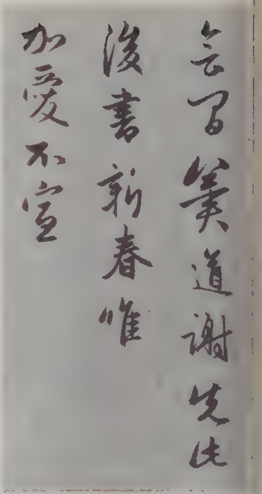

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FIG. 42.—*Hsing-shu* BY CHA MENG-FU (1254–1322)

In *K'ai-shu* each line, each square or angle, and even each dot can be shaped according to the will and taste of the calligrapher. Indeed, a Chinese word in regular style presents an almost infinite variety of problems of structure and composition and when executed it presents to the onlooker a design whose abstract beauty can draw the mind away from the literal meaning of the word itself.

The greatest exponents of Chinese calligraphy were Wang Hsi-chih (321–379) and his son Wang Hsien-chih (344–388). Few of their original works have survived, but a good number of their writings were engraved on stone tablets and rubbings were made from them. Many great calligraphers wrote after their styles, but none ever surpassed them. Since the 7th century there have been many master-calligraphers such as Ou-yang Hsün (557–641), Sun Kuo-t'ing (?–688), Ch'u Sui-liang (596–658), Yen Chen-ch'ing (709–784), Liu Kung-ch'üan (778–865), Su Shih (1036–1101), Huang T'ing-chien (1045–1105), Mi Fei (1051–1107), Emperor Hui'tsung (1082–1135), and Chao Meng-fu (1254–1322). A noted modern calligrapher was Yü Yu-jen (1878–1964).

Wang Hsi-chih not only provided the greatest example in the regular style of writing but also relaxed the tension somewhat in the arrangement of the strokes in the regular style by giving easy movement to the brush to trail from one word to another, as in Fig. 42. This is called *Hsing-shu* or running style, as if the hand were walking fast while writing. This in turn led to the creation of *Ts'ao-shu* or grass style as if the wind had blown over the grass in a manner disorderly yet orderly. The English term "cursive writing" cannot describe the Chinese grass style, for even a cursive hand can be deciphered without much difficulty. But Chinese words in grass style are greatly simplified forms of the regular style and can be deciphered only by those who have practised calligraphy for years. It is not a style for general use but for the calligrapher who wishes to produce a work of abstract art.

Technically speaking, there is no mystery in Chinese calligraphy. It depends on the skill and imagination of the writer to give interesting shapes to his strokes and to compose beautiful structures from them without any retouching or shading, and, most important of all, with well-balanced spaces between the strokes. This balance needs years of practice and training. The tools for Chinese calligraphy are very few—good ink, ink stone, a good brush, and good paper (some prefer silk). Even a child can fill up a squarish space with lines—straight or curved or circular—but to fill it so as to liberate the visual beauty of the linear shapes and composition depends on artistic insight and training of a master.

The fundamental inspiration of Chinese calligraphy, as of all arts in China, is nature. In *K'ai-sh*
or regular style each stroke, even each dot, suggests the form
of a natural object. As every twig of a living tree is alive, s
every tiny stroke of a piece of fine calligraphy has the energy o
a living thing. This is very different from the strokes in a printe
word. Printing does not admit the slightest variation in the shape
and structures, but strict regularity is not tolerated by Chines
calligraphers, especially those who are masters of the *Ts'ao-sh*
A finished piece of fine calligraphy is not a symmetrical arrange
ment of conventional shape, but something like the coordinate
movements of a skillfully composed dance—impulse, momentum
momentary poise, and the interplay of active forces combining t
form a balanced whole. The study of Chinese calligraphy i
the study of a highly advanced form of art with two keynotes—
a simulation in every stroke and a dynamic equilibrium in th
structure.

The art of calligraphy has long been highly esteemed in Japa
as in China. There is no definit
record of when the Japanese be
gan to use Chinese words—calle
kanji in Japanese. It is know
that a Korean scribe named Wa
brought some Chinese books o
Confucian classics such as *Th*
Analects, Great Learning, an
Book of Mencius, to Japan nea
the end of the 4th century A.
From the 7th century onwar
many Japanese scholars, particu
larly Buddhist monks, went t
China and some Chinese came t
Japan. As Indian Buddhis
reached Japan via Korea an
China and took root there, the us
of *kanji* in Japan gradually grew
Eventually *kanji* became the o
ficial system of writing in Japa
because it was the instrument o
transmission of Chinese Bu
dhism. Most of the Chinese Bu
dhist monks who went to live i
Japan were scholars and good ca
ligraphers; their writings on th
Buddhist scriptures and othe
subjects were highly admired an
esteemed not only for their ae
thetic value as calligraphy bu

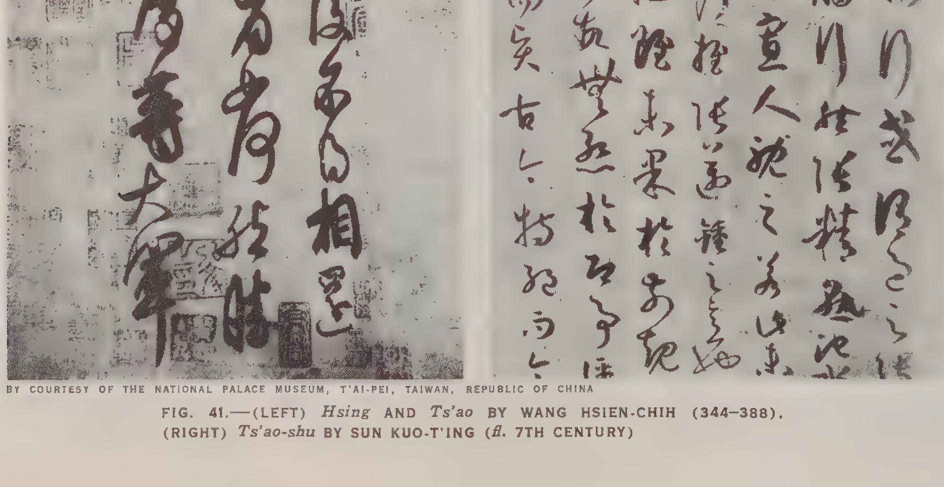

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FIG. 41.—(LEFT) *Hsing* AND *Ts'ao* BY WANG HSIEN-CHIH (344–388). (RIGHT) *Ts'ao-shu* BY SUN KUO-T'ING (*fl.* 7TH CENTURY)

Types of Japanese Zen Calligraphy

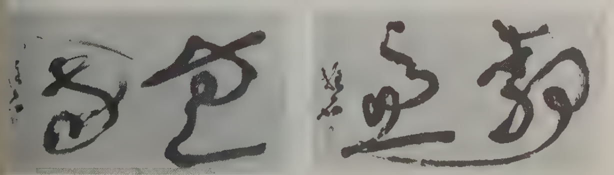
Kanji	Hiragana	Transliteration	Description
印可状	いんかじょう	*Inkajō*	document of permit approval
字號	じごう	*Jigō*	name or title given to a monk by his master
法語	ほうこ	*Hōgo*	words of the law or words of admonition
偈頌	げじゅ	*Geju*	gatha or hymn or short moral poem
遺偈	ゆいげ	*Yuige*	a will in the form of a gatha or hymn
進道語	しんどうこ	*Shindōgo*	instruction or words leading disciples to practise the dharma or law
詩	し	*Shi*	poetry
額字	かくし	*Gakuji*	tablet with a few words inscribed horizontally
書簡	しょかん	*Shokan*	letter or written communication

so because they were the work of devout personalities and inuced a sense of religious awe in the onlookers. Many of the arly Japanese emperors were ardent Buddhists and also acquired masterly hand in *kanji* writings. So did many Japanese Zen riests, and their calligraphy tended to exercise a religious effect pon the Japanese mind. Theirs became a special type of calligrahy in Japan, namely, Japanese Zen calligraphy or *Bokuseki,* clasfied into the nine items by Horie Tomohiko, as given in the table.

Naturally it was unsuitable for Japan to adopt an entire foreign nguage like Chinese, and Japanese thinkers began to devise a ew, native script known as *hiragana,* which was often referred to "women's hand" or *onnade* in Japanese. It was used particurly in the writing of Japanese poetry and had an elegant and raceful appearance. Thus in Japanese calligraphy there are vo different and distinctive types of writing, one in *kanji* and the her in *hiragana.* Among the best-known Japanese calligraers are Kūkai (Kōbō Daishi) (774–835), Emperor Saga (786–2), Ono no Michikaze (894–966), Fujiwara no Yukinari 72–1029), the Zen priest Daitō (1283–1350), and Ryōkan 757–1831). The modern living Zen authority, Shinichi Hisaatsu (1889–), has been the unique calligrapher of the esent age in Japan.

There are many outstanding pieces of Japanese calligraphy in *nji,* but they could not show distinction when put together ith their Chinese counterparts. However, Japanese *hiragana* lligraphy stands out prominently and proudly, especially in the yle of *renmentai,* where the *hiragana* are written continuously d connected together without break, and in *chōwatai,* in which me *kanji* words join hands with the *hiragana.* Japanese calgraphy in *renmentai* or in *chōwatai* has some resemblance to the hinese grass style, but the two are easily distinguishable. In hinese grass style, although the words are greatly simplified and veral words can be joined together with trailing strokes, each parate word normally still retains its regular spacing within an naginary square, big or small. But Japanese *hiragana* cannot be aced so separately and evenly. Therefore, a whole piece of *nmentai* calligraphy looks like a big bundle of beautiful silk rings hanging down confusedly yet artistically as if the calligraher had arranged them quite unconsciously. They were arranged nsciously of course, but the calligrapher seems to have let his hand move swiftly of its own accord. The separate strokes and dots have no distinctive shape but join other strokes and dots in the following *hiragana.* The strokes or lines in *hiragana* are not shaped like living things, nor are they of even thickness; but there must be good spacing between the strokes or lines and between one *hiragana* and another, so that there is no confusion or blur in the completed piece. This is an art and the whole piece has to be executed with speed and without hesitation. *Hiragana* requires solid training and artistic insight.

To complete the whole piece with its strokes or lines not too varied in shape yet not too even in thickness needs a special training; in order to keep the tip of the brush at an even distance from the paper the writer must cultivate a very steady hand. It is said that some Japanese calligraphers trained themselves with rigid discipline by supporting the right arm with a long cord hanging from the ceiling, so that the hand would be able to move the brush at a fixed distance from the paper with little variation. After the effect was achieved, the arm was then left entirely free. The Japanese calligrapher lays his paper on the floor and writes, while the Chinese lays his on a table. Both endure hardship in training, and both can produce wonderful results. (Y. CH.)



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G. 43.—MODERN JAPANESE CALLIGRAPHY BY SHINICHI HISAMATSU
889–)

ISLAMIC CALLIGRAPHY

In the 7th and 8th centuries A.D. the Arab armies conquered for Islam territories stretching from the shores of the Atlantic to Sind. Besides a religion, they brought to the conquered peoples a language both written and spoken. The Arabic language was a principal factor in uniting peoples who differed widely in race, language, and culture. In the early centuries of Islam, Arabic was the official language of administration: but more than that it was, and has remained, the language of religion and learning.

The Muslim believes that God (Allah) revealed to the Prophet Muhammad the Koran through the Archangel Gabriel as intermediary. For him, not only the sense but also the very words of the sacred text are inspired: and that is why in the Islamic world the Koran is recited not in the vernacular but in the original Arabic. The apparent great respect for the written word of God clearly explains the reason calligraphy was accorded a high rank among the arts; and why to copy the Koran was esteemed a most meritorious act. The names that are recorded of those who excelled in the art of writing far outnumber those of architects, painters, and craftsmen.

The Arabic Script.—The Arabic script was evolved probably during the 6th century A.D. from Nabataean, a dialect of Aramaic current in northern Arabia. The earliest surviving examples of Arabic before Islam are inscriptions on stone.

Arabic is written from right to left and consists of 17 characters or outlines, certain of which by the addition of dots placed above or below the character provide the 28 letters of the Arabic alphabet. Short vowels are not included in the alphabet, being indicated by signs placed above or below the consonant or long vowel which they follow. Certain characters may be joined to their neighbours; others to the preceding one only and others to the succeeding one only. When coupled to another, the form of the character undergoes certain changes.

These features and the fact that there are no capital forms of letters give the Arabic script its particular character. A line of Arabic suggests an urgent progress of the characters from right to left. The nice balance between the vertical shafts above and the open curves below the middle register induces a sense of harmony. The peculiarity that certain letters cannot be joined to their neighbours provides articulation. For writing, the Islamic calligrapher uses a reed pen (*qalam*) with the working point cut on an angle. This produces a thick down stroke and a thin up stroke with an infinity of gradation in between. The line traced by a skilled calligrapher is a marvel of fluidity and sensitive inflection, communicating the very action of the master's hand. Even in monumental inscriptions whether on stone or some other intractable material, the craftsman still tries to retain this sense of the guiding hand by graduating the thickness of his line.

The Principal Scripts.—Broadly speaking there are two distinct scripts in the early centuries of Islam: cursive script and Kufic script. For everyday purposes a cursive script was employed: typical examples are to be seen in the Arabic papyri from Egypt. Rapidly executed, the script does not appear to have been subject to formal and rigorous rules; and not all the surviving examples are the work of professional scribes. Kufic script, however, seems to have been developed for religious and official purposes. The term Kufic means the script of Kufa, an Islamic city founded in Mesopotamia in A.D. 638; but the actual connection between the city and the script is not clear. Kufic is a more or less square and angular script. In monumental and funerary inscriptions in stone the angular forms may be partly dictated by the material. Professional copyists employed a particular form for reproducing the earliest copies of the Koran that have survived. These are written on parchment and date from the 8th to the 10th century. They are mostly of an oblong as opposed to codex format. The writing is often large, especially in the early examples, so that there may be as few as three lines to a single page (fig. 44). The script can hardly be described as stiff and angular; rather the pace is majestic and measured. Arab scholars writing in this early period record a great number of scripts. Unfortunately their descriptions do not allow us to determine the precise nature of these.

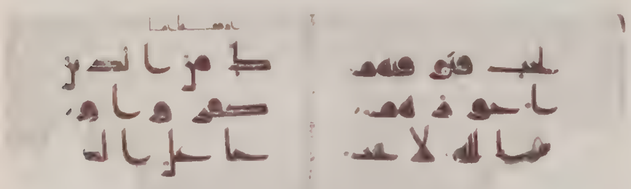

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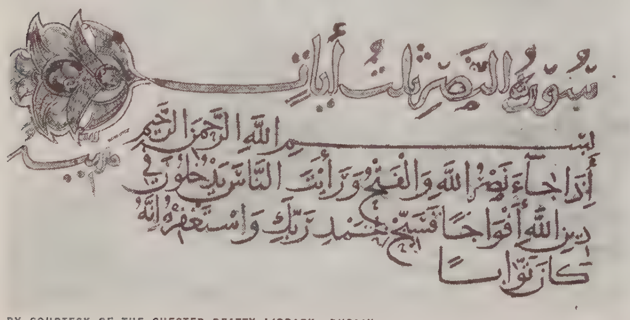
FIG. 44.—DOUBLE OPENING OF KORAN COPIED FOR AMĀJŪR, GOVERNOR OF DAMASCUS (870–874 A.D.), 9TH CENTURY, SYRIA

Kufic went out of general use about the 11th century, although it continued to be used as a decorative element contrasting with those scripts which superseded it. About A.D. 1000 a new script was established and came to be used for copying the Koran. This is the so-called *naskhi* script which has remained perhaps the most popular script in the Arab world. It is a cursive script based on certain laws governing the proportions between the letters. The two names associated with its development are Ibn Muqla (d. 939) and Ibn al-Bawwab (d. 1022) both of whom lived and worked in Mesopotamia. Of the latter's work a single authentic example survives, a manuscript of the Koran in the Chester Beatty Library, Dublin (fig. 45). *Naskhi* was used for copying the Koran from the 11th century onward.

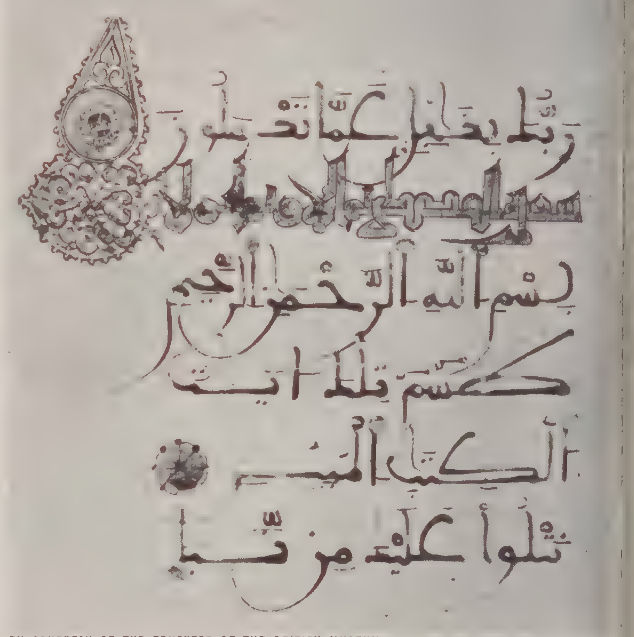


BY COURTESY OF THE CHESTER BEATTY LIBRARY, DUBLIN

FIG. 45.—KORAN COPIED BY IBN AL-BAWWAB, 1000–01 A.D., BAGHDAD (MS. 1431, FOL. 283)

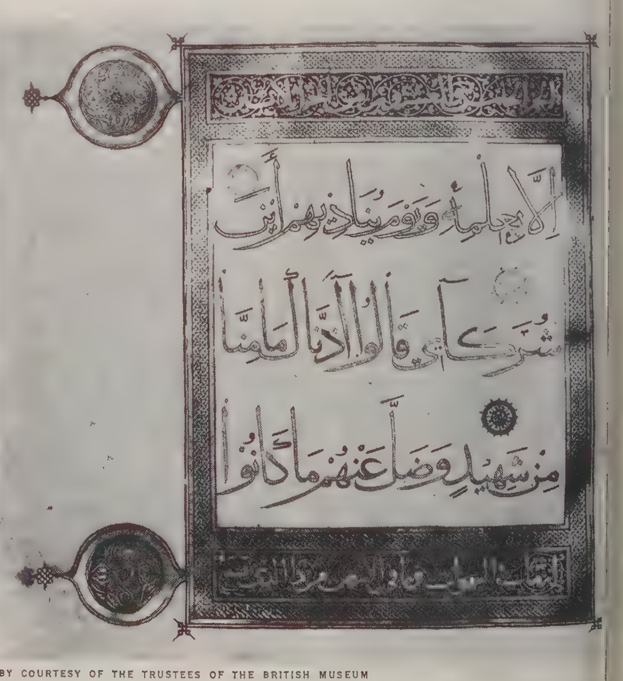
The conception of proportional relationships between the letters gave rise to other scripts, more or less variants on *naskhi:* such as the large and majestic *thuluth* script which came to be adopted for many of the large copies of the Koran produced from the 13th century (fig. 47). In Mameluke Egypt of the 14th and 15th centuries the *tumar* script was also used for large Korans.

Distinctive scripts were developed in particular regions. I Spain, the *maghribi* ("Western") script was evolved and becam



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

FIG. 46.—KORAN, 13TH OR 14TH CENTURY, NORTHWEST AFRICA OR SPA

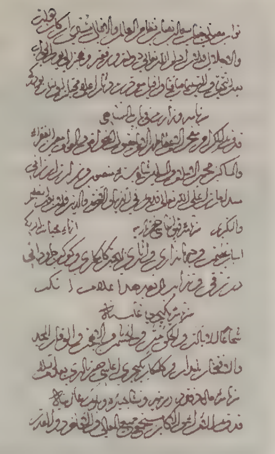


BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

FIG. 47.—KORAN COPIED FOR THE SULTAN ULJAI'TU, 1310, MOSUL

e standard script for Korans north Africa. Derived ulti- ately from Kufic, it is charac- erized by the exaggerated exten- on of horizontal elements and of e final open curves below the iddle register as well as by cer- in orthographic peculiarities fig. 46).

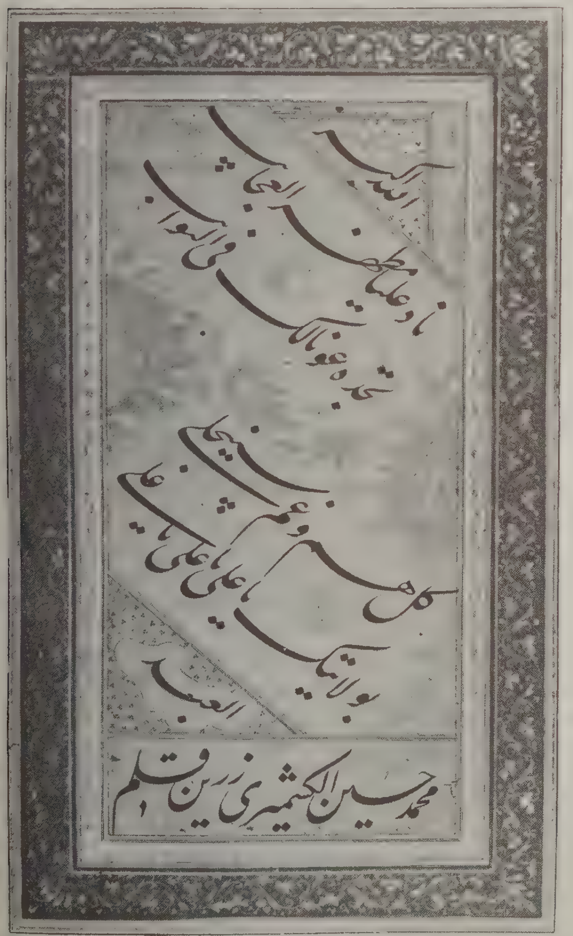
Both Persia and Turkey made nportant contributions to callig- aphy. In these countries the rabic script was adopted for the ernacular. The Persian scribes vented the *taliq* script in the 3th century. The term *taliq* eans suspension and aptly de- cribes the tendency of each word drop down from its preceding ne. At the close of the same entury a famous calligrapher, ir Ali of Tabriz, evolved *astaliq* which, according to its ame, is a combination of *naskhi* nd *taliq*. Like *taliq* this is a fluid and elegant script and both ere popularly used for copying Persian literary works.



BY COURTESY OF THE BODLEIAN LIBRARY, OXFORD

FIG. 48.—DIWANI SCRIPT, 1598–99 (MS. LAUD OR. 67, FOL. 77 RECTO)

A characteristic script developed in Ottoman Turkey was that sed in the chancellery and known as *diwani*. It is highly man- ered and difficult to read (fig. 48). Peculiar to Turkish calligra- hy is the *tughra*, a kind of royal cypher based on the names and titles of the reigning Sultan and worked into an intricate and beautiful design. A distinctive *tughra* was created for each Sultan and affixed to imperial decrees by a skilled calligrapher, the *nishanji*.



COURTESY OF THE BODLEIAN LIBRARY, OXFORD

G. 49.—PENMANSHIP SPECIMEN OF MOHAMMED ZARRIN QALAM, BETWEEN 13 AND 1670 (MS. OUSELEY ADD. 167, FOL. 9 RECTO)

There has always existed in the Islamic world a keen appreciation of fine handwriting and from the 16th century it became a practice to assemble in albums specimens of penmanship. Many of these assembled in Turkey, Persia, and India are preserved in museums and libraries (fig. 49). Calligraphy, too, has given rise to quite a considerable literature such as manuals for professional scribes employed in chancelleries.

In its broadest sense calligraphy also includes the Arabic scripts employed in materials other than parchment, papyrus, and paper. In religious buildings verses from the Koran were inscribed on the walls for the edification of the faithful whether carved in stone or stucco or executed in faience tiles. Religious invocations, dedications, and benedictory phrases were also introduced into the decoration of portable objects. Generally speaking there is a close relationship between these and the scripts properly used on the conventional writing materials. It was often the practice for a skilled penman to design monumental inscriptions.

(R. H. P.-W.)

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CALLIMACHUS (fl. *c.* 260 B.C.), Greek poet and scholar, was so highly esteemed in antiquity that no other Greek poet except Homer is so often quoted by ancient grammarians. A native of Cyrene in north Africa, son of Battus (hence he calls himself Battiades in *Epigr. 35* and is so styled by the Latin poets), he first became a schoolmaster in Eleusis, a suburb of Alexandria, but later was introduced to Ptolemy Philadelphus and found employment in the Alexandrian library. According to the lexicon of Suidas his works numbered more than 800, but only six hymns and 63 epigrams survive intact. However, the papyri discoveries made in Egypt during the 19th and 20th centuries have filled many gaps in the text of other poems, of which previously only discontinuous fragments were extant. This is particularly true of Callimachus' chief poetical work, the *Aetia* ("Causes"), a narrative elegy in four books, containing a medley of recondite tales from Greek mythology and history. It included two love stories with happy endings (unusual in Alexandrian poetry), the famous tale of Acontius and Cydippe (*frag.* 67–75 in R. Pfeiffer's edition) and the less familiar one of Phrygius and Pieria (*frag.* 80–83). Another papyrus contains *Diegeseis* ("Expositions") of book 4 and the last *Aetia* of book 3, headed by the first line of each *Aetion*, and proves that in these books Callimachus passed from one *Aetion* to another without any formal connection, but in book 1 and perhaps in book 2 the poet represented himself as obtaining his information from the muses whom he interviewed on Mt. Helicon to which he had been carried in a dream. Ovid imitated this colloquy with the muses in his *Fasti*. In reality Callimachus drew his material from general histories like that of Timaeus or from the chronicles of local historians.

The *Aetia* were probably first published about 270 B.C. and established Callimachus' primacy in elegy (Quintilian calls him *princeps elegiae*), but he also later composed elegies for special occasions, the best-known being the *Lock of Berenice*, translated rather freely by Catullus (66). Also interesting, in a more pedestrian mood, were the *Iambi*, a collection of 13 poems, mainly in the iambic or choliambic metre, on topics ranging from literary criticism and social satire to congratulations on the birth of a daughter. There are also fragments from the *Mele* ("Lyrics"), the most striking of which is the funeral ode for Arsinoë, the consort of Philadelphus. Callimachus deemed long epic unsuitable to the age, but his short epic, the *Hecale*, was justly famous. It takes its name from the old lady at whose cabin Theseus spent the night before his struggle with the Marathonian bull. Her homely reception of the hero and their ensuing conversation occupied much of the poem, but many details still remain obscure. The six *Hymns* (five in hexameters and one in elegiacs) exhibit great originality in varying the traditional form, especially ii, v and vi which are dramatic and lyric rather than epic. The *Epigrams* cover a wide range of topics and show that Callimachus was as much a master in this field as he was in elegy.

Callimachus' poetical creed, in particular his insistence on consummate craftsmanship within a relatively small compass, provoked much opposition from his contemporaries, and in a prologue (*frag.* 1) to what seems to be a final edition of his collected poems he answers his critics, whom he nicknames "Telchines" ("malevolent demons"). His quarrel with Apollonius Rhodius, his former pupil, formed part of this controversy. The *Ibis*, a poem in which he may have imprecated unpleasant deaths on Apollonius, is lost, but Ovid's poem with the same name was inspired by it.

Callimachus was also a prolific writer in prose. Here his most famous work was the *Pinakes* ("Tablets") in 120 books, an elaborate catalogue of the Alexandrian library, which laid the foundation of the history of Greek literature; many others, such as his encyclopaedias on special subjects and his collections of *Mirabilia* and the like, are cited by later Greek scholars.

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CALLINUS, Greek elegiac poet, active in Ephesus about th middle of the 7th century B.C., appears to have written narrativ poems about the period of the Trojan War and the subsequen colonization by the Greeks of the coastal districts of Asia Minor The only actual quotations which survive, however, deal eithe with the Cimmerians and the Trerians, nomadic peoples whos raids terrorized all Asia Minor for many years in the 7th centur (the Cimmerians actually sacked Sardis *c.* 652) or with the danger threatening Ephesus from some unspecified enemy. The longes is an appeal to the young men to cast off their cowardly sloth an prepare to fight, and if necessary die, for their country.

See J. M. Edmonds, *Elegy and Iambus,* vol. i, pp. 40–49, "Loeb Series (1931); C. M. Bowra, *Early Greek Elegists,* Martin Classical Lecture pp. 13–16 (1938). (JN. A. D.)

CALLIOPE, the chief of the Muses (*q.v.*), occasionally i late authors the Muse of epic poetry (Gr., "beautiful voice").

CALLISTHENES (OF OLYNTHUS) (*c.* 360–328 B.C.), Gree historian, was appointed to attend Alexander the Great as historia of his Asiatic expedition on the recommendation of his uncle an former tutor, Aristotle. He offended Alexander by censuring hin for the adoption of certain oriental customs and was subsequentl accused of being privy to a conspiracy. He was thrown into priso where he died in distressing circumstances, the details of whic are in dispute. His death was commemorated by his friend Theophrastus in *Callisthenes or a Treatise on Grief*. Callisthene wrote a history of Greece from the peace of Antalcidas (387) t the Phocian War (355); a history of the Phocian War; an accoun (presumably unfinished) of Alexander's expedition; and othe works, all of which have perished. It is known that he allude to the story of Alexander's divine birth, which means that h must have been the first to do so.

The romantic life of Alexander, the basis of all the Alexande legends of the middle ages, originated during the time of th Ptolemies, but in its present form belongs to the 3rd century A. Its author is usually known as pseudo-Callisthenes, although i the Latin translation by Julius Valerius Alexander Polemius (beginning of the 4th century) it is ascribed to Aesopus. There ar also Syrian, Armenian and Slavonic versions, in addition to fo Greek versions (two in prose and two in verse) which date fro the middle ages.

Valerius' translation was completely superseded by that of Le archpriest of Naples in the 10th century, the so-called *Historia d Proeliis* ("History of Battles"). *See* also ALEXANDER ROMANCES *Ancient Sources.*

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CALLOT, JACQUES (1592–1635), French artist, one c the first great creative artists to practise the graphic arts excl sively, was born at Nancy, where his father was a minor cou official. His career was divided into two parts: an Italian perio *c.* 1609–21; and a Lorraine period from 1621 until his deat Callot learned the technique of engraving under Philippe Thoma sin in Rome. About 1612 he joined Giulio Parigi in Florence. A that time Medici patronage expended itself almost exclusively o *feste,* and Parigi and Callot were employed to make pictori records of these mannered, sophisticated entertainments. Call succeeded in evolving a naturalistic style while preserving th artificiality of the occasion. He organized a composition as if were a stage setting and reduced the figures to a tiny scale, eac one being indicated by the fewest possible strokes. This require a very fine etching technique. His breadth of observation, h lively figure style and his skill in assembling a large, jostlin crowd, secured for his etchings a lasting popular influence all ov Europe.

He had a genius for caricature and the grotesque. His series plates of single figures, for example the *Balli di Sfessania,* th *pricci* and the *Gobbi,* are witty and picturesque, and show a rare e for factual detail.

With a few exceptions, the subject matter of the etchings of e Lorraine period is less frivolous and Callot was hardly em- oyed at all by the court at Nancy. He illustrated sacred books, ade a series of plates of the Apostles and visited Paris to etch imated maps of the sieges of La Rochelle and the Île de Ré. In s last great series of etchings, the "small" and the "large" *isères de la Guerre,* he brought his documentary genius to bear the atrocities of the Thirty Years' War. He was one of the st etchers to use the technique of the repeated biting, and often mbined graver work with etching. Callot is well known for his ndscape drawings in line and wash, and for his quick figure idies in chalk.

Callot died at Nancy, March 24, 1635.

See D. Bechtel (ed.), *Jacques Callot* (1955). (M. W. L. K.; X.)

CALMETTE, ALBERT (LÉON CHARLES) (1863–33), French bacteriologist, co-developer of the tuberculosis vac- e BCG, was born at Nice, July 12, 1863. He received his dical degree at Paris in 1886. He introduced a protective um against snake bite and described the ophthalmic tuberculin ction.

In collaboration with Camille Guérin, he developed the most dely used vaccine for the prevention of tuberculosis. As the ult of a fortuitous observation he found that virulent bovine ercle bacilli lost their virulence when cultured on a bile-con- ning medium, but that these attenuated bacilli were still able confer a certain amount of immunity against infection with her bovine or human tubercle bacilli. This strain is named er its discoverers Bacillus Calmette-Guérin or BCG. The ccine prepared with the live organisms came to be widely used oughout the world, proving its efficacy in reducing the incidence d severity of all forms of tuberculosis.

A director of the Pasteur institute, Calmette defended in merous scientific publications his most important discovery, ich was universally recognized only after his death, which oc- rred Oct. 29, 1933.

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CALMETTE, GASTON (1858–1914), French journalist o exposed the financial duplicity of the government. He was rn at Montpellier, July 30, 1858. As editor of *Le Figaro* in 1913 d 1914 he originated the bitter attacks on the policy of the nister of finance, Joseph Caillaux (*q.v.*) whom he accused of ering advantages to his friends. Earlier, in the Rochette case 1911, it was alleged by *Le Figaro* that under the influence of the ancier Vereux the course of justice had been delayed. Calmette s fatally shot by Mme Caillaux at the office of *Le Figaro* on rch 16, 1914, when incriminating documents on the minister re about to be published. (A. PE.)

CALNE, a market town and municipal borough in the Chip- nham parliamentary division of Wiltshire, Eng., 16 mi. S.W. of indon on the Bath road. Pop. (1961) 6,574. Lying in the lley of the Calne west of the Marlborough downs, it was the e of a palace of the West Saxon kings. A synod met there in 8 and a witenagemot was summoned in 997. In the Domesday rvey Calne was a royal borough and it returned two members parliament from 1295 until 1832. In the reign of Edward III emish weavers helped to make it a large wool centre. The esent borough seal dates from 1565 and the area was more than pled in 1934. The tower of the church of St. Mary the Virgin by Inigo Jones; the grammar school was founded by John ntley in 1660. Robert Grosseteste (*q.v.*) and Edmund Rich *e* EDMUND, SAINT) were two famous medieval rectors. Bacon ring is the staple industry and there is also milling. Bowood use, 2 mi. S.W., seat of the marquess of Lansdowne, was designed the Adam brothers (later additions were removed in 1955).

From 1772 to 1780 Joseph Priestly was librarian and literary npanion to Lord Shelburne at Bowood.

CALOCHORTUS, a genus of about 40 species of western North American plants of the lily family (Liliaceae; *q.v.*). They are attractive corm-bearing plants, with linear-lanceolate leaves and showy yellow, white, lilac or blue flowers often spotted in the centre and borne singly or in terminal clusters.

The species are known under several common names, such as mariposa tulip, butterfly tulip, globe tulip, star tulip, mariposa lily (*q.v.*), butterfly lily, sego lily and as fairy lantern and pussyears. The sego lily (*C. nuttallii*) is the state flower of Utah. Most of the species are easy to grow in porous, well-drained garden soil but do not stand alternate thawing and freezing.

(J. M. BL; X.)

CALOMEL, a white powder used in medicine since the 16th century. Once the most popular of cathartics, calomel is also said to stimulate the liver. The recognition of its potential toxicity, together with the development of superior and safer cathartics, resulted in a decline in calomel's use as an internal medicine. It is still used in salves and ointments, having mild antiseptic action. Its use as a fungicide has also declined.

Calomel, or mercurous chloride, Hg_2Cl_2, occurs in nature as the minor mineral, horn mercury. It is manufactured by subliming mercuric chloride, $HgCl_2$, and mercury, and can also be prepared by heating mercurous sulfate and common salt or by precipitating from a mercurous salt solution by the addition of hydrochloric acid.

Pure, dry calomel is reasonably stable, subliming unchanged at low red heat. The vapour consists of Hg_2Cl_2 molecules, but moisture catalyzes the decomposition into mercury and mercuric chloride, especially when heated. Light causes partial decomposition. This disassociation is the cause of toxicity in samples improperly prepared or stored.

Calomel darkens upon treatment with ammonia, a reaction often used for its identification. It is insoluble in water but is attacked by many oxidizing agents, which convert it into compounds of bivalent mercury. Hot nitric acid converts it to mercuric nitrate, $Hg(NO_3)_2$. In contact with many metals the mercury is displaced.

Solutions of potassium chloride, saturated with calomel, give constant electromotive forces against the mercury electrode. There are three standard calomel electrodes in common use as references in electrochemical investigations (*see* HYDROGEN IONS). They contain saturated KCl, 1 molar KCl and 0.1 molar KCl, with the values −0.2420 v., −0.2810 v. and 0.3338 v. respectively, when measured at 25° C. against the normal hydrogen electrode (arbitrarily chosen as zero). (WN. B.)

CALONNE, CHARLES ALEXANDRE DE (1734–1802), French statesman whose efforts to reform the structure of French finance and administration provoked the so-called "revolt of the nobles" in 1787 and made inevitable the summoning of the estates-general that he had hoped to avoid and that led directly to the French Revolution. Born at Douai on Jan. 20, 1734, Calonne had held various legal and administrative appointments from 1757 in French Flanders and in Artois before he first attracted public notice in 1766, when he tried unsuccessfully to overcome the opposition of the province of Brittany to the central government's fiscal policy, thereby incurring the hostility of the parlements. After this he was made intendant of Metz (1768) and of Lille (1774). As the candidate of the prince de Polignac's group of court favourites, Calonne became controller-general of finance on Nov. 3, 1783. His main task was to initiate financial retrenchment and reform after the American Revolution. He reconstituted a sinking fund in 1784, reformed the gold coinage in 1785 and gave his support to the Anglo-French commercial treaty of 1786. He also attempted to revive French credit by a program of extensive public works, including the development of Le Havre and Cherbourg. In 1786 he sought to stave off national bankruptcy by radical reforms as advocated by the Physiocratic school. These included the institution of a proportional land tax levied in kind on the privileged orders as well as on the third estate, the calling of "provincial assemblies" in the *pays d'élection* and the reform of the *corvée* and *gabelle* and the abolition of the internal customs duties. Afraid of the opposition of the parlements, he submitted these proposals to a quasi-representative assembly of notables in Feb. 1787. The intrigues of his political opponents, Jacques Necker's criticisms and the antagonism of the higher clergy and magistrates caused the rejection of these plans and Calonne's dismissal in April 1787. His revelation of the annual deficit of more than 100,000,000 livres and the failure of his reform schemes ensured the summons of the estates-general in Aug. 1788.

Calonne's subsequent activities were largely devoted to the cause of counter-revolution. He left France in 1787 and became one of the severest critics of the financial and ecclesiastical policy of the Constituent assembly. He published his criticisms in London in 1790 under the title of *De l'état de la France, présent et à venir.* From Dec. 1790 till the fall of the French monarchy he acted as chief minister and adviser to the *émigré* princes. Louis XVI and Marie Antoinette, however, distrusted him, and the suspicion of the Prussian and Austrian governments and the rivalry of the baron de Breteuil (L. A. Le Tonnelier) paralyzed his influence after 1792. After returning to France in 1802, he died on Oct. 29.

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(A. GN.)

CALORIE. The calorie, a unit of energy, was originally defined as the quantity of energy (or heat) necessary to raise the temperature of one gram of water, at constant atmospheric pressure, by 1° C. The kilocalorie (sometimes called the kilogram-calorie or large calorie) is 1,000 cal. The calorific value of foods is usually given in terms of kilocalories and through loose usage the prefix "kilo" is often omitted. The "calories" counted by persons on a reducing diet are kilocalories.

Since about 1925, the calorie has been defined in terms of the joule (*see* CALORIMETRY: *Units*). The use of the calorie as a unit of energy is common in those fields of science and engineering where the energy change is thought of in terms of the quantity of heat added to or subtracted from a substance in order to effect a change. Thus the heat capacities of substances, heats of melting and vaporization and heats of reaction associated with a chemical change are usually expressed in terms of calories. (*See* also HEAT; PHYSICAL UNITS; THERMODYNAMICS.)

On the Celsius temperature scale, formerly called the centigrade scale (the name Celsius was adopted by the General Conference on Weights and Measures in 1948), the melting point of ice is defined as 0° C. and the boiling point of water at atmospheric pressure is defined as 100° C. The quantity of heat represented by the calorie was found by experiment to differ by nearly 1% over the temperature range between 0° and 100° C. and consequently it was necessary to define the temperature at which the specific heat of water is to be taken as 1 cal. Three common definitions have been employed: (1) the 20° cal. (4.1816 joule), from 19.5° to 20.5° C.; (2) the 15° cal. (4.1855 joule), from 14.5° to 15.5° C.; (3) the mean calorie (4.1897 joule), defined as $\frac{1}{100}$ of the heat necessary to raise the temperature of 1 g. of water from 0° to 100° C.

In early calorimetric measurements quantities of heat were measured by comparison with the specific heat of water and it was convenient to define the calorie in terms of the properties of water. Since about 1910 most accurate calorimetric measurements have employed electrical heating, and the energy introduced, expressed in joules, could be determined to high precision from electrical measurements. Prior to the international acceptance of the joule as a unit of heat (1948) there existed a sort of temporary electrical standard, the international joule, which was based on subsidiary electrical standards rather than on the Metre, Kilogram, Second (MKS) system. By 1948 it was possible to determine the absolute values of these units with the necessary precision and to drop the temporary electrical units. The calorie, which had since 1925 been defined in terms of such units, was simply redefined in terms of absolute rather than international joules, and the real values did not change, leaving the mass of thermodynamic data numerically unaltered.

In the United States the thermochemical calorie, defined 4.1840 joules, is commonly used as the unit for heat capaciti latent heats and heats of reaction. In engineering steam tabl the "I.T." calorie, originally defined as $\frac{1}{860}$ int. watt-hr. (4.18 joules), is internationally used. The name of this calorie, fi applied in 1934, derives from the initials of the first and thi words of the designation "International Steam Table" or t German equivalent *"Internationale Dampf-Tabelle."*

(J. W. ST.)

CALORIMETRY. Calorimetry is the scientific term f the measurement of energy in the form of heat. This term nee to be distinguished from thermometry (*q.v.*), which is the measu ment of temperature, or the degree of hotness or coldness. He is measured quantitatively by observing the effects that it produc The most important effects for present purposes are: (1) rise temperature of a substance when heat is added; (2) change in t physical state of a substance as from solid to liquid or from liqu to vapour (*see* PHASE EQUILIBRIA), and (3) transformation chemical, electrical or mechanical energy into heat or vice ver

Many different types of calorimeters have been devised f measuring amounts of heat by observing quantitatively the effe produced or comparing the effects produced when energy in oth forms is transformed into heat.

Calorimetric measurements are widely employed in many fie of science and industry. They are routinely used in the measu ment of the heating value of coal, oil and natural gas and in determination of the heat of combustion of foods.

Calorimetric measurements have been used to measure the ergy changes in radioactive decay, the binding energies of ato in molecules and crystals and the energy of interaction betw electrically charged particles (ions) in solution, to mention onl few. The measurement of the heat capacities of substances is importance in the understanding of the atomic vibrations in cr tals, the properties of electrons in a metal, the interactions betw the elementary magnets in an iron magnet and many other physi phenomena.

It is possible to define thermodynamic properties of a substan which depend only on the pressure, temperature, amount of terial and chemical nature of the substance (*see* THERMODYNA ICS). One such property is the energy, E. In a process carr out at constant volume, under conditions so that no mechani or electrical energy is involved, the change in the internal energy a substance is equal to the heat absorbed by the substance. processes carried out at constant pressure, if the only mechani or electrical energy involved is the work done against the exter atmosphere, the heat absorbed by a substance is equal to the char in another thermodynamic property, the enthalpy or heat conte The enthalpy, H, is $E + pV$ where p is the pressure and V t volume.

Calorimetric measurements are therefore measurements of ergy or enthalpy changes associated with changes in temperat of a substance, changes of state (solid, liquid or gas) or chan accompanying chemical reactions. The realization that the h content of a particular substance in a given state of aggregatior proportional to the mass of the substance and otherwise deper only on the temperature and pressure was first put in categori form by Sadi Carnot (*see* HEAT) as the basis of his argum on the motive power of heat by the method of the cycle.

The heat capacity of a substance at constant pressure is rate of change with temperature of the heat content (or enthalp The heat capacity per gram is called the specific heat. Thus specific heat is the quantity of heat required to raise the tempe ture of one gram of a substance by one degree. In principle calorimetric measurement of the specific heat of a substance sists in introducing a measured quantity of heat and measur the consequent rise in temperature of the substance. Thus if add an amount of electrical energy, W, by means of an electri heater to a substance of mass, m, and observe a temperature ΔT, then the specific heat of the substance is given by $W/(m\Delta$ The heat added to the substance will be equal to the electri energy, W, only if there is no heat exchange by conduction radiation between the substance and its surroundings and the ore in accurate calorimetric measurements it is important to have ood thermal insulation between the calorimeter and the surroundngs and to make corrections for any small heat exchange with the urroundings which may be present. The famous measurements of ne "mechanical equivalent of heat" by James Prescott Joule (*see* elow) were measurements of the specific heat of water and other ubstances in terms of mechanical energy.

The science of thermochemistry (*q.v.*) deals with changes in nergy and enthalpy accompanying chemical reactions, and is based n calorimetric measurements. By combining measurements of eat capacities to very low temperatures (in most cases to 15° K., a temperature obtainable with liquid hydrogen) with thermochemical data it is possible to calculate the amounts of the various eactants and products present at equilibrium in a chemical reacion and thus to determine the maximum possible yield, under pecified conditions of temperature and pressure, of a desired roduct. Using the results of calorimetric measurements and the aws of thermodynamics, one can determine, to list only three xamples: the maximum amount of useful work obtainable from he reaction of a ton of coal with the oxygen of the atmosphere; he optimum conditions for the fixation of nitrogen through reacon with hydrogen to form ammonia; or the minimum pressure ecessary, at a sufficiently high temperature so the reaction rate s not too slow, to make diamonds from coke. The calorimetric neasurement of low temperature heat capacities and heats of comustion of substances participating in reactions taking place in iological systems permits the calculation of free energy changes useful work) available in metabolic processes occurring in living rganisms.

Because of the importance of thermochemical data for deermining the equilibrium in chemical reactions, numerous measrements have been made, usually employing calorimetric methods, f the heats of tens of thousands of chemical reactions, and the esults have been critically reviewed and combined into tables hich list, at a selected temperature and pressure, the heat of ormation from the elements of several thousand chemical comounds. Since the enthalpy (or heat content) is a property of the ubstances involved in a chemical reaction the chemist is able, y reference to such tables, to calculate the heats of any reaction etween compounds listed in the tables and thus is able to predict he heat effects accompanying a vastly greater number of reactions han those which have been measured directly. An authoritative ompilation of such thermochemical data is the U.S. National ureau of Standards *Circular 500*, "Selected Values of Chemical hermodynamic Properties," Washington, 1952.

Early Methods of Calorimetry.—One of the earliest calorimeters, devised about 1760 by Joseph Black, consisted of a block f ice hollowed out in the centre and covered with a slab of ice. he method of operation is briefly as follows. A substance of nown mass, M_s, is heated to a temperature, t_1, quickly dropped nto the ice calorimeter and the cover put on. Sufficient time is allowed for the substance to cool to the ice temperature, t_0. The water formed by the heat given up to the ice is removed and its mass, M_w, is determined by weighing. Equating the heat given up by the substance to the heat absorbed by the ice, gives the relation

$$M_s(h_1-h_0)=M_wL$$

where L is the amount of heat required to melt unit mass of ice, called the latent heat of fusion of ice, and h_1-h_0 is the amount of heat given up by unit mass of the substance in cooling from t_1 to t_0. The mean specific heat, C_m, of the substance over the temperature interval is given by

$$C_m=(h_1-h_0)/(t_1-t_0)=M_wL/M_s(t_1-t_0).$$

The symbol h appearing in the above expression represents the enthalpy (or heat content) per unit mass. It is related to the enthalpy, H, defined earlier by the equation $H=M_sh$.

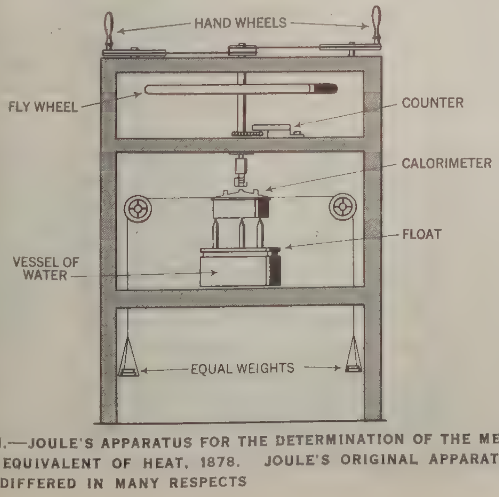

FIG. 1.—JOULE'S APPARATUS FOR THE DETERMINATION OF THE MECHANICAL EQUIVALENT OF HEAT, 1878. JOULE'S ORIGINAL APPARATUS OF 1850 DIFFERED IN MANY RESPECTS

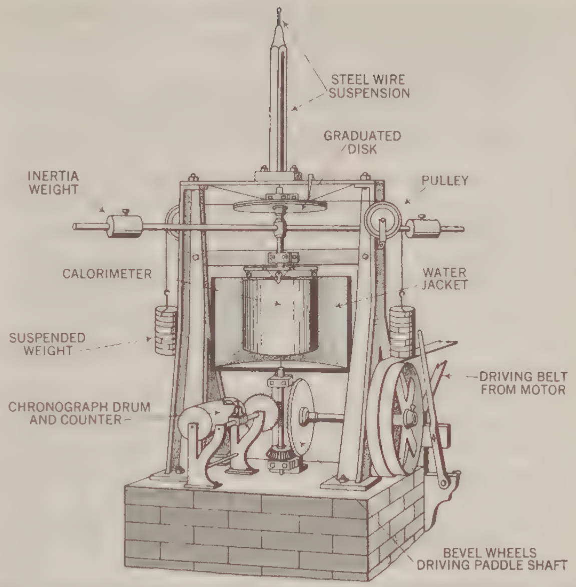

FIG. 2.—ROWLAND'S APPARATUS FOR THE DETERMINATION OF THE MECHANICAL EQUIVALENT OF HEAT, 1879

About 1830 Carnot estimated the heat necessary to heat one kilogram of water by 1° Celsius or Centigrade to be equivalent to 370 kilogram metre (kg.m.), which is about 13% lower than the present accepted value. Carnot planned to determine this quantity experimentally but his early death in 1832 stopped these experiments.

Henri Regnault used a method of calorimetry called the method of mixtures. A substance is heated to some desired temperature and dropped into a calorimeter containing a known amount of water at a known temperature. The rise in temperature of the water serves to measure the amount of heat given up by the substance in cooling from its initial temperature to the final temperature of the calorimeter.

James Prescott Joule used calorimeters in which mechanical energy was transformed into heat by utilizing the potential energy of weights to drive paddles which stirred a liquid and raised its temperature. His experiments began about 1840 and continued up to 1878. He made these experiments with different substances to show that heat was a form of energy quite independent of the substance which was heated. The numerical relation between mechanical energy and heat, known as the mechanical equivalent of heat, or Joule's equivalent, subsequently has been denoted by the letter *J*. As a further tribute to Joule, all science now honours him by the use of his name for a unit of energy.

Henry A. Rowland, using apparatus similar to that used by Joule but with characteristic attention to detail, made a series of experiments covering the range of temperature from 5° to 35° C. to study the variation in specific heat of water with temperature.

Recent experiments seem to substantiate Rowland's estimate that his results in the range 15°–25° C. would not be changed by as much as 2 parts in 1,000.

Units.—Physical units are treated in a special article on this subject (*see* PHYSICAL UNITS). Nevertheless, it seems desirable to give some consideration here to the units used in calorimetry.

Heat is related to other forms of energy by the first law of thermodynamics (*q.v.*) which states that the change in energy of a substance is the sum of the heat absorbed by the substance and the energy acquired by the substance because of electrical, mechanical or other work done on it. It is therefore most consistent to use as a unit of heat the unit accepted for other forms of energy. This unit is the joule, and in Oct. 1948 the 9th General Conference on Weights and Measures adopted a resolution recommending the use of the joule as the unit of heat.

For many years, however, quantities of heat could be measured most conveniently and accurately in terms of the temperature rise of a known mass of water. This fact led to the general use of heat units based on the properties of water such as the calorie: that quantity of heat required to heat one gram of water 1° C.; and the British thermal unit (B.T.U.): that quantity of heat required to raise the temperature of one pound of water 1° F. (*See* CALORIE.)

With the development of accurate electrical standards near the beginning of the 20th century, it became possible to measure energy introduced into a calorimeter electrically more accurately than heat can be measured in terms of the specific heat of water. For a time the international joule, based upon working standards of electrical units, was used as the unit of heat. On Jan. 1, 1948, the international electrical units were replaced by absolute electrical units, and the joule (sometimes called absolute joule to distinguish it from the temporary standard, the international joule) became the accepted unit of heat. Nonetheless much scientific data is still expressed in terms of the older units, the calorie or the B.T.U.

TABLE I.—*Specific heat of water in joules per degree Celsius per gram*

Temperature °C.	Specific heat	Temperature °C.	Specific heat
0	4.2174	50	4.1804
10	4.1919	60	4.1841
15	4.1855	70	4.1893
20	4.1816	80	4.1961
30	4.1782	90	4.2048
40	4.1783	100	4.2156

These units are now defined, however, not in terms of the properties of water but as being equal to a given number of joules. Thus the thermochemical calorie is by definition equal to 4.1840 joules. In order to convert older data based upon the specific heat of water to the defined calorie a "Table of values considered as the most probable at the present time of the specific heat of water in joules per degree" was drawn up as a result of the 9th General Conference on Weights and Measures. Some of the values are reproduced in Table I. It is seen from this table that the defined thermochemical calorie differs by only 0.036% from the specific heat of water at 15° C.

In engineering steam tables the I.T. (from the first and last words of *Internationale Dampf Tabelle*, "International Steam Table") calorie (1.000654 thermochemical calories) and the B.T.U. are often used. The accepted values of 10 of the more commonly used units of energy, each expressed in terms of the others, are given in Table II.

Ice Calorimetry.—Although attempts to measure heat by observing the quantity of ice melted by it were made in the latter half of the 18th century, the first really successful calorimeter based on this principle was that described by Robert Bunsen. A modern instrument, of the type described by Bunsen, provided with a vacuum jacket was first suggested by Hugh L. Callendar in an article on calorimetry in the 11th edition of the *Encyclopædia Britannica.* A layer of ice is formed on the central tube from the air-free water surrounding it. The heat to be measured is liberated in the central tube, or bulb, and the quantity of ice melted by it is measured by the resulting change in volume of the ice-water system as indicated by motion of the mercury meniscus in a graduated capillary tube. A. Schuller and V. Wartha described an ice calorimeter in which the change in volume was measured by weighing the mercury drawn into the system when ice was melted.

An ice calorimeter is usually calibrated by observing the volume or weight of mercury drawn into the calorimeter when a known quantity of heat is added. The calibration factor is given by the relation

$$\frac{\triangle Q}{\triangle M_{\mathrm{Hg}}}=\frac{L}{(V_i-V_w)\rho_{\mathrm{Hg}}}$$

where $\triangle Q$ = heat added,

$\triangle M_{\mathrm{Hg}}$ = mass of mercury,
L = latent heat of fusion of ice, per gram
V_i = specific volume of ice,
V_w = specific volume of water at 0° C.,
ρ_{Hg} = density of mercury at 0° C.

The possibility of reducing thermal leakage was not fully utilized in the earlier ice calorimeters described in the literature apparently because the importance of both a high thermal resistance and a low temperature difference between the calorimeter and its environment was not fully appreciated. In the early calorimeters, the bulb was immersed directly in an ice bath s that the thermal resistance between the calorimeter bulb and th ice bath was very small.

The temperature difference between the ice bath and the calorimeter bulb was small but nevertheless appreciable, as a rule, because of impurities in the ice bath and because of the effect o

TABLE II.—*Conversion factors for units of energy** (revision of April 30, 1952)

Units	joule	int. joule	cal.	I.T. cal.	B.T.U.	kw.hr.	h.p.-hr.	ft. lb. (wt.)	cu. ft. lb. (wt.) per square inch	litre-atmosphere
1 joule =	1	0.999835	0.239006	0.238849	0.947831×10^{-3}	2.777778×10^{-7}	3.72505×10^{-7}	0.737561	5.12195×10^{-3}	9.86896×10^{-3}
1 int. joule =	1.000165	1	0.239045	0.238889	0.947988×10^{-3}	2.778236×10^{-7}	3.72567×10^{-7}	0.737682	5.12279×10^{-3}	9.87058×10^{-3}
1 cal. =	4.1840†	4.18331	1	0.999346	3.96573×10^{-3}	1.162222×10^{-6}	1.558562×10^{-6}	3.08595	2.14302×10^{-2}	4.12917×10^{-2}
1 I.T. cal. =	4.18674	4.18605	1.000654	1	3.96832×10^{-3}	1.162983×10^{-6}	1.559582×10^{-6}	3.08797	2.14443×10^{-2}	4.13187×10^{-2}
1 B.T.U. =	1055.040	1054.866	252.161	251.996	1	2.930667×10^{-4}	3.93008×10^{-4}	778.156	5.40386	10.41215
1 kw.-hr. =	3,600,000†	3,599,406	860,421	859,858	3412.19	1	1.341019	2,655,218	18439.01	35528.2
1 h.p.-hr. =	2,684,525	2,684,082	641,617	641,197	2544.48	0.745701	1	1,980,000†	13750.	26493.5
1 ft.-lb. (wt.) =	1.355821	1.355597	0.324049	0.323837	1.285089×10^{-3}	3.766169×10^{-7}	5.05051×10^{-7}	1	6.94444×10^{-3}	1.338054×10^{-2}
1 cu.ft.-lb. (wt.) per square inch	195.2382	195.2060	46.6630	46.6325	0.1850529	5.423283×10^{-5}	7.27273×10^{-5}	144	1	1.926797
1 litre-atmosphere =	101.3278	101.3111	24.2179	24.2021	0.0960417	2.814662×10^{-5}	3.77452×10^{-5}	74.7354	0.518996	1

*To convert the numerical value of a property expressed in one of the units in the left-hand column of the table to the numerical value of the same property expressed in one of the units of the top row of the table, multiply the former value by the factor in the block common to both units. †Exact by definition.

Source: Frederick D. Rossini *et al.*, *Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds*, American Petroleum Institute Researc Project 44, Carnegie Institute of Technology (Pittsburgh, Pa., 1953).

the pressure of the mercury column on the freezing point of the water in the calorimeter.

Even with small temperature differences this caused relatively large thermal leakage. Charles V. Boys in 1887 suggested the use of an insulating air space between the calorimeter and an enclosing vessel surrounded by ice, and showed experimentally that such a device reduced thermal leakage to about one-seventh its value without the air space. C. Dieterici reported the use of a similar device. Ernest Griffiths in 1913 described an ice calorimeter enclosed in an unsilvered vacuum bottle which was closed by a rubber stopper and immersed in powdered ice, and reported a probable error (of a single observation) of 0.08% in the measurement of 140 to 620 cal. T. E. Stern in 1928 described measurements of specific heat by means of a vacuum-jacketed ice calorimeter similar to that suggested by Callendar, and reported a probable error (of a single observation) of 0.1% in the measurement of about 240 cal.

The principal advantages of the ice calorimeter over other ypes of calorimeters in use are as follows: (1) the heat transfer between the calorimeter and its surroundings can be made very small; this advantage may be considerable where the heat is liberated in the calorimeter over a long period of time; (2) the calorimeter has a high sensitivity (about 0.1 cal.); (3) there has been some question as to the constancy of the calorimeter calibration constant. Since there has been considerable variation of the measured density of ice, there is some doubt that its density is constant. If this doubt is justified, the calibration factor of the calorimeter would not be constant since the amount of mercury drawn in depends upon the difference in density beween ice and water. However, some of the causes of the variaions of the measured density of ice would not affect the constancy of the calibration factor. It does seem possible that strains et up in the ice as it is frozen may require time to be relieved. Although Griffiths stated that he allowed only three or four hours after freezing an ice mantle, Stern claimed that consistent reults were not obtained until four days after the ice mantle was ormed.

If pure air-free water is used in a Bunsen ice calorimeter, an estimate based on experiments made since 1900 indicates hat the intake of 1 gr. of mercury is equivalent to 270.4 int. joules within about 0.1%.

Some of the disadvantages of the ice calorimeter are as follows: (1) the calorimeter must be used at one temperature; (2) acurate accounting must be made of any volume changes in the alorimeter system; (3) there has been some uncertainty as to he constancy of the calorimeter calibration factor.

A number of calorimeters similar to that of Bunsen, but using n organic liquid having a freezing point in the neighbourhood of oom temperature have been described in the literature. Although he change in volume upon melting is smaller for such organic ompounds than for water, the heat of fusion is also smaller, and n some cases the net result is a greater change in volume per alorie for the organic compound than for water. Thus, H. Sachse n 1929 described a calorimeter using diphenyl ether (melting point 26.5° C.) instead of ice. It was claimed that measurements ould be made to 0.1 cal. by observing the motion of mercury n a graduated capillary, and to 0.02 cal. by weighing the expelled mercury.

Aneroid Calorimetry.—For many purposes, particularly for se at extreme temperatures, the type of calorimeter known as he aneroid has been used. Although the term aneroid strictly mplies a calorimeter without liquid, it is generally interpreted as meaning a calorimeter in which temperature equalization is produced mainly by metallic conduction rather than by the stirring f a liquid. In the absence of liquids to distribute heat, the caloimeter is free from most of the restrictions imposed by the volality, freezing point and, sometimes, the immobility of the bath quid. On the other hand this introduces the disadvantage of depending mostly on thermal conduction and radiation to secure niformity of temperature throughout the calorimeter in which eat is absorbed.

To secure good results, the calorimeter should be made of highly conducting material such as copper or silver, with close attention to geometrical design to promote rapid equalization of temperature throughout the calorimeter without unduly increasing its heat capacity. In general, if high accuracy is required, there must be sufficient thermoelements (devices for measuring small electric currents) to integrate temperature differences between the calorimeter and its jacket, the temperatures of which are likely to be less uniform than in a stirred-liquid calorimeter.

One of the early aneroid calorimeters was used by H. C. Dickinson and N. S. Osborne to measure the heat of fusion of water and the specific heat of water and ice. This calorimeter was patterned after an earlier one described by D. R. Harper in 1913 and was made of copper, with a capacity of about 550 ml. and a wall thickness of 5 mm. which served to hasten equalization of temperature on its surface so that the correction for heat leak could be measured more accurately. The mean temperature of the calorimeter was determined by means of a platinum resistance thermometer embedded in a helical groove in the copper and the energy for heating was supplied electrically by means of a constantan heater in a second helical groove in the copper. In order to evaluate the heat leak between the calorimeter and its jacket, it was necessary to use several differential thermocouples.

Low-Temperature Calorimetry.—Calorimeters for use at low temperatures are generally of the aneroid type since it is not practical in most cases to use a stirred-liquid type. Walter Nernst and his collaborators developed an aneroid calorimeter which was used in the early investigation of low-temperature heat capacities. W. F. Giauque and C. J. Egan described a calorimeter used primarily for the investigation of heat capacities and heats of transition, fusion and vaporization of condensed gases. It may be readily adapted to the measurement of the heat capacities of solids. The calorimeter is made of gold or copper with internal vanes to aid in the distribution of heat. On the outside of the cylindrical calorimeter is wound a gold wire which serves both as a thermometer and heater. There is also a thermocouple which serves as the primary standard for temperature measurement. The calorimeter is surrounded by a massive shield of copper and lead whose temperature remains constant while energy is introduced electrically into the calorimeter. In a measurement the shield is adjusted to a temperature slightly above that of the calorimeter. Sufficient energy is introduced into the calorimeter to raise its temperature slightly above that of the shield and the rise in temperature is noted. Before the next measurement, the shield is heated and again set at a slightly higher temperature than the calorimeter. In a typical experiment the temperature increments of individual measurements range from about one degree at 12° K. to six degrees near room temperature. Since the shield is never very different in temperature from the calorimeter the heat interchange between them is small and may be accurately allowed for. This type of calorimeter is called isothermal since the shield temperature remains constant during a measurement.

In an adiabatic low-temperature calorimeter the massive shield of the isothermal calorimeter is replaced by a lighter shield whose temperature may be rapidly varied. A thermocouple is used to indicate the temperature difference between the calorimeter and the shield and while the calorimeter is being heated electrically the shield is also heated so as to minimize the temperature difference. A calorimeter of this type was described by J. C. Southard and F. G. Brickwedde. Both isothermal and adiabatic low-temperature calorimeters are capable of an accuracy of from one to two parts per thousand in the measurement of heat capacity. Above 200° K., where the heat exchange by radiation becomes large, the adiabatic calorimeter is capable of greater precision than the isothermal type.

In the range below 10° K., extreme care is necessary to minimize heat exchange by conduction between the calorimeter and its surroundings. In this temperature range thermocouples or platinum resistance thermometers lose their sensitivity and some other device must be used to indicate the rise in temperature in a heat capacity measurement. Carbon thermometers, suitable for use between 0.1° K. and 20° K., were described by W. F. Giauque, J. W. Stout and C. W. Clark. Thermometers made of germanium are also sensitive in this region and the preparation and calibration of such thermometers were described by J. E. Kunzler, T. H. Geballe and G. W. Hull.

Calorimetry of Saturated Fluids.—Many problems in thermodynamics are concerned with the properties of saturated fluids, where the term saturated restricts them to conditions where both liquid and vapour are present in equilibrium with each other. As an example the steam tables which the mechanical engineer uses are based on the enthalpy and entropy of saturated liquid water and water vapour.

Osborne developed a systematic method for the calorimetry of saturated fluids and applied it to measurements of the properties of saturated liquid water and water vapour from the freezing point to the critical point. This method makes use of a single calorimetric apparatus with which a system of measurements may be made to determine some of the essential thermal properties of a fluid, in particular the enthalpy H. The calorimeter is provided with two outlet tubes, one at the bottom for introducing or withdrawing liquid and the other at the top for withdrawing vapour. Valves are provided on these tubes for sealing the fluid in the colorimeter and for controlling the rate at which fluids are withdrawn. The calorimeter is surrounded by an envelope, the temperature of which is controlled to prevent any net exchange of heat with the calorimeter. All experiments are made with both liquid and vapour in the calorimeter when saturated fluids are being investigated.

The essentials of this method are as follows. First, consider two experiments (a) and (b) with the same calorimeter, (a) with a large amount of liquid and some vapour to maintain the saturation state and (b) with a small amount of liquid. In these two experiments the calorimeter contains the masses of fluid M_a and M_b respectively, and the quantities of energy Q_a and Q_b are found necessary to heat the calorimeter and its contents from the same initial temperature, t_1, to the same final temperature, t_2. The difference of the energies, Q_a-Q_b, is used to heat the difference of the masses of the fluid contents, M_a-M_b, from one temperature to the other. The quotient of these differences would be equal to the change in enthalpy, H, of the liquid, were it not for the extra vapour in experiment (b). This requires a correction term $-L\dfrac{v}{v'-v}$ where L is the latent heat of vaporization and v and v' are the specific volumes of the saturated liquid and vapour respectively. This gives the equation:

$$\frac{Q_a-Q_b}{M_a-M_b}=\left[H-L\frac{v}{v'-v}\right]_{t_1}^{t_2}\equiv\left[\alpha\right]_{t_1}^{t_2}$$

Notice that in getting α, by the method of differences in the fillings, not only is the energy correction for the heat capacity of the empty calorimeter eliminated but also other energy corrections which are the same, as long as both liquid and vapour are in the calorimeter. These α experiments are essentially liquid heat capacity experiments.

Consider another type of experiment which may be called a vaporization experiment, for getting the enthalpy of the saturated vapour. Consider a calorimeter nearly filled with liquid and let energy be supplied to evaporate liquid to vapour, most of which is withdrawn through a throttle valve at a rate so controlled as to keep the temperature of evaporation constant. The theory shows that the heat added, $\triangle Q$, divided by the mass withdrawn, $\triangle M$, is equal to the latent heat L plus the correction, $L\dfrac{v}{v'-v}$. This correction is the energy necessary to vaporize water to fill the space no longer filled with liquid. This gives the equation:

$$\frac{\triangle Q}{\triangle M}=L+L\frac{v}{v'-v}\equiv\gamma.$$

Consider a third type of experiment where liquid instead of vapour is withdrawn as heat is added. Here, liquid is evaporated to fill the space which is emptied. This gives the equation:

$$\frac{\triangle Q}{\triangle M}=L\frac{v}{v'-v}\equiv\beta.$$

This is the same quantity that appears as a correction term in the preceding equations for the heat of the liquid and the heat of vaporization.

These three functions, which can be determined experimentally, may be used to calculate the more familiar functions

$$\begin{aligned}H&=\alpha+\beta\\L&=\gamma-\beta=H'-H\\H'&=H+L=\alpha+\gamma\end{aligned}$$

So far these derivations use only the first law of thermodynamics. If the second law with the Clapeyron relation is used, the following equations result:

$$\beta=L\frac{v}{v'-v}=vT\frac{dp}{dT}$$

$$\gamma=L+L\frac{v}{v'-v}=L\frac{v'}{v'-v}=v'\,T\frac{dp}{dT},$$

where T is the absolute temperature and p the vapour pressure. This relation gives a way of comparing the calorimetric data with volumetric data providing the vapour pressure slope and the absolute temperature are known.

For the measurements of these properties, a calorimeter is used for containing a sample of fluid while its thermal behaviour is observed. The thermal behaviour is determined by three principal quantities which must be measured: (1) mass subjected to process; (2) energy added to system; and (3) change of state produced. The measurement of mass is relatively simple because the samples are sealed in tight containers with valves, and never opened to the outside when accounting for mass. The measurement of energy is not as simple because no way has yet been found to make calorimeters quite tight for heat. The measurement of the change of state involves the measurement of change in temperature or pressure.

Flow Calorimetry.—The continuous electric method of flow calorimetry was first reported by H. L. Callendar and H. T Barnes, and the method was used for measuring the specific heat of water from 0° to 100° C. From 1897 this method has been used for other liquids and gases.

The principle of the method is to add measured electric power to a fluid flowing through the calorimeter at a steady measured rate and to observe the change of state produced. The state of the fluid is determined by its temperature and pressure. The difference in the initial and final fluid temperature in the calorimeter is usually determined with platinum resistance thermometers or differential thermoelements. The power added to the fluid between the initial and final states must include an accounting not only of the electric energy input but also of the energy leak to or from the fluid while in the calorimeter. The heat capacity of the calorimeter does not enter into the measurements but may affect the attainment of a sufficiently steady state for reliable determinations.

The calorimeter used by Callendar and Barnes consisted of a small glass tube about one-half metre long which contained a platinum heater wire and had enlargements at the ends for differential platinum resistance thermometers. Heat leak was minimized by enclosing the heater tube and thermometers in vacuum jacket. The rate of flow was varied over a ratio of nearly two to one to evaluate heat leakage.

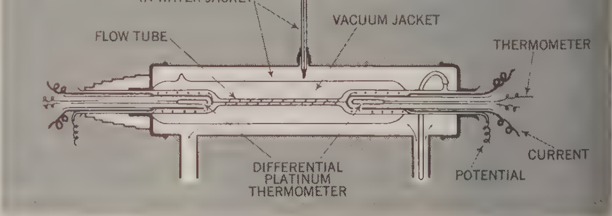
MERCURY THERMOMETER IN WATER JACKET
VACUUM JACKET
FLOW TUBE
THERMOMETER
CURRENT
DIFFERENTIAL PLATINUM THERMOMETER
POTENTIAL

FIG. 3.—CONTINUOUS ELECTRIC CALORIMETER FOR OBSERVING THE VARIATION OF THE SPECIFIC HEAT OF WATER

W. F. Swann used a flow calorimeter for measuring the specific ieat of air and carbon dioxide at atmospheric pressure. The heat eak varied from 2% to 20% of the heat added but was determined and corrected.

Karl Scheel and Wilhelm Heuse also measured the specific heat if air and carbon dioxide but used a smaller calorimeter which vas better adapted for their measurements with small amounts of ither gases. Their calorimeter was constructed chiefly of glass and vas used for measurements at one atmosphere of pressure at tem-eratures from −182° C. up to 20° C. This calorimeter had a imple scheme of radiation shielding which was controlled by the iowing gas and avoided large heat leakages so that the total cor-ection for heat leakage was only a few tenths of one per cent.

L. Holborn and Max Jakob used a flow calorimeter to study the 'ariation of the specific heat of air with pressure at pressures up to oo atmospheres and at the mean temperature of 60° C. Their alorimeter was large and made of steel to withstand these high ressures but had so large a heat capacity that from three to four iours were required to reach a sufficiently steady state for re-iable measurement.

Oscar Knoblauch and his associates made researches over a eriod of many years, determining the dependence of the specific eat of saturated steam on both temperature and pressure over uccessive regions covering the range of steam engineering ractice.

N. S. Osborne, H. F. Stimson and T. S. Sligh described a flow alorimeter which was used for the determination of the specific eat of superheated ammonia vapour at temperatures from −15° o +150° C. and at pressures ranging from 0.5 to 20 atmospheres atm.). Their calorimeter was designed to minimize heat leakage, y means of two shields, the first at the initial and the second at ie final temperature. The temperatures of these shields were ontrolled by the fluid flow at the initial or the final temperatures. hese shields in turn were surrounded by guards. The first guard as maintained at the initial temperature by circulation of the inlet uid. The second guard was maintained at the final temperature y electric heating. The space between the shields and guards was vacuated to minimize heat leak by gaseous conduction, and the irfaces were of polished nickel to reduce the heat transfer by adiation. The correction for thermal leakage in this calorimeter arely exceeded 0.2% of the power input.

Bomb Calorimetry.—Heats of combustion of solids and quids are ordinarily measured by means of a bomb calorimeter. uch an instrument consists essentially of a metal vessel filled ith water in which is immersed a "bomb," or gas-tight metal ontainer capable of withstanding an internal pressure of the rder of 200 atmospheres, together with some arrangement for irring the water and a thermometer for measuring its tempera-ure. A measurement of heat of combustion is made by burning measured quantity of combustible material in the bomb filled ith oxygen to an initial pressure of 20 to 35 atm. and observing ie resulting rise in temperature of the calorimeter. This tempera-ure rise, when corrected for thermal leakage and other small fects, is proportional to the heat produced by the combustion. small amount of water is placed in the bomb in order that the pace may be saturated initially with water vapour. The water rmed in combustion is then condensed to the liquid state, and nce the combustion takes place at constant volume, the direct sults of bomb-calorimetric measurements are total heats of mbustion at constant volume. Such results can be readily con-erted, however, so as to yield values of total or net heat of com-ustion at constant pressure.

Although a number of workers had previously made measure-ents of heats of combustion of gases at constant volume, C. L. erthelot and M. Vieille appear to have been the first to make such easurements on nonvolatile materials in oxygen under a pressure ove that of the atmosphere. Improvements in the Berthelot pe of bomb calorimeter were made by various workers, espe-ally by T. W. Richards and his co-workers, and by H. C. Dickin-n. Much of the work of W. P. White on the stirred-liquid type calorimeter is applicable to bomb calorimetry.

The bomb should be made of a material which does not rust in contact with water, and its interior wall must be resistant to oxidation and to attack by acids, particularly nitric and sulfuric acids, which may be formed in combustion. Various special steels and other alloys have been used for the construction of bombs, and, in cases where the material was not sufficiently resistant to oxidation or attack by acids, bombs have been lined with gold, platinum or porcelain. An improved corrosion-resistant alloy (illium) for use in the construction of calorimetric bombs was developed by S. W. Parr about 1915. W. A. Roth used bombs made of a corrosion-resistant steel (austenitic chrome nickel steel V2A) developed at the Krupp works in Germany.

Bomb-calorimetric measurements have applications in the testing of fuels, in the determination of fuel values of foods and in thermochemistry. (*See* also FUELS; NUTRITION.)

In order to obtain accurate results in bomb-calorimetric measurements it is necessary to determine accurately: (1) the nature and amount of the combustion reaction which takes place in the bomb; the nature, amount and thermal effect of any side reactions; and the energy used to ignite the charge of combustible; (2) the temperature rise of the calorimeter, corrected for heat transfer between calorimeter and environment and for heat of stirring; and (3) the "energy equivalent" of the calorimeter, which is the quantity of energy required to produce unit temperature rise of the calorimeter.

In the bomb calorimetry of fuels the amount of the combustion reaction is determined by weighing the charge of fuel burned. In measurements to determine the heat of combustion per mole of an organic compound it is preferable to determine the amount of the combustion reaction from the mass of one of the products formed; for example, the carbon dioxide, since this procedure will eliminate the effect of inert impurities such as dissolved air or water, and since the molecular weight of the product will be more accurately known than that of the organic compound.

In order to establish the nature of the reactions which take place in the bomb, it is necessary to know the nature and amounts of the impurities in the compound burned, the nature and amounts of the products formed and the states of all reactants and products. It has been found in a large number of cases that combustion in the bomb is substantially complete, so that the products of combustion of substances containing only the elements carbon, hydrogen and oxygen are gaseous carbon dioxide and liquid water. If the substance burned contains nitrogen, or if the oxygen used contains nitrogen as an impurity, some nitric acid will be formed; and if the substance burned contains sulfur, sulfuric acid will be formed. The amounts of such acids are determined and corrections are applied for the heat developed in the reactions by which they are formed. It has been pointed out by E. W. Washburn that in work of high accuracy it is necessary to correct for departures of the gaseous reactants and products from their thermodynamic standard states. The correction varies from a few hundredths of one per cent to several tenths of a per cent depending upon the nature and mass of the substance burned, the volume of the bomb, the initial pressure of the oxygen and the amount of water placed in the bomb. Exact determination of the thermodynamic state of a volatile liquid requires that evaporation be prevented until the instant of ignition. This may be done crudely by the use of gelatine or similar capsules, with independent determination of the heat of combustion of the capsule material. It is done accurately by enclosing the volatile material in a thin glass bulb made with a flexible side so that it can be completely filled with liquid and will not break when oxygen under pressure is admitted to the bomb.

The charge of combustible material is ignited either by a small piece of filter paper or similar material, which is ignited by an electrically heated platinum wire, or by a short length of iron wire which is ignited electrically. In either case the energy used to ignite the charge can be determined in blank calorimetric experiments in which only the filter paper or iron wire is burned, or the energy supplied electrically can be measured by one of several methods and the heat of combustion of the iron wire or other kindler can be calculated from its weight and known heat of combustion per unit weight.

In commercial testing of fuels the temperature rise of the calorimeter is usually measured by means of a Beckmann or other mercurial thermometer. For work of high precision a thermoelectric or platinum resistance thermometer is used. Some workers have minimized heat transfer between calorimeter and surroundings by using the adiabatic method in which the temperature of the "jacket" enclosing the calorimeter is kept approximately equal to that of the calorimeter. However, most modern bomb-calorimetric measurements of high precision have been made by the simpler method in which the temperature of the jacket is kept constant and a correction for thermal leakage and heat of stirring is applied to the observed temperature rise. Accidental differences between the temperature of the jacket and that of the calorimeter, when the attempt is made to keep the two equal, are likely to introduce errors greater than those encountered in making the ordinary corrections for heat loss to a jacket at constant temperature. The constant temperature jacket also avoids much loss of time. Otherwise the jacket has to be cooled for each combustion.

In practically all modern work the energy equivalent, or effective heat capacity of the calorimeter is determined experimentally by supplying a measured quantity of energy to the calorimeter and observing the resulting temperature rise. The calorimeter is thus used to compare an unknown with a known quantity of energy by comparing the corresponding temperature rises. Such a procedure eliminates the effect of the temperature scale used, as well as the effect of calorimetric lags which obey the ordinary law of lag. The energy supplied to the calorimeter in the determination of the energy equivalent may be supplied electrically, and its amount determined from observations of current, voltage and time; or it may be supplied by burning in the calorimeter a known mass of a standard substance, the heat of combustion of which has been measured in terms of electric energy units. The substance most commonly used for this purpose is benzoic acid, the heat of combustion of which has been determined with an accuracy approaching 0.01% by a number of workers.

Combustion Calorimetry of Gases.—Although heats of combustion of gases can be measured by means of a bomb calorimeter, such measurements can be made more accurately with some type of calorimeter in which the gas is burned at constant pressure. Although A. Schuller and V. Wartha made measurements of heat of combustion of hydrogen at constant pressure by means of a Bunsen ice calorimeter, the type of calorimeter most commonly used for such measurements has been the stirred-water type. The gas of which the heat of combustion is to be measured is burned in a reaction vessel immersed in the water of the calorimeter. Oxygen and the gas to be burned are led into the reaction vessel through tubes connected to sources of supply outside the calorimeter. The gaseous products of combustion pass from the reaction vessel through a tube a part of which is ordinarily wound into a helix immersed in the calorimeter water.

Measurements by one of the earliest calorimeters of this type were described by Pierre Dulong. P. A. Favre and J. T. Silbermann in 1852 described a calorimeter embodying some improvements over that of Dulong, including a water jacket separated from the calorimeter by an air space, and an arrangement for stirring the calorimeter water. Most later measurements of heats of combustion of gases, with the exception of those of Schuller and Wartha referred to previously, have been made by means of calorimeters similar in design to that of Favre and Silbermann. The apparatus described by F. D. Rossini embodied a number of refinements not included in similar apparatus described by previous workers, and results accurate to 0.02 or 0.03% have been obtained with it.

The requirements which must be met in order to obtain accurate results in measurements of heats of combustion of gases at constant pressure are quite similar to those mentioned in connection with bomb-calorimetric measurements.

The amount of gas burned in an experiment is determinable from the mass of one of the products formed; for example, water, if the gas burned is hydrogen, a pure hydrocarbon, or any compound containing only C, H and O; or carbon dioxide, if the gas burned is carbon monoxide. The nature of the reaction which takes place, and the nature and amount of any side reactions, are determined by suitable chemical examination of the gas and oxygen and of the products of combustion. Some of the water formed in combustion will be carried out of the calorimeter as vapour during a calorimetric experiment and some will remain as vapour in the reaction vessel, while the larger part of it will be condensed to the liquid state in the reaction vessel. The amount of water remaining in the vapour state is determined, and suitable correction is made to obtain the final result corresponding to the desired state of the water. The correction to take account of the departures of the gaseous reactants and products from their thermodynamic standard states is much smaller than in the case of bomb-calorimetric measurements, but is required in work of high accuracy. The gas is ignited by means of an electric spark, and the ignition energy is determined calorimetrically in blank experiments. Correction is also applied to the results to take account of any difference in temperature of the calorimeter and the entering gases. The measurement of temperature rise of the calorimeter, the correction for thermal leakage and heat of stirring and the electrical determination of the energy equivalent of the calorimetric system are carried out in the same manner as for a bomb calorimeter.

The Standing Commission on Thermochemistry of the International Union of Chemistry (*First Report* of the Stdg. Comm. on Thermochemistry of the Int. Union of Chem.) in 1934 suggested the use of pure hydrogen as a standard substance for determining the energy equivalent in cases where an electrical determination is not convenient.

Fuel Gas Calorimetry.—Probably more laboratories are regularly engaged in determinations of calorific values of gaseous fuels than in any other kind of calorimetric measurement. The requirements as to calorimetric accuracy in such determinations are not as severe as in thermochemical measurements on pure gases, and the calorimeters used are, therefore, designed more fo rapid operation than for accuracy. Ordinarily, either a gas calorimeter of the water-flow type or some type of recording calorimeter is used in the testing of gaseous fuels. An accuracy of about 0.5% can be attained with either of these types of calorimeter.

Gas is burned in a water-flow calorimeter at a uniform rate and the heat produced is absorbed in a stream of water. The mass of water flowing through the calorimeter, during the time that a measured volume of gas is burned, and the resulting temperature rise of the water furnish the data necessary for computing the quantity of heat imparted to the water.

The volume of gas burned is measured by a so-called wet gas meter, and the measured volume is reduced to standard conditions on the basis of a calibration factor for the meter, and observations of the pressure and temperature of the (saturated gas. The temperature rise of the water is obtained from corrected readings of mercurial thermometers. The mass of heated water collected is determined by weighing. Corrections are applied to the results for heat loss from the surface of the calorimeter, and for the latent heat of the difference in the masses o water vapour entering and leaving the calorimeter. The energy equivalent of the calorimeter does not enter into the measurement because the temperature distribution in the calorimeter remains practically constant during an experiment. C. W. Waidne and E. F. Mueller in 1914 reported the results of an exhaustiv investigation of the measurement of calorific values of gases b means of water-flow calorimeters.

In one widely used type of recording calorimeter the gas i burned at a constant rate and the heat produced is absorbed b a stream of air. The rates of flow of gas, air for combustion an heat-absorbing air are regulated by metering devices similar i construction to the ordinary wet gas meter. These metering devices are motor-driven, and are geared together so that the rati of the rates of flow of gas and air is constant. The temperatur rise of the heat-absorbing air is therefore proportional to th calorific value of the gas. This temperature rise is measured by pair of nickel resistance thermometers, translated into Britis thermal units per standard cubic foot of gas and recorded graph ically. The characteristics of the resistance thermometers are such as to compensate approximately for the effect of changing temperature. The calorimeter is adjusted by the manufacturer so that it will indicate the appropriate calorific value of pure hydrogen. The results of an investigation of this calorimeter were reported by R. S. Jessup.

Respiration Calorimetry.—The term respiration calorimeter has been applied to devices which serve to measure quantities of heat involved in biological processes, particularly those of animals and man. Since these processes generally involve energy in other forms such as chemical and mechanical, a respiration calorimeter generally must be designed to take account of energy in these forms also. This calls for means whereby air and food, if any, can be supplied to a living animal or plant within the calorimeter and the products removed.

The first application of this principle in the United States was at Wesleyan university, Middletown, Conn., in charge of W. O. Atwater and E. B. Rosa, later of the national bureau of standards. Their original respiration calorimeter was similar to that of Max Joseph von Pettenkofer of Munich, Ger., and was used in investigations of nutrition of man which were begun by the department of agriculture in 1894. In the course of its use at Wesleyan university the calorimeter was modified from an open to a closed type. In the latter type the air supplied to the occupant of the calorimeter is circulated in a closed system, being withdrawn, purified and supplied with the necessary replacement oxygen before returning to the calorimeter. This system permitted more accurate measurement of the oxygen absorbed. This apparatus and others modeled after it have been in use by the U.S. department of agriculture in Washington in connection with a variety of biological processes. These applications have included human beings, domestic animals and the processes of ripening of fruits.

Essentially, a respiration calorimeter is an airtight shell surrounded by another so devised that transfer of heat between the two is made negligible or can be measured. Provision is made for supplying the necessary air, food and other essentials and removing the used air and other waste products. The size of the shell depends on the use to which it is to be put. Chemical analysis and measurements of heats of combustion of what goes in and what comes out, together with determination of heat generated within the calorimeter, permit an accurate thermal analysis of the biological processes involved. The heat liberated in the calorimeter commonly is absorbed in water circulated through coils in the calorimeter and is determined by measuring the amount of water and its rise in temperature. Details of construction and measuring techniques necessarily vary greatly, depending on the nature of the measurements required. *See* also RESPIRATION.

(H. C. DN.; J. W. ST.)[1]

CALPRENÈDE, G. DE C. DE LA: *see* LA CALPRENÈDE, G. DE C. DE.

CALPURNIUS SICULUS, TITUS (fl. *c.* A.D. 60), Roman poet, was the author of seven pastoral eclogues. These were generally printed together with the four eclogues of Nemesianus (*q.v.*), but in 1854 M. Haupt established with certainty the difference of authorship and date. Very little is known of Calpurnius' life; his name Siculus may indicate Sicilian origin, or may be a conventional indication of his literary debt to the Sicilian Theocritus, originator of pastoral poetry. Again, he may have been the son of a freedman of C. Calpurnius Piso (the leader of the conspiracy against Nero in A.D. 65); a panegyric poem (*Laus Pisonis*) addressed to him is extant, and this may well be by Calpurnius Siculus, though all that can be said with certainty is that it belongs to his period. It has also been ascribed at various times to Virgil, Ovid, Statius and Lucan; of these only the last is a possible claimant. Attempts have been made to identify the characters in the *Eclogues* with real persons, but these remain little more than hypotheses. Two short and incomplete poems called (from the place of their discovery in Switzerland) the *Einsiedeln Eclogues* are also extant; these certainly belong to the age of Nero, and are sometimes attributed to Calpurnius Siculus, but without much likelihood.

The *Eclogues* are in the Vergilian tradition, and the influence of Virgil is pervasive. Four of them are rural in type, and three (i, iv, vii) courtly, using the pastoral setting for the praises of the emperor Nero and his achievements. The movement of the hexameter is a mixture of Virgilian and Ovidian rhythm; and the impact which the poems make is agreeable if one grants their imitative nature. They are expressed in a neat and elegant diction, graceful and melodious, remarkably free from the violent rhetoric which characterized much Silver Age poetry. They lack the faults of striving after effect, but they lack its virtues too, and although they contain some contemporary subject matter and references, they add nothing new to the development of Latin literature.

The *Laus Pisonis* is a panegyric poem of the type of the pseudo-Tibullian *Panegyricus Messallae,* a type practised in the *Silvae* of Statius and later by Claudian and Sidonius. Its diction is fluent and its rhythm smooth; it handles its conventional theme without excessive hyperbole, and is one of the best examples of its kind.

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CALTAGIRONE, a town of Sicily, Catania province, lies 75 km. (47 mi.) S.W. of Catania city by road in a picturesque hilly position. Pop. (1961) 44,435 (commune). The upper part of the town joins the lower by a great flight of steps built in the 17th century. All the churches date from the 18th century and there is a big ornamental garden. The town is joined to Catania by road and rail. Ceramics and terra cotta work form the chief industries; agriculture, especially cultivation of cereals, vines and olive and cork trees, is important in the district. The name Caltagirone comes from Qal'at al-Genun (the castle of Genun, the Saracen chieftain who built it). Although it is one of the oldest Sicilian towns, with Siculan, Greek, Roman and Norman remains, its classical name is unknown. The town was badly damaged by earthquake in 1693 and by air raids in 1943. (GI. C.)

CALTANISSETTA, a city of Sicily and capital of Caltanissetta province, is situated 1,867 ft. (596 m.) high in mountains west of the Salso valley, 139 km. (86 mi.) by road southeast of Palermo. Pop. (1961) 62,793 (commune). The centre of the city is the Piazza Garibaldi and the modern quarter is to the west. The cathedral and adjoining church of S. Domenico (both 1622) and the Collegiate church (1605) are in baroque style. The Moncada palace (17th century) is baroque, while the palaces of Bordonaro, Benintendi and Lanzirotti are 19th-century neoclassical. Pietrarossa castle has Greek and Norman remains, and the abbey of S. Spirito and Sta. Maria la Vetere church (both 12th century) are Norman. Train and coach services run to other centres. Main industries are sulfur mining and agriculture. There is an institute of mineral technology. Caltanissetta is sometimes identified with the ancient cities of Gibil-Habib or Sabucina, but recorded history does not begin until the Norman occupation in the 11th century. The city passed to Italy in 1860, and in World War II was occupied by Allied forces on July 18, 1943.

(SA. GR.)

CALUMET, the name given by the French in Canada to the peace pipe of the American Indians (Norm. Fr. *chalumet,* Lat. *calamus,* a "reed"). This pipe occupied a position of peculiar symbolic significance among the tribes, and was the object of profound veneration. It was smoked on all ceremonial occasions, even on declarations of war, but its special use was at the making of treaties of peace. It was usually about 2½ ft. long, and in the west the bowl was made of red pipestone (catlinite). The pipe

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[1] This article was originally prepared in collaboration with members of the National Bureau of Standards staff: C. S. Cragoe, H. F. Stimson, R. S. Jessup, D. C. Ginnings, R. B. Scott and F. D. Rossini.

BY COURTESY OF THE MUSEUM OF THE AMERICAN INDIAN

CALUMET, PEACE PIPE OF THE AMERICAN INDIAN

stem was of reed decorated with eagles' quills or women's hair. Native tobacco mixed with willow bark or sumac leaves was smoked.

The pipe was offered as a supreme proof of hospitality to distinguished strangers, and its refusal was regarded as a grievous affront. In the east and southeast the bowl was of white stone, sometimes pierced with several stem holes so that many persons might smoke at once.

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CALUMET CITY, a city in Cook County, Ill., U.S., on the Indiana state line and adjoining Hammond, Ind., is a part of the Chicago standard metropolitan statistical area. Pop. (1970) 32,956. (For comparative population figures *see* table in Illinois: *Population.*) It is on the outer edge of the Lake Michigan plain 5 mi. from Lake Michigan and 4 mi. from Lake Calumet, strategically located near the Great Lakes-Gulf Waterway and Calumet Harbor and the heavy industrial area of Gary-South Chicago. Its night clubs, most of them on State Street, known as "the strip," have at times attracted some notoriety.

The city developed as a residential suburb of the industrial belt and until 1924 was called West Hammond. (For the definition of its name *see* Calumet.) It was incorporated as a city in 1925. In the latter part of the 20th century industrial development within Calumet City itself increased in importance. (D. A. Pr.)

CALVADOS, a *département* of northern France, in Normandy, fronts the English channel in the Baie de la Seine between the Cotentin peninsula and the Seine estuary. Area is 2,198 sq.mi. Pop. (1968) 519,695. It lies between the *départements* of Manche and Eure to west and east and is bounded by the *département* of Orne to the south. The *département* of Calvados was formed in 1790 from the districts of Bessin, Cinglais, Hiémois, the Campagne de Caen, Auge and the western part of Lieuvin, and was named from a reef of rocks that stretches along the coast between the mouths of the Orne and Vire rivers. The Aure, Orne, Dives and Touques (from west to east) rivers enter the Baie de la Seine. The Collines de Normandie, crossing the southwest of Calvados, form the highest ground, above 1,000 ft., but most of the *département* is low lying, though the surface is varied by the succession of geological outcrops. Running from south to north, where they are cut off by the coast line, they give an alternation of clay vales and limestone platforms. The coast line is correspondingly varied, with extensive cliff sections and offshore reefs and, elsewhere, sand dunes backed by marshy tracts. Trouville is the chief of several coast resorts. In World War II, from the first landings on the beaches of this coast, the Allied forces penetrated into France in 1944.

Calvados has a damp, mild climate, and the clay vales in Bessin and Auge provide rich pastures where cattle are fattened and dairying is extensively pursued. Large quantities of butter and cheese are produced, and Pont-l'Évêque is especially well known. The limestone and chalk platforms of the Campagne de Caen and Lieuvin have more arable land, especially devoted to corn, sugar beet and fodder crops. Cider-apple orchards are widespread, and cider brandy (known as calvados) is distilled. The Caen district has for centuries provided fine building stone used in many historic buildings in England as well as in northern France. More recently rich iron ore, occurring in the Silurian rocks in the area south of Caen, has been exploited and is shipped by the canalized Orne or used by local furnaces.

Bayeux, Caen, Lisieux and Vire are the centres of the four *arrondissements* into which Calvados is divided. Caen (*q.v.*), the capital, is the seat of a court of appeal and the centre of an *académie* (educational division). The *département* forms the diocese of Bayeux. There are fine Romanesque and Gothic churches at Caen and elsewhere, and at Falaise in the south is the castle of the first dukes of Normandy, the birthplace of William the Conqueror.

For the history of the region, *see* Normandy. (Ar. E. S.)

CALVARY, the place where Jesus was crucified. The word comes from the Latin *calvaria,* the Vulgate translation of the Greek *kranion,* "skull" (Luke xxiii, 33). In Matt. xxvii, 33 and John xix, 17 "the place of a skull," to which Jesus was taken for crucifixion, is said to be called in Aramaic *Golgotha.* It evidently lay outside Jerusalem (*cf.* Heb. xiii, 12) on the north side and near a road (Matt. xxvii, 39). The name suggests a hillock shaped like a skull, or a known place of execution (but John xix 41, which says a garden was there, seems opposed to this), or a spot where a skull was known to have been found (no evidence supports this). The Holy Sepulchre (*q.v.*) was near (John xix 42). The location has been sought most often where the Church of the Holy Sepulchre now stands, within the present city walls but some have favoured the somewhat skull-shaped hillock called "Gordon's Calvary," just north of the Damascus gate.

(F. V. F.)

CALVÉ, EMMA (Rosa Emma Calvet) (1858–1942) French operatic soprano, best known for her performances in the title role of Bizet's *Carmen.* Born at Décazeville (Aveyron), on Aug. 15, 1858, she spent her early youth in Spain. She studied principally under Mathilde Marchesi and made her debut as Marguerite in Gounod's *Faust* in Brussels (1882). After appearing in Bizet's *Les Pêcheurs de Perles* and Mascagni's *Cavalleria Rusticana* she returned to Spain to study the part of Carmen in which she succeeded Marie Galli-Marié, who created the part, a the Paris Opéra-Comique in 1892. She subsequently sang this part throughout Europe and the United States and her interpretation of it was long considered the model. She bought the chateau de Cabrières at Millau and, after 1925, retired from the stage to teach. She died at Millau on Jan. 6, 1942.

See Emma Calvé, *Sous tous les ciels j'ai chanté* (1940).

CALVERLEY, CHARLES STUART (1831–1884), English poet whose brilliance as a parodist and translator derived from lively wit and unusual skill in imitation, was born at Martley Worcestershire, on Dec. 22, 1831, the son of the Rev. H. Blayds his family resumed the ancestral name of Calverley in 1852. A Harrow and Balliol college, Oxford, Calverley was a general favourite; a delightful companion, a distinguished athlete and brilliant scholar. In 1851 he won the chancellor's prize for Latin verse, but a year later, to avoid the consequences of a college escapade, he migrated to Christ's college, Cambridge. He wa elected fellow of Christ's college in 1858, published *Verses an Translations* in 1862 and was called to the bar in 1865; but he wa prevented by a skating accident from following a professiona career, and during his last years he was an invalid. He died a Folkestone, Kent, on Feb. 17, 1884. The sparkling, witty verse of his *Translations Into English and Latin* (1866), *Theocritu Translated Into English Verse* (1869), *Fly Leaves* (1872) an *Literary Remains* (1885) brought him many imitators.

See *Complete Works,* with a biographical notice by Sir W. J. Senda (1901).

CALVIN, JOHN (1509–1564), Genevan theologian and reformer, was born at Noyon in Picardy on July 10, 1509, the fourth son of Gérard Cauvin, a man of low birth who rose to be secretary to the bishop and attorney to the cathedral chapter of Noyon. Calvin's mother, Jeanne le Franc, was the pious daughter of a well-to-do innkeeper of Cambrai, whose father, like Gérard, had been received into the Noyon *bourgeoisie*. (The amily name seems to have been written indifferently as Cauvin, Chauve, Chauvin, Calvus and, always in the capitulary registers of Noyon, Cauuin. It was Latinized by John for scholarly purposes as Calvinus, and on occasion was used in the anagrammatic orms Alcuinus and Lucanius.)

Early Life.—Destined by his father for an ecclesiastical career, John Calvin was educated in the household of the noble Hangest amily from which for generations had come the bishops of Noyon. n May 1521 he was appointed to the first of several benefices that were to finance his education, undoubtedly receiving the customary onsure. When the plague threatened Noyon in 1523, Calvin accompanied the three Hangest boys to study in Paris. He attended he Collège de la Marche as an out-student, imbibing early the pirit of humanism from his excellent Latin teacher Mathurin Cordier, who became his lifelong friend and later joined him in Geneva. He may also have learned of Ockhamism from the Scot-ish teacher John Major. He soon moved to the Collège de Montaigu, a bastion of churchly orthodoxy led by Noël Beda, under whom Erasmus and Rabelais had chafed as students, and where gnatius of Loyola was soon to study. In college disputations Calvin showed brilliance and unusual precosity. He also acquired knowledge of medieval thought and a habitual agility and preci-ion of expression that remained with him long after he had for-aken the formal logic of scholasticism as a "science of wind." Enduring friendships were formed at this time, especially with Claude de Hangest, who became abbot of St. Elois in Noyon; Nicholas and Michel Cop, sons of the king's Swiss physician, Guillaume Cop, a leading humanist medical scholar and his own kinsman Pierre Robert (Olivétan), translator of the Bible into French. He frequented the home of Guillaume Budé, the most minent French Hellenist and one of the first (with G. Cop) of the oyal lecturers; Budé's sons later became citizens of Protestant Geneva.

Having achieved the master of arts degree, Calvin, in obedience o his father, turned from theology to the study of law. He left Paris for Orléans in March 1528 to hear the lectures of the dis-inguished jurist Pierre de l'Estoile, and in the autumn of 1529 progressed to Bourges to continue under the Italian Andrea Alciati. Calvin's first published writing is the preface to a work of his riend Nicholas Duchemin defending the conservative L'Etoile gainst the innovating Alciati. Other close associates—indicating road interests and a sociable nature in the young Calvin—were rançois Daniel, François de Connan and the somewhat older Melchior Wolmar, a classicist of Lutheran affinities with whom Calvin began the study of Greek. Calvin's residence at Bourges was cut short by the death of his father in May 1531. He went to Paris, where the "new learning" was at length contesting the upremacy of scholasticism in the university, and there continued he study of Greek with Pierre Danès and began Hebrew with rançois Vatable, both royal lecturers. In April 1532 Calvin pub-shed his commentary in Latin on Seneca's treatise *De Clementia*, edicated to Claude de Hangest. This writing bears no mark of Protestant interests, but shows him to be a gifted and ambitious oung Christian humanist with noticeable sympathies for ancient toicism. Soon afterward Calvin returned to Orléans where he nished his doctorate in law and served briefly as proctor for the nation" of students from Picardy.

Calvin visited Noyon in Aug. 1533 and by October of the same ear was settled again in Paris, where the court was now favour-ng the humanists around Jacques Lefèvre d'Étaples (Faber tapulensis) under the influence of Margaret of Angoulême, queen f Navarre and sister of Francis I. Calvin's close friend Nicholas op in his address as newly elected rector of the university hampioned this group and used some excerpts from a sermon of uther in speaking of law and grace. The oration (wrongly attributed to Calvin by early biographers) split the university and precipitated a royal proscription of the "Lutheran sect," causing Cop and Calvin to flee the city. Calvin soon returned briefly to Paris and probably early in 1534 traveled into the more receptive district of Angoulême, where he was the guest of Louis du Tillet, a cathedral canon and son of a notable family. Calvin used the splendid Tillet library during several months of reading and reflection, and traveled to Nérac for his only meeting with the aged Lefèvre, who was living under the protection of Margaret of Navarre.

Conversion to Protestantism.—The "sudden" conversion of Calvin mentioned in the preface to his *Commentary on the Psalms* has been dated by responsible investigators as early as 1528 (E. Doumergue) and as late as the spring of 1534 (J. T. McNeill). A lack of autobiographical writing by Calvin and the wide range of religious opinion in France at the time make a clear solution impossible. He must have had knowledge of the Lutheran version of reform from the time of his first arrival in Paris, which coincided with the burning of Jean Vallière for Lutheran opinions, the condemnation of Luther's writings by the Sorbonne having already taken place. While writing on Seneca he lived at the home of the outspoken Protestant Étienne de la Forge, later martyred. His intellectual associates, however, seem to have been chiefly from the circle of Lefèvre, such as François Daniel and Gérard Roussel, who were to remain within the Roman church. The first act of Calvin indicating a decisively Protestant stand would seem to be that of May 1534. As a holder of benefices he ordinarily would have been ordained about this time, but instead he journeyed to Noyon and resigned the benefices, thereby severing his long-standing tie to the diocese. His movements now become difficult to trace, but he visited Paris, Orléans and Poitiers. The hostile but partly trustworthy 16th-century historian Florimond de Raemond presents uncorroborated accounts of Calvin's activities in Poitiers, including an administration of the Lord's Supper as a Protestant rite. More likely this came after he was a pastor in Geneva.

Calvin's first theological tract, entitled *Psychopannychia* (written in 1534, published in 1542), was not directed against Rome but opposed Anabaptist revival of the idea that the soul of man sleeps between death and the general resurrection. Much more important and of permanent value for understanding Calvin's evangelical orientation is the preface he wrote in 1534 to the French translation of the Bible published a year later by Olivétan.

The year 1534 was thus decisive for Calvin, and subsequently he began to assume intellectual leadership among advocates of Protestant reform. Again endangered in Paris, he went to Angoulême and set out with Louis du Tillet for Basel, where he lived under the pseudonym Martianus Lucanius, welcomed by the Reformation leaders Oswald Myconius, Pierre Viret and Heinrich Bullinger and guided in the study of Hebrew by Sebastian Münster. Though he was exiled, Calvin's interests were with French evangelicals who were being persecuted by Francis I. The king had endeavoured to retain the political support of Lutheran Germany against Charles V by calling his victims Anabaptists. Calvin, indignant, presented a full statement of French Protestant belief under the title *Institutes of the Christian Religion*, prefaced by a respectful yet stinging dedicatory epistle to the king. The book itself (in Latin; no French copy of the 1536 edition has ever been found) was immediately recognized as a superb normative statement of reformed theology, despite the author's youth. Four of the six chapters follow a traditional pattern of instruction giving expositions of the Ten Commandments, the Apostles' Creed, the Lord's Prayer and the sacraments (baptism and Lord's Supper). To these Calvin added a polemic fifth chapter on false sacraments, and a sixth "On Christian Liberty, Ecclesiastical Power and Civil Administration." In this first edition nearly all the themes of Calvin's mature thought are present, although he was to develop, elaborate, reorganize and more than quadruple the bulk of the work through various editions until the final one of 1559.

Geneva.—As the *Institutes* went to press in Basel, Calvin departed for the court of Renée, duchess of Ferrara and cousin to Margaret of Navarre, to try to aid (without success) the cause of reform there. Returning, as he hoped, to a life of scholarship in Basel or Strasbourg, he was detoured through Geneva by the war between Francis I and Charles V. Calvin's progress was arrested in Geneva when Guillaume Farel, a fiery former pupil of Lefèvre who had succeeded in planting the evangelical standard in that city, demanded and received Calvin's reluctant aid. Calvin began lecturing, inconspicuously and without payment, on Paul's epistles in the church of St. Pierre in Aug. or Sept. 1536, and was later received as a pastor. Farel's position in Geneva had been insecure, partly because of his own limitations as thinker and organizer but especially because religious reform, in the minds of the citizenry, was confused with Genevan political revolt against the duke of Savoy and his vacillating pawn the bishop of Geneva (*see* GENEVA). Also the reform felt itself harassed by Anabaptist teachers until they were expelled by the city Council of Two Hundred following public disputations in early 1537. Farel remained the leader, but Calvin's influence was increasingly strong, especially in forming a plan of compulsory education and close moral supervision for the entire city. All citizens were required under threat of expulsion to make public avowal of a confession of faith that Farel had written. Frequent and worthy observance of the Lord's Supper was Calvin's rationale for the discipline and the chief ground of insistence that administration of discipline (including the ultimate verdict of excommunication) be solely in the hands of the ministers rather than the magistrates. Severe moral restrictions had been written into Genevan law long before the Reformation, but strict enforcement in the control of the church was a novelty not well received by many of the gay-living and independent citizenry. In this period Calvin composed his brilliant and succinct *Instruction in Faith* as a device for public education. This document was at issue when Pierre Caroli, chief pastor of Lausanne, demanded rather the use of ancient creeds and finally accused the Genevans of Sabellianism and Arianism.

Caroli, who was to return twice to the Roman communion before he died, was brought before a synod in which the Bernese participated and dismissed on charges of advocating prayers for the early resurrection of the dead and of personal immorality. Calvin's Trinitarian orthodoxy was officially vindicated. His formidable vehemence and erudition in debate before the synod served notice that a new Protestant leader of immense significance was emerging.

Although Genevan elections of Feb. 1537 had supported the Farel-Calvin policies, the opposition came into control one year later. The new leaders represented not an anti-Reformation party but one oriented politically toward Bern because this city was a necessary bulwark against Savoy and because it represented a milder liturgical and moral pattern of reform. (Though Geneva was not yet a member of the Swiss confederation, it had entered into a contract of joint citizenship with Bern as one method of protecting itself against Savoy.) The Bernese rites (including the use of unleavened bread in communion, fonts in baptism, observance of festival days, etc.) were technically matters of indifference to Calvin and his associates, but it was a cardinal principle that the authority for change should rest with the ministers and not with the civil rulers. Early in 1538 the Council of Two Hundred forbade the ministers to exclude anyone from communion, adopted the Bernese rites without consulting the church authorities and refused to delay the matter until the meeting of a general Swiss synod in Zürich. The ministers, fearing profanation of the sacrament in the uproar, refused to administer it at all on Easter Sunday, 1538, but preached boldly although they had been forbidden to do so and had experienced some personal danger from mob action. The city councils quickly gave Calvin, Farel and their blind associate Corauld three days to leave the city. The Swiss synod arranged a return on milder terms, but the Genevese, with some connivance of the Bern pastor Peter Kunz, refused and the banishment was reaffirmed.

Strasbourg.—Farel settled at Neuchâtel and Calvin at Strasbourg, where, as pastor of a church of French refugees and colleague of Martin Bucer, he spent three of his happiest and most productive years. Sharing the passion of Bucer and Philipp Melanchthon (whom he met at the diet of Regensburg) for the unity of the church, he attended Charles V's conference on Christian reunion at Frankfurt, and represented Strasbourg at the conference of Hagenau (1540) and the Disputation of Worms (1540–41). In 1539 Calvin published a *Commentary on Romans* and a revised Latin edition of the *Institutes*, which, translated by him into French, became an important early classic (published 1541) of that language. His *Short Treatise on the Lord's Supper* and *Form of Prayer and Manner of Ministering the Sacrament According to the Use of the Ancient Church* represent his decisive liturgical work and show Bucer's influence. In Aug. 1540 Calvin married Idelette de Bure, the widow of Jean Stordeur of Liège, whom he had converted from Anabaptism. In her Calvin found "the excellent companion of my life," a "precious help" in his many labours and illnesses. She died in 1549. Their only child, Jacques, born July 28, 1542, lived only a few days.

Return to Geneva.—During Calvin's absence political and religious chaos threatened in Geneva. An attempt of Cardinal Jacopo Sadoleto to restore Roman Catholicism was frustrated largely by a letter of Calvin, perhaps the finest brief apology for the Reformation ever written. After official communications and deputations were sent from Geneva urging Calvin's return, he reluctantly assented, arriving on Sept. 13, 1541. He now determined to carry out his whole original scheme of reform and to set up in all its integrity that form of church polity which he had carefully matured during his residence at Strasbourg. The "Ecclesiastical Ordinances" thus adopted became influential for Reformed ("Presbyterian") polity subsequently in Europe, the British Isles and America. Its salient features were "four orders of office" (pastors, teachers, elders and deacons) and a ruling body called the consistory (composed of pastors and elders) which guided church affairs. The Genevan government system of councils, embodying both aristocratic and democratic elements, was not changed much by the reform, but the interrelations among the councils shifted and close interaction with the church consistory gave the whole a quite new aspect. Fourteen years of intense struggle and the granting of citizenship to a large new population of religious refugees were needed before the triumph of the new discipline was secure.

(For a more detailed history of the progress of the Reformation in Geneva, *see* REFORMATION; REFORMED CHURCHES.)

Among the theological controversies of Calvin was that on predestination and election in which his opponents were Albert Pighius and Jerome Bolsec, and that in which Sébastien Castellio was denied ordination because of irregular views of the Holy Spirit and the biblical canon. Michael Servetus, a brilliant eccentric scholar debated by letter and publication with Calvin, attacking the prime doctrine of Protestant and Catholic orthodoxy, the Trinity. Condemned to burning in Vienne, but escaped, Servetus after a long trial was finally burned at the stake in Geneva, an act typical of the age but one that has placed Calvin's historical image among the persecutors of religious dissent (*see* SERVETUS, MICHAEL). Calvin was also involved in lengthy but unresolved contention with the Lutherans respecting the Lord's Supper—the Lutherans holding that the body and blood of Christ are present with the elements so as to be consumed by all partaking, even the unworthy; and the Reformed affirming a real but spiritual presence partaken of only by the faithful.

Nor was it only in religious matters that Calvin busied himself; he was consulted on countless affairs great and small that came before the councils—questions of law, police, economy, trade, manufacture and foreign diplomacy. To him the city owed its trade in cloths and velvet, from which much wealth accrued to its citizens; sanitary regulations that made Geneva the admiration of all visitors were introduced by him.

The academy he founded in 1559 with Theodore Beza as recto was a crowning work, the intellectual centre of international Calvinism for many years to come. The curriculum united classica studies, as conceived among the humanists, with reformed theology, showing traces of the conceptions of Budé, Melanchthon and Johannes Sturm of Strasbourg.

Along with these many activities Calvin continuously wrote heological, exegetical, liturgical, polemical and church constitutional works, many of which carried influential social, political and conomic ideas. Beza estimates that Calvin averaged 286 sermons n French and 186 lectures in Latin annually. His wide-ranging orrespondence fills ten volumes of the collected works. He published commentaries on the Hebrew and Greek texts of nearly ll the books of the Bible, combining techniques of literary, historical and textual analysis with great erudition and penetrating nsight.

The incessant and exhausting labours to which Calvin gave himelf could not but affect his fragile health. On Feb. 16, 1564, he preached his last sermon, and on April 20 he made his will. On he 27th he received the Little Council, and on the 28th the Genevan ministers, in his sickroom; on May 2 he wrote his last etter—to his old comrade Farel, who hastened from Neuchâtel to ee him once again. Calvin spent much time in prayer and died uietly in the arms of Theodore Beza on the evening of May 27. The next day he was buried without pomp "in the common cemtery called Plain-palais," in a spot not now to be identified.

Calvin suffered chronic illness throughout his adult life. He was sparing in his food and simple in his dress; he slept little and was capable of extraordinary intellectual efforts. Possessed of most retentive memory and a very keen power of observation, he poke simply, directly, but with great weight. Though he had many acquaintances, he had few close friends. If somewhat severe nd irritable, he was at the same time scrupulously just, truthful nd steadfast, and commonly cheerful and even playful among his ntimates.

Theology.—Fundamental to all Calvin's thought was his conception that the Reformation was not founding something new but was purifying the church and restoring its pristine condition in reection of scholastic errors and papal heresies. Significantly, the nal edition of his *Institutes,* which he conceived as a guide to Bible study, is organized into four books after the sequence of octrines in the ancient Apostles' Creed—Creator, Redeemer, pirit and Church—and is buttressed throughout with materials from Church Fathers. The most characteristic thought in his heology concerns the mystery of the grace of God, who redeems inners although they are unworthy of redemption and incapable f meriting it. The believer, thus, is the undeserving recipient of aith, of sonship and of membership in Christ's body as a sheer ift of the Holy Spirit. The man of faith has been "chosen," or elect" or "predestined" by God for salvation and may not boast of ontributing either his own decision or any good works to procure ternal life.

Following the outline of his own *Institutes* (1559), Calvin's hought might be summarized as follows:

Book I, "On the Knowledge of God the Creator," begins with the nextricable interrelatedness of the knowledge "of God and ourelves" and the positive religious and ethical demands that such nowledge makes upon all men through the revelation in creation nd conscience. But since man's sin has blinded him, God has hosen special means to restore him: the revelation known as cripture, to which God enlightens the mind by the "internal tesmony of the Holy Spirit," without which a mere assent of the mind cannot be redemptive. Having established Scripture in a rief excursus (ch. vi-ix), promising to take up the matter later III, ii), Calvin proceeds to a fairly traditional exposition of the octrine of the Trinity according to the orthodox formulas, and of he doctrines of creation and providence.

Calvin's special emphases are shown in that he develops the angers of idolatry in worship (with Rome in mind) as a prelude o discussing the Trinity and in his rigorous insistence that every rop of rain and every thought of man represents a particular xpression of the divine will. Here Calvin verges on determinism: difficult and disputed point especially in view of his strong insistnce on human responsibility for every exigency of life, excepting nly salvation.

Book II, "On the Knowledge of God the Redeemer in Christ . . . ," presents first the need for redemption: man's sin, which as spread corruption through the totality of his being. This is nherited from Adam by every man both as guilt and as a lively tendency to disobey God, though in such a way as to pervert rather than to abolish the excellent gifts of mind and body enjoyed by all humanity. These remaining gifts, however, are providential and exhibit God's patience but not his gracious will to save. The excellent mathematicians, lawyers and philosophers of antiquity, for all their continuing value, were not (so far as man can judge) men of faith, and mere human excellence will not remove the curse of their sin. A special chapter, prepared for the final edition of the *Institutes* (ch. vi), presents the Old Testament and the Law of Moses as preliminary and specially accommodated forms of the revelation to be made finally clear in Christ, for "the hope of the pious [patriarchs and prophets] has never been placed anywhere but in Christ." The chief use of the Decalogue is not so much to convict sinners as to guide the chosen into faithful obedience. The person of Christ is seen in traditional Chalcedonian terms, but his redeeming activity is freshly formulated as the assumption of Old Testament functions of prophet, priest and king. Christ himself was at the same time the atoning sacrifice both in the perfection of his life and in his voluntary suffering, which God in his mercy chose to accept to cover the sin of men.

Book III, "On the Manner of Receiving the Grace of Christ . . . ," presents faith as the "principal work" of the Holy Spirit by which the benefits of Christ are made available to men and "union with Christ" is effected. Thus joined to Christ, the believer has life in him and knows (but with a faithful assurance, not a carnal security) that he is redeemed, having the witness of the Spirit that he is a child of God, and having the promises both "revealed to our minds and confirmed to our hearts" by the same Spirit (III, ii, 7, *et passim*). From faith springs repentance, proceeding from a sincere fear of God, and consisting in the mortification of the flesh and the "old Adam" within us and a vivification of the Spirit. Through faith also the believer receives justification, his sins are forgiven, he is accepted of God and is held by him as righteous, the righteousness of Christ being imputed to him. This imputed righteousness, however, is not disjoined from real personal righteousness, for regeneration and sanctification come to the believer from Christ no less than justification; the two are not to be confused, but neither are they to be separated. The assurance which the believer has of salvation he receives from the operation of the Holy Spirit; but this again rests on the divine choice of the man to salvation in God's eternal free purpose, whereby he has predestined some to eternal life and some to eternal death. The former he effectually calls to salvation, and they are kept by him in progressive faith and holiness unto the end (Bk. III *passim*).

Thus predestination, which Calvin took over chiefly from Augustine, is treated in a unique way, not as an adjunct to the doctrine of God (as in later "Calvinist" theologians) and as a "part of providence" (as in Thomas Aquinas), but as an implicate of grace and faith.

Book IV, "On the Outward Means or Helps by which God Invites Us into the Fellowship of Christ . . . ," presents the church and sacraments as gracious means or instruments used by God to support the weakness experienced by all believers. The church is made up of "all the elect from the beginning of the world," fully known only to God, who "knows and has marked those who know neither him nor themselves." Yet this same church is visible to men in every generation as the "whole multitude of men spread over the earth who profess to worship one God and Christ," and who in various particular places preach and hear the Word of God and rightly administer and receive the sacraments. The latter two "marks" of the true church distinguish it, even when it is corrupt (IV, i, 7–11). The chief officers of the church are pastors, who preach the Gospel, administer the sacraments and maintain discipline; and teachers, who lecture in theology and conduct schools in languages and the humanities. With these are joined for the government and discipline of each church certain pious men as a senate of elders, and also deacons, who care for the poor. These officers are elected by the people and ordained by the laying on of the hands of the pastors (iii, 4–16). The sacraments are two—baptism and the Lord's Supper. Baptism (ordinarily of infants) is the sign and seal of membership in the church; it serves both for the confirmation of faith and as a confession before men. The Lord's Supper is a sacred communication of Christ's flesh and blood, whereby he transfuses his life into believers, uniting by the Spirit "things which are separated in space" when he truly and efficaciously presents his body and blood through the symbols of bread and wine. In the mystery of the Supper a "real participation of him" is enjoyed, yet he is not affixed to the elements or in any way circumscribed (IV, xv–xvii). A great elaboration of polemic material and critical comment on the history of the church makes Book IV the longest section of the *Institutes*. The state is dealt with briefly in the final chapter (xx) showing Calvin's perception that forms of government may change in response to historical circumstances, although whatever the form, rulers are recognized as legitimate only if they provide for true religion among their subjects. Calvin preferred a representative government with an educated populace, but with a strong sustaining aristocratic element to restrain the capriciousness of the many. For portrait *see* article REFORMATION.

See also references under "Calvin, John" in the Index.

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(E. A. DY.)

CALVIN, MELVIN (1911–), U.S. chemist, winner of the 1961 Nobel prize in chemistry for research into photosynthesis, was born April 8, 1911, in St. Paul, Minn. He received a B.S. degree from the Michigan College of Mining and Technology, Houghton, in 1931 and a Ph.D. degree from the University of Minnesota in 1935. He then spent two years at the University of Manchester, Eng., as a fellow of the Rockefeller foundation. In 1937 he joined the faculty of the University of California at Berkeley, undertaking additional duties there as director of the bio-organic division of the Radiation laboratory in 1946.

He discovered the chemical pathways that are followed in green plants during the conversion of stored light energy, carbon dioxide and water into the thousands of compounds essential for their growth. The unraveling of the intricate details of photosynthesis is significant since all life on earth is ultimately dependent upon the conversion of sunlight to usable chemical energy.

He also conducted research in the fields of radiation chemistry, organic chelate compounds and the origin of life. (MU. G.)

CALVINISM means, first, the careful balance of complementary doctrines which form the theology of John Calvin (*q.v.*). Second, it means the developments on speculative or pietistic lines of a selection of these doctrines by Calvin's followers or those who claimed, not always defensibly, to be his followers. Third, it means the historical developments in various countries of theological ideas, patterns of worship, church organization, and moral discipline derived from the writings of Calvin and of his followers and from the practices of the Calvinistic Church of Geneva in the 16th century. These doctrines and practices became the hallmark of the Reformed churches (*q.v.*) of the continent and of those generally known in English-speaking countries as Presbyterian churches.

Calvin sought to hold together in balance the full range of biblical teaching, disposed in a coherent pattern but not with absolute logical precision—he often refused to make conclusions that hi followers were willing to make. In so doing they distorted the balance of his theology, partly in response to the success of the theological definitions of the Council of Trent and the energetic attacks of the Counter-Reformation.

Calvinism in its second form began to develop after Calvin' death (1564). His successor at Geneva, Theodore Beza, changed certain emphases in Calvin's theology. For example, in hi *Tractationes theologicae* (1570) he reverted to the medieval Scholastic practice of discussing predestination under the headings of God and Providence (whereas Calvin had eventually related it to the person and work of Christ), thus introducing powerful element of speculative determinism into the doctrine Beza also emphasized literalism in the inspiration of the Bible which brought an attitude to biblical interpretation differing from that of Calvin. One consequence of this was that Beza, like man of the English Puritans, noting that the words bishop and presbyter were interchangeable in the New Testament, was convinced that the only true ministry of the church must be presbyterian (*i.e.*, nonepiscopal). Beza also regarded church discipline exercised by presbyterian organization as fundamental to the church' existence, and he was followed in this view by the Scottish reformer John Knox, who made discipline a third "note" of the tru church, together with the Word and sacraments. These developments, never postulated by Calvin, tended to produce a mor legalistic pattern in doctrine and discipline. The Five Article of the Synod of Dort (*q.v.*; 1618–19) represent a powerful definition of this post-Calvin "Calvinism," and include the proposition that Christ died only for the elect, a statement which Calvi himself did not formally propose. (*See* also PRESBYTERIANISM.

A modification of the determinist element in Bezan Calvinism was provided by the introduction of the theology of "the covenants," which sought to draw attention away from speculation on absolute predestination to the successive covenants made b God with man (from Adam through Moses to Christ) in whic man is to respond in obedience in daily life to God's commandments in the moral law, through the covenant of grace in Christ Here the process of sanctification tended to be allied with th obedience shown through works demanded of Adam in paradise and after the Fall renewed by the "covenant of grace." This wa clearly expounded in the *Summa doctrinae de foedere et testamento Dei* (1648) of Johannes Cocceius (*q.v.*). The Westminster Confession (*q.v.*; 1648), still a standard of many English-speaking Presbyterian churches, is influenced by this theology Another modification of the original doctrines of Calvin was th pietistic and pragmatic concern for personal sanctification, separated from Calvin's insistence on the objective reality of church and sacraments, which developed among the English Puritans, *e.g* William Perkins. Eighteenth-century English-speaking evangelicals, such as Jonathan Edwards and George Whitefield, emphasized the doctrine of irresistible grace as propounded in the Five Articles, together with personal experience of conversion (*see* CALVINISTIC METHODISM). Until recently, the term Calvinism has tende to imply this association of ideas.

The third meaning of Calvinism refers to the theological emphases and forms of church organization, worship, and discipline that became widespread in the 16th century in France, Holland the Palatinate in Germany, Scotland, and elsewhere, and produced the Reformed or Presbyterian churches. Documents reflectin these emphases are the Palatinate's *Heidelberg Catechism* (1563 the Church of Scotland's *The Book of Common Order* (1564) an *The First Book of Discipline* (1560), and *The Directory of Worship* and *The Presbyterian Form of Church Government* of th Westminster Assembly of Divines (1643–49).

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CALVINISTIC METHODISM, the popular designation of he Presbyterian Church of Wales. Its origin usually is atributed to the religious experience of conversion undergone by the ayman Howel Harris (1714–73) in Talgarth church, Brecknockhire, on Whitsunday, May 25, 1735, as a result of which he ecame an itinerant preacher. About the same time, Daniel Rowands (1713–90), curate of Nantgwnlle and Llangeitho in Cardiganhire, passed through a similar experience, and after the two men ad met at Defynnog in Aug. 1737 they were the joint means of tarting a nation-wide religious revival. Co-operating at first with ome of the more pious clergy and dissenting ministers of Wales nd with the leaders of English Methodism, they sought to supplement the normal services of church and chapel by establishing rivate societies. Doctrinal and personal differences, however, oon appeared. In the dispute between George Whitefield and ohn Wesley over the doctrine of free grace (1739–41), the Welsh eaders sided with the former, and Methodism in Wales thereby ecame Calvinistic rather than Arminian. A little later, doctrinal ifferences between Harris and Rowlands over patripassianism the doctrine that the Son was the Father appearing in human orm and that the Father therefore suffered on the cross as the on), reinforced by criticism of Harris' imperiousness and of his ssociation with Madam Griffith of Cefn Amwlch, led to a rupture n 1750, as a result of which Harris retired from active evangelism nd established a community or "family" at Trefeca, Brecknockhire; the breach was not healed until 1762. Later still, in 1791, nother leader, Peter Williams, was expelled because of his Sabelan views. On the death of the early leaders—who included Howell Davies and William Williams of Pantycelyn, the hymn writer of Welsh Methodism—the leadership of the movement assed into the hands of Thomas Charles (*q.v.*) of Bala, the real ounder of the Sunday school in Wales and one of the founders f the British and Foreign Bible society. Hitherto, despite occaional secessions, Methodism had remained a forward movement within the established church, but the death of so many of its lergy supporters, the anomalous position of its lay exhorters, nd the threat to its existence from Lord Sidmouth's bill of 1811 *see* Sidmouth, Henry Addington) forced Charles, after some reluctance, to take the decisive step of ordaining nine laymen at he Bala association in June 1811 and 13 at the Llandeilo associaion the following August.

Calvinistic Methodism thus became a Nonconformist denomiation, with its Confession of Faith (1823) and its Constituional Deed (1826). Its first association was held at Dugoedydd in 742, the first joint Anglo-Welsh association at Watford in 1743, nd the first general assembly in 1864. An act of 1933 secured the hurch's autonomy in spiritual matters. Its polity and doctrine re Presbyterian (*see* Presbyterianism) and the great majority f its congregations worship in Welsh. In 1960 communicants in s three constituent associations numbered about 150,000 and its rdained clergy about 700.

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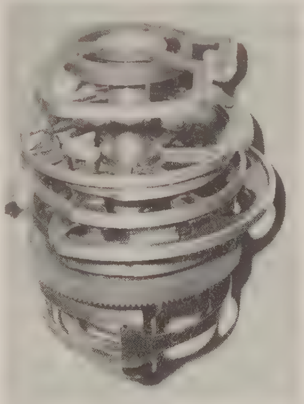
CALVUS, GAIUS LICINIUS MACER (82–*c.* 47 B.C.), Roman poet and orator, who, as a poet, followed his friend Catulus (*q.v.*) in style and choice of subjects. He was a son of the nnalist Licinius Macer. Only 20 meagre fragments of his poetry urvive. As an orator he was the leader of the opponents of the orid Asiatic school, who took the simplest Attic orators as their model. Of his speeches 21 are mentioned, the most famous being hose delivered against Publius Vatinius, tribune in 59 B.C.

For the verse fragments *see* W. Morel (ed.), *Fragmenta oetarum Latinorum* (1927); for the prose fragments, *see* H. Malovati (ed.), *Oratorum Romanorum Fragmenta,* 2nd ed. (1955). *See* also H. J. Rose, *A Handbook of Latin Literature From the Earliest Times to the Death of St. Augustine,* 3rd ed. (1954). (E. A. B.)

CALYDON, an ancient town of Aetolia, according to Pliny he Elder 7½ Roman mi. from the sea, on the Euenus (Evinos) iver on a site about 6 mi. E. of modern Missolonghi near the illage of Evinokorion. It was said to have been founded by Calydon, son of Aetolus; to have been the scene of the hunting, by Meleager and other heroes, of the Calydonian boar; the Calydonians are said to have taken part in the Trojan War. In 391 B.C. it was in the possession of the Achaeans. After the battle of Leuctra (371 B.C.) it was restored by Epaminondas to the Aetolians. Augustus moved its inhabitants to Nicopolis Actia, founded to commemorate his victory at Actium (31 B.C.). The walls of Calydon, now the *Palaiokastro* of Kurtaga on the Evinos, have a circuit of more than two miles. Excavations since 1925 have revealed remains of a temple of Artemis Laphria ("the Forager").

CAM (Cão), **DIOGO** (*fl.* 1480–1486), Portuguese navigator and explorer, was the first European to discover the mouth of the Congo river; he also explored the west coast of Africa between Cape St. Catherine (1° 52′ S.) and Cape Cross (21° 50′ S.). The surviving records of the two voyages made by Cam are brief. In 1482 John II chose him to explore the African coast beyond Point St. Catherine, the farthest point chartered by seamen of Fernão Gomes. Leaving Mina in June (?) 1482, he reached Loango bay (Praia Formosa de S. Domingos) about Aug. 4. A few days later he discovered the mouth of the Congo and set up a stone pillar (*padrão*) to mark the overlordship of his country (this pillar was destroyed by the Dutch when they entered the Congo in 1642). He then sailed a short way upstream and found its banks inhabited by Negroes, like those of the Guinea coast; they appeared willing to trade.

Cam then coasted southward along the present Angola coast and erected a second pillar at Cape Santa Maria (Monte Negro, 13° 26′ S.), probably the most southerly point of his first voyage. He returned to Lisbon before April 1484, when John II ennobled him, granted him an annuity and authorized him to add to his coat of arms two pillars in memory of those he had erected.



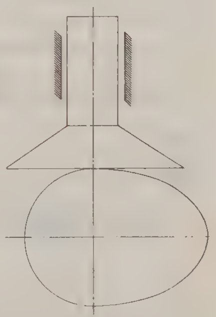
BY COURTESY OF MERGENTHALER LINOTYPE CO.

FIG. 1.—CAM ASSEMBLY FOR A LINOTYPE

During his second voyage, Cam revisited the Congo and subsequently erected two more *padrões,* at another Monte Negro (15° 41′ S.) and at Cape Cross (21° 50′) (all four pillars were later discovered *in situ*). The date and place of Cam's death are not known. (E. M. J. C.)

CAM, a part of a machine or mechanism used for transforming rotary or oscillating motion by direct contact (sliding or rolling) into any prescribed motion of a second part known as a follower. This combination is extremely versatile and useful in performing a great variety of jobs in engines, machinery and household appliances. In machinery where automatic control and accurate timing are necessary, the cam is an indispensable part of the mechanism. Fig. 1 shows a set of cams assembled on a shaft which actuate and control most of the mechanical action of the Linotype, a machine that sets type for books, magazines and newspapers.

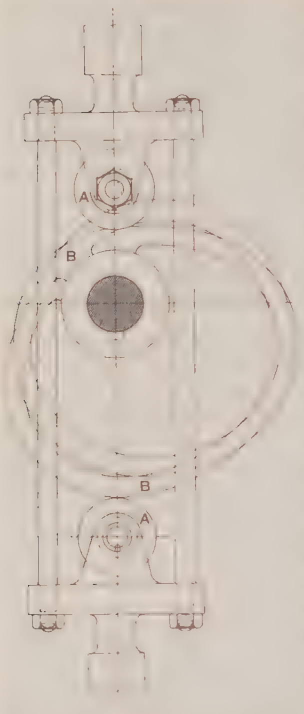
The cam itself may take many forms, such as: (1) a disk or plate of desired profile; (2) a plate with a track cut in the face (face cam); (3) cylindrical or conical members with a track cut around the surface; (4) a cylinder or cone with the end cut to a required profile; (5) a sliding wedge of the necessary shape; (6) spiral or lobed bodies for three-dimensional motion; (7) other special shapes.



FROM H. A. ROTHBART, "BASIC CAM SYSTEMS" IN "MACHINE DESIGN," MAY 31, 1956; REPRODUCED BY PERMISSION OF PENTON PUBLISHING COMPANY

FIG. 2.—DISK CAM WITH FLAT-FACE FOLLOWER

The follower that is moved by the cam may have a knife edge at the point of contact, a flat or curved face or a roller to



FROM V. L. DOUGHTIE AND W. H. JAMES, "ELEMENTS OF MECHANISM"; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC

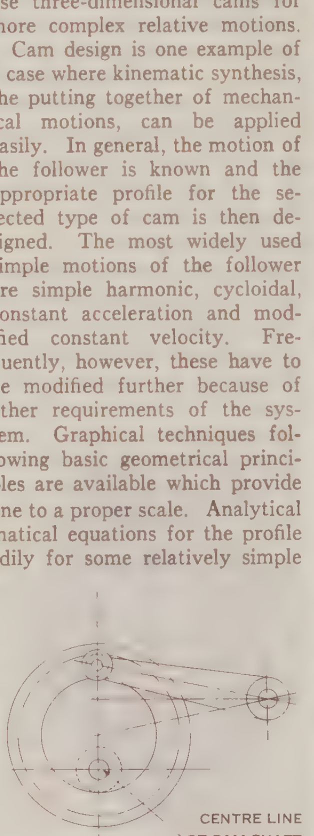
FIG. 3.—DISK CAM WITH ROLLER-FOLLOWER CARRYING (A) ROLLERS RESTING ON (B) CAMS

reduce friction. It may also be made to move in a straight line or pivoted about a fixed centre.

A few of the typical combinations are shown schematically in figs. 2–8. Engine valve cams generally are of the type illustrated in fig. 2 and use circular arcs for most of the profile. This characteristic makes a cam relatively easy to machine, but not always the best for high-speed operation. Computing machines and some automatic machinery use three-dimensional cams for more complex relative motions.

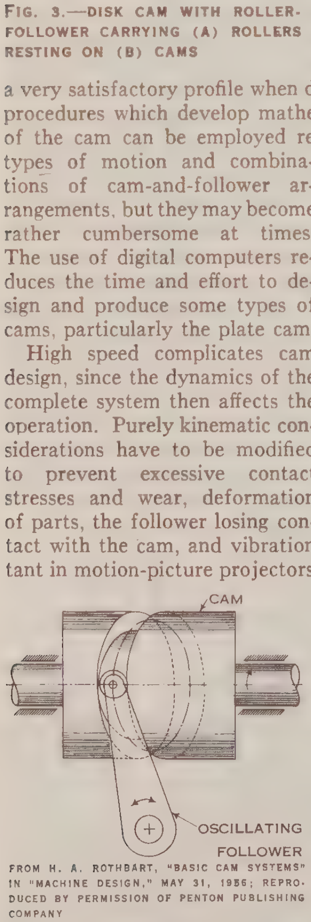
Cam design is one example of a case where kinematic synthesis, the putting together of mechanical motions, can be applied easily. In general, the motion of the follower is known and the appropriate profile for the selected type of cam is then designed. The most widely used simple motions of the follower are simple harmonic, cycloidal, constant acceleration and modified constant velocity. Frequently, however, these have to be modified further because of other requirements of the system. Graphical techniques following basic geometrical principles are available which provide a very satisfactory profile when done to a proper scale. Analytical procedures which develop mathematical equations for the profile of the cam can be employed readily for some relatively simple types of motion and combinations of cam-and-follower arrangements, but they may become rather cumbersome at times. The use of digital computers reduces the time and effort to design and produce some types of cams, particularly the plate cam.

High speed complicates cam design, since the dynamics of the complete system then affects the operation. Purely kinematic considerations have to be modified to prevent excessive contact stresses and wear, deformation of parts, the follower losing contact with the cam, and vibrations. Such aspects are very important in motion-picture projectors and cameras, high-speed printing presses, engines, machine guns and other equipment.



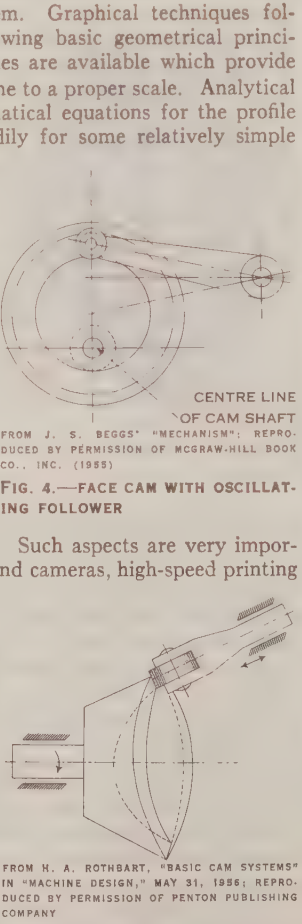
FROM J. S. BEGGS' "MECHANISM"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC. (1955)

FIG. 4.—FACE CAM WITH OSCILLATING FOLLOWER



FROM H. A. ROTHBART, "BASIC CAM SYSTEMS" IN "MACHINE DESIGN," MAY 31, 1956; REPRODUCED BY PERMISSION OF PENTON PUBLISHING COMPANY

FIG. 5.—CYLINDRICAL CAM WITH OSCILLATING FOLLOWER



FROM H. A. ROTHBART, "BASIC CAM SYSTEMS" IN "MACHINE DESIGN," MAY 31, 1956; REPRODUCED BY PERMISSION OF PENTON PUBLISHING COMPANY

FIG. 6.—CONICAL CAM WITH TRANSLATING FOLLOWER

Cams are made by various processes, such as flame cutting, casting, die forging, stamping, powder metallurgy or machining. Most industrial cams are produced on standard machine tools, with or without special cam-milling attachments, or on specially designed machines. In one method the desired contour is laid out on the cam blank and the machine operator cuts the blank along the scribed line. In the tracer control method the cam surface is milled or ground by a cutter guided by an information device, such as a hardened master cam, punched tape or a servo system.

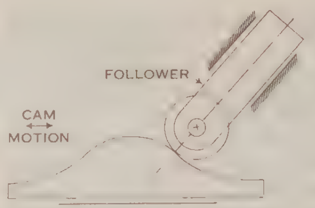


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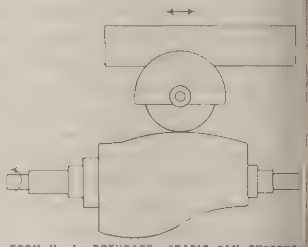
FIG. 7.—TRANSLATING CAM AND FOLLOWER



FROM H. A. ROTHBART, "BASIC CAM SYSTEMS" IN "MACHINE DESIGN," MAY 31, 1956; REPRODUCED BY PERMISSION OF PENTON PUBLISHING COMPANY

FIG. 8.—THREE-DIMENSIONAL CAM

BIBLIOGRAPHY.—R. T. Hinkle, *Kinematics of Machines*, ch. 7, (1953); H. H. Mabie and F. W. Ocvirk, *Mechanisms and Dynamics of Machinery*, ch. 3 (1957); H. A. Rothbart, *Cams: Design, Dynamics, and Accuracy* (1956). (F. J. B.)

CAMAGÜEY, a province and its capital city, in east-central Cuba. Although second in area (10,172 sq.mi.), it was the smallest province in population until about 1925. Thereafter, though it remained sparsely peopled, its population grew rapidly (195 census, 618,256). The province was established in 1879 as Puerto Príncipe, the former name also of the capital. Its early importance as a cattle-raising centre has continued, with more than 1,000,000 cattle grazing the wide, gently rolling savannas. Afte 1900, cultivation of sugar cane expanded until the province became a leading sugar producer. Its northern coast consists of long archipelago of large cays resting on a very wide insular platform and has no bays of importance except Nuevitas at the eastern end. The southern (Caribbean) coast is swampy with no goo natural harbours.

The city was founded in 1514 as Santa María de Puerto Príncipe at the site of present Nuevitas, chief sugar port of Cuba It was moved inland in 1528 to the Indian village of Camagüey Because of the great production of livestock, sugar and other agricultural products and of chromite in the province, Camagüey ha risen to be the largest interior city of Cuba (pop., 1953 census 110,388). The city is an important communications, trading an industrial centre. It is on the Central highway and connecte by rail with Havana, Santiago de Cuba and the ports of Nuevitas 45 mi. N.E., and Santa Cruz del Sur, 45 mi. S. It has an international airport.

Camagüey retains many traces of colonial architecture, and th old part of the city contains narrow, irregular streets, interrupted by small plazas. Parts of the original cathedral of 161 have probably survived later alterations. The prosperity of th colonial city evoked assault by buccaneers in 1668.

(D. R. D.)

CAMALDOLESE (CONGREGATIO MONACHORUM EREMITARUM CAMALDULENSIUM, O.S.B.), an independent Benedictin monastic order founded about 1012 by St. Romuald (*q.v.*) o Ravenna, a former Cluniac abbot. Romuald established a colon of hermits at Campo Maldoli (Camaldoli), an upland valley i the Abruzzi, under the Benedictine rule with an eremitical interpretation and strict silence. The monks inhabited huts within a enclosure that contained the common oratory, their regime bein very similar to that of the later Carthusians. The fourth prior Rudolf (prior 1074–87), founded a cenobitic branch in a nearb valley lower down the mountain for sick and elderly monks an those engaged in administration. Later foundations of both type vere made, the cenobitic branch reverting to traditional Benedic- ne practice; the two congregations were reunited in 1935. At the id-20th century two eremitical congregations exist, the original stitute as above, and a reformed body founded in 1523. The rder spread slowly in the middle ages, but more rapidly in Italy nd France in the 17th and 18th centuries. Almost all the monas- eries have been founded in Italy, with settlements in Brazil and e United States.

Among notable members of the order have been the canonist ratian, the humanist Ambrogio Traversari, the painter Lorenzo Ionaco and Pope Gregory XVI. The original "desert" of amaldoli, a picturesque site, is still occupied, though the cli- atic conditions are severe. The head house of the second branch at Frascati.

Historically the Camaldolese are significant as the first fruit f the great 11th-century monastic reform movement. Romuald, y adding a note of severity to the Benedictine rule and by choos- g the eremitic life, initiated and helped to mold a movement at was to give birth to the Carthusians and the early Cistercians. *ee* also Orders and Congregations, Religious.

See A. Des Mazis in A. Baudrillart (ed.), *Dictionnaire d'histoire et géographie ecclésiastiques,* vol. xi (1949). (M. D. K.)

CAMARGO, MARIE (ANNE DE CUPIS DE) (1710– 770), Belgian ballerina, the most brilliant dancer of the Paris péra from 1726 until her retirement in 1751. A technical inno- ator, noted for her speed and agility, she perfected the *entrechat* d *cabriole* (jumping steps previously executed chiefly by men), d was the first dancer to shorten her ballet skirts to show her inkling feet and ankles.

Born in Brussels, on April 15, 1710, Camargo studied in Paris der Françoise Prévost, and danced in Brussels and Rouen before r debut at the Paris Opéra in 1726, in *Les Caractères de la Danse.* er sensational success provoked the jealousy of her aging teacher, révost, who relegated her to the ensemble. However, she soon on an unexpected triumph by improvising a spectacular solo when avid Dumoulin failed to enter on cue for a demon dance. The cident created a furore, and Camargo went on to consolidate r popularity, eventually dancing roles in 78 ballets and operas. e died in Paris on April 20, 1770.

Among her many admirers was the Comte de Clermont. A fine rtrait of her by Nicolas Lancret hangs in the National Gallery, ashington, D.C. (Ln. Me.)

CAMARGUE, the sparsely populated delta of the Rhône southern France, between the Grand Rhône and Petit Rhône annels, with an area of nearly 300 sq.mi. The highest ground this flat district is found along the embankments of past and esent channels; in the intervening basins are marshes and shallow goons that dwindle during the dry summer. The area is notable r its rich bird life, including flamingoes, and the largest lagoon, e Étang de Vaccarès, is a bird sanctuary. The Camargue is posed to the blasts of the mistral, the wind that sweeps down e Rhône valley.

The Camargue was formerly little used, except for wintering eep and rearing bulls for the Provençal bullfights, but it has en extensively reclaimed in modern times for viticulture and, ring and since World War II, for rice cultivation. The medieval rt of Aigues-Mortes (*q.v.*), within the shell of its old ramparts, is fossil town. Near the mouth of the Grand Rhône, Port St. Louis an artificial port of modern creation. (Ar. E. S.)

CAMARINA, an ancient city of Sicily, situated on the south- n coast near the modern village of Santa Croce Camerina, 17 mi. E. of Gela. It was founded by the Greek city of Syracuse *c.* 9 B.C., as an outpost against Gela, but was defeated by the other city *c.* 553 in an attempt to assert its independence.

Hippocrates, tyrant of Gela, received the territory of Camarina om Syracuse and restored the town about 491, but it was de- royed in 484 by his successor Gelon and its population trans- rred to Syracuse; the people of Gela, however, founded it anew 461. It was abandoned by order of Dionysius of Syracuse in 5 and paid tribute to Carthage. Restored by Timoleon of rinth in 339, it was destroyed by the Romans during the First nic War in 258. Remains of the temple of Athena and foundations of houses are still visible.

See B. Pace, *Camarina* (1927).

CAMARINES NORTE, a province in southeastern Luzon, in the Bicol region, Republic of the Philippines, fronting on the Philippine Sea in the western Pacific, with a land area of 816 sq.mi. and a population (1970 est.) of 264,000. It includes the Calagua Islands, offshore, and several islets in San Miguel Bay. In the western, mountainous section lumbering and gold mining are the chief industries, the main mining district being Paracale in the north. Along the central east coast is the largest lowland, containing most of the agricultural land and population. Coconuts and rice are the chief crops. In the coastal lowland is Daet, the provincial capital municipality (pop. [1970 est.] 48,600). (J. E. Sr.)

CAMARINES SUR, a province in southeastern Luzon, in the Bicol region, Republic of the Philippines, land area 2,033 sq.mi.; pop. (1970 est.) 1,155,000. Off the northern shores are Lahuy, Quinalasag, and Butauanan islands, and about 20 other islets. Volcanic peaks are scattered over the region, interspersed by agricultural lowlands. Lumbering, fishing, and agriculture are the chief occupations. Most farms are small, and rice and coconuts are the main crops; abacá (Manila hemp) is an important minor crop.

Naga, the provincial capital and an important commercial city on the railroad, was chartered in 1948. Pop. (1970 est.) 76,700. It has one of the largest Roman Catholic cathedrals in the Philippines. Farther south are the local trade towns and municipality centres of Iriga, on the railroad (pop. [1969 est.] 105,000), and Nabua, to the west (pop. [1969 est.] 93,000). (J. E. Sr.; X.)

CAMASSIA (Quamasia), a small genus of North American bulbous herbs of the lily family (Liliaceae; *q.v.*), with grasslike leaves and showy white to blue or purplish-blue flowers in graceful racemes. The eastern camass or wild hyacinth (*C. scilloides*) grows from 12 to 18 in., bears violet to blue or white flowers and is popular in rock gardens. The common camass (*C. quamash*) and its numerous variants of the western United States has blue, blue-violet or white flowers, and the Leichtlin camass (*C. leichtlini*), also of the western United States and adjacent Canada, has blue-violet to cream-white flowers. The last-named species is perhaps the most popular for the open border, while the first is most suitable for the rock garden. The bulbs should be planted, preferably in groups of eight or more, in the fall and not be disturbed. (J. M. Bl.)

CAMBACÉRÈS, JEAN JACQUES RÉGIS DE, duc de Parme (1753–1824), French statesman, the legal expert who was second consul with Napoleon Bonaparte and then archchancellor of the empire, was born at Montpellier on Oct. 18, 1753, of a family long associated with the legal profession. At Montpellier he became counselor in the *cour des aides* in 1774 and president of the criminal court there in 1791. Elected to the Convention as deputy (1792), at the trial of Louis XVI he voted for the sentence of death to be delivered but to take effect only if France were invaded. He discreetly kept clear of party quarrels and concerned himself mainly with judicial and legislative matters. The two successive drafts for a civil code which he and P. A. Merlin (Merlin de Douai) produced were not enacted. After Nov. 1794 he became a member of the committee of public safety and occupied himself with foreign affairs, being instrumental in concluding the peace treaties of 1795 with Tuscany, with Prussia, with the Dutch and with Spain. When the Convention was dissolved he became a member of the Council of the Five Hundred, which put him forward, unsuccessfully, as a candidate for the Directory. A third draft for a civil code on which he also collaborated was not debated. As he was not re-elected in May 1797, he turned to practising law privately. Then, in July 1799, he was appointed minister of justice.

Having discreetly assisted Bonaparte and E. J. Sieyès to organize the *coup d'état* of Brumaire (Nov. 1799), Cambacérès became second consul in the following December. In 1802 he helped materially to establish the life consulate for Bonaparte. Though he disapproved of the execution of the duc d'Enghien and of the proclamation of the empire, he was made archchancellor of the empire in 1804 and given the title of duc de Parme in 1808.

He presided over the senate and, as a rule, over the council of state and exercised extended powers during Napoleon's absences. As Napoleon's principal adviser on all juridical matters from 1800 to 1814, he was instrumental in formulating the civil code (1801–04) and the four subsequent codes (1804–10). Often consulted on other matters of state, he tried to temper Napoleon's impetuosity, especially in foreign affairs. According to L. A. Thiers, he was against the attacks on Spain (1808) and on Russia (1812).

Excluded from public life at the Restoration (1814), Cambacérès reluctantly returned to it in the Hundred Days, at Napoleon's bidding, when he directed the ministry of justice and presided over the chamber of peers. Exiled at the second Restoration, he lived in Belgium until 1818, when he was allowed to return to France. He died in Paris on March 8, 1824.

Cambacéres was grave and pompous in demeanour but often showed weakness of character. Clear thinking and deliberate in his actions, with a profound knowledge of the law, he was a fluent and persuasive speaker. He had a European reputation as a gourmet who gave superb dinners.

See J. Thiry, *Cambacérès* (1935). (C. E. Du.)

CAMBAY, GULF OF, a trumpet-shaped inlet of the Arabian sea on the west coast of India, narrowing northward between the Kathiawar peninsula on the west and the coast of Gujarat on the east. Its shape and orientation in relation to the southwest monsoon winds explain its high tidal range (40 ft.) and the velocity with which the tides enter. But it shallows rapidly: all its ports have suffered from silting because of flood torrents entering its head; and shoals and sandbanks are treacherous.

CAMBAY town is at the head of the gulf but was never of great significance; all the ports have been supplanted by Bombay and trade is only local. On the opposite side of the gulf, Bhavnagar suffers less from silting and has been modernized to serve as a leading seaport of the Kathiawar peninsula. (L. D. S.)

CAMBERT, ROBERT (*c.* 1628–1677), can be considered the first French composer of opera as we know it, though the dramatic sense of the word cannot be applied to any of his works. He was born in Paris about 1628 and became a pupil of the harpsichord composer Jacques Champion de Chambonnières. His first stage work, the *Pastorale d'Issy*, was performed in 1659, with text written by the poet Pierre Perrin. The greatest success of these two men came in 1669 when they were granted by Louis XIV the exclusive right to produce operatic performances. They founded the first Académie Royale de Musique and opened it with a performance in 1671 of their masterpiece, the five-act pastoral opera *Pomone*. In 1672 Jean Baptiste Lully managed to gain the royal "opera privilege" from Cambert, and in consequence Cambert left France for England. He arrived in London in 1673 and is said to have become superintendent of music at the court of Charles II. On the French model he founded a short-lived Royall Academy of Musick in Covent Garden. He died in London in 1677, supposedly poisoned by a servant. (B. P.)

CAMBIASO (CAMBIASI), **LUCA** (1527–1585), often familiarly known as IL LUCHETTO, Genoese painter and the first master of a native school at Genoa. Son of a painter, Giovanni Cambiaso, he was born at Moneglia, near Genoa, on Oct. 18, 1527. His early style was profoundly influenced by the frescoes of Perino del Vaga and Pordenone (1483?–1539) in the Doria palace at Genoa, and there are substantial echoes in his work of Correggio and Veronese; but his mature style was original and distinctive. He executed an immense amount of work in fresco for Genoese palaces and churches sometimes co-operating with his father or, later, with Giambattista Castello (1509?–1569) from whom he learned much about space composition, drawing and colour. Most of his altarpieces and subject pictures remain in Genoa and its neighbourhood.

His turbulent and Mannerist early style gave way to a more calm and measured sense of pattern, and a number of his later "nocturnes" had a profound effect on baroque painting. He was summoned to Spain by Phillip II in 1583 to succeed Castello in painting frescoes at the Escorial. His lively and attractive drawings are very numerous and many show the heads and principal forms blocked out in a broad cubistic manner. He died at the Escorial in Madrid, Sept. 6, 1585. (E. K. WE.; X.)

CAMBIO, ARNOLFO DI: *see* ARNOLFO DI CAMBIO.

CAMBODIA (KHMER REPUBLIC), an independent republic of Southeast Asia, formerly a constitutional monarchy (until October 1970) and a part of French Indochina (until 1955). It is 69,898 sq.mi. (181,035 sq.km.) in area and is bordered by Thailand (Siam) to the northwest, by Laos to the northeast, by the Republic of Vietnam to the southeast and by the Gulf of Siam to the southwest.

Physical Geography.—Formed mainly in a recently alluviate tectonic depression, much of the surface of Cambodia is a low lying plain around the Tonle Sap (Great lake), a natural floo reservoir of the lower Mekong (*q.v.*) and its distributaries. North of it rises the dry, steep, flat-topped Chaîne des Dangrek (Phnom Dangrek) sandstone scarp adjoining which to the east are low hills through which the Mekong enters from the north, separatin the scarp from outliers of the Chaîne Annamitique. The Cambodian plain is geologically continuous northwestward with the Bangkok plain but to the southwest is edged by the abrupt Cardamom mountains, making a rocky coast poorly accessible from land an sea. The plain is regularly flooded over large areas and carrie much tropical fresh-water swamp vegetation. The Tonle Sap nowhere deeper than 6 ft. (2 m.) during the dry season, contain thick aquatic plants that hasten sedimentation and often hinde boats. Settlements are attracted to waterside for the transpor facility and to low hills for safety from the extensive floods. Th climate is tropical, warm and humid, with heavy summer rain and some cool season rains near the Cardamoms where the rainfall may exceed 250 in. (6,350 mm.) a year. (E. H. G. D.)

Archaeology.—There is no evidence of Paleolithic culture in Cambodia; such stone implements as are known belong to th Neolithic phase, though they are, in part at least, contemporar with bronze implements in the same region. The objects ar from certain kitchen middens, open sites and surface finds; ther are also museum specimens of uncertain provenance and age The material is sufficiently distinct to be grouped as the Somrong-sen culture after a site to the southeast of the Tonle Sap di covered by P. Roques in 1876 and more fully investigated by H Mansuy. Further researches, notably by Étienne Patte and Pa Levy, show a wider distribution in the region of the Tonle Sa and its extension northward into Vietnam. In no site has mor than one archaeological level been observed. The artifacts include shouldered hoes, axes, adzes, chisels and gouges, with hammerstones, grindstones, polishers, disks, cylinders and bark beater and a few knives and scrapers; fishhooks, harpoons, shell ornaments and stone beads are also known. The manufacturin processes include percussion, sawing and polishing; axes sho unequal bifacial grinding of the cutting edge, an apparent characteristic of southeastern Asia. Some tools show affinities wit the later stage of the Bacsonian culture. All the pottery is handmade, poorly fired and unpainted, decorated with cord pattern incised geometric designs and arrangements of curved and wav lines. Some of these patterns, as well as the forms of the vessels are known from southeastern China. The presence of crucible with the bronze finds points to some local manufacture, thoug the types are known from Laos, Burma and Yünnan. Th evidence available does not permit precise dating, but it seem unlikely that the sites are much earlier, though culturally less rich than those of the more northerly Dong-son culture complex.

In the absence of stratified sites, the relation between th Somrong-sen culture and the later phases of Cambodian civilization has not as yet been established. Early Chinese accounts o the life of this region suggest that it cannot have been very different from that exemplified by the material discussed above Certain sites in the Transbassac, southwest of Saigon, probabl represent the earliest considerable western influences upon Cambodian Neolithic and Aeneolithic peoples. These sites, discovere by aerial reconnaissance, were partially investigated by the Écol Française d'Extrême-Orient during the years 1942–45. They sho traces of brick buildings upon heavy granite foundations as well a pile dwellings. There is evidence of a vast system of canals bot for irrigation and for navigation between what appear to be settl ents of considerable size. The est known of these, Oc Èo, is a ectangle, 3 km. (1.9 mi.) long by ½ km. wide, about 24 km. (15 i.) from the sea today. This is onnected by canal with another ite, Ta Kèo, which seems to have erved as its port. It seems lmost certain that this great omplex of interconnected sites epresents the Fou-nan (Fu-nan) f the Chinese texts, first located this region by Paul Pelliot. xcavations at Oc Èo have re- ealed evidence for wide trade re- tions in southern Asia (con- rming, strikingly, the Chinese ccounts). There is also evi- ence that this region, obviously fluenced markedly by Indian ltures, shared with other re- ons of southeastern Asia stone- sing techniques hitherto associ- ted in this area with the building f megaliths. The emphasis pon the mountain (Fou-nan = *phnom*, "mountain") in religion nd toponymy seems connected with other local widely scattered lts. Finds on the site include gold ornaments, totaling 1,200 g. weight, some bronze objects, a surprising number of artifacts tin and lead, intaglios, cameos and terra cottas, vast numbers f beads made of glass and semiprecious stones, with implements nd tools of wood, iron and stone. The inscribed seals, carnelian, ronze and tin have their legends in Sanskrit and date from the nd to the 4th centuries A.D. A glass disk shows the bust of a an with Scythian headdress, plaited hair and beard, smelling a ower, a known Sassanian motif. Roman finds include intaglios, me with grylli, and two gold bracteates, one being of Anto- nus Pius, datable to A.D. 152. These last almost certainly derive om India. A later Han mirror testifies to Chinese connections. ut the indigenous decorative styles, relying upon natural themes ith a marked marine and littoral bias, seem to point to a strong ndonesian element in the culture of Fou-nan.

BY COURTESY OF UNITED NATIONS

TEMPLE AT ANGKOR WAT, CAMBODIA: 12TH CENTURY

Architecture and Art.—There follows a further gap in nowledge of Cambodian archaeology, though this can be filled to me extent, so far as architecture is concerned, by the representa- ons of buildings in low relief on surviving buildings of the earliest hmer period and of the last stages of the kingdom of Tchen-la ee below). To this period may belong some wooden Buddhist atuary in the Saigon museum and one or two pieces in stone from e lower Mekong which are strongly Indian in influence. The ildings which survive suggest the adaptation of wooden archi- ctural techniques to buildings in more durable materials. Thus e external roof is constructed in stories which do not reflect e internal vaulting. The predominating horizontal lines suggest ood frame structures. There are, in fact, two styles of building, ough both are characterized by single-chamber structures *prasat*). The more simple is without the large base and the rich namentation of the other with its projecting niches on four des (three with false doors) and its higher, though fewer-storied, ofs. To this period, the 7th century, belong the temples of Sam- r Prei Kuk in Kompong Thom, probably the capital, Içanapura, Içanavarman I (616–627?), to whose reign are to be assigned so the first buildings of Phnom Bayang. Asram Maha Rosei of interest because of the fine Harihara image (in the Musée uimet, Paris) which was found in it and because the building, stone instead of the more usual brick of this period, was shown Mauger to be derived from Indian originals which include the ve temples of Ajanta (its undoubted Javanese affinities with e temples of the Dieng plateau being cognate rather than direct). rom this region (Phnom Da) came a Vishnu, with two other atues (probably of 6th-century), now at Phnom Penh.

After the Sambor period, which marks the beginning of the decline of direct Indian influence, it is possible to distinguish a period when Cambodian architecture evolved along existing lines (Prei Khmeng period). To this phase belongs the fine Harihara of Prasat Andet. By the second half of the 8th century (Kompong Prah period) the step pyramid style emerges (Ak Yom), though it is clear that by Sambor times the single *prasat* was giving way to quincuncial arrangements of temples. The reproduction of buildings in low relief as suitable ornament for the pediment gives way to garlands and vegetal designs. At Kulen in the 9th century a large group of temples shows signs of a conscious archaism, reflecting styles of the Sambor period, which is a marked feature of Khmer art history. In the styles of Kulen and the succeeding Prah Ko period there are also clear traces of Javanese and Cham influence; these styles recur, characteristically, in the 10th century (Bantéay or Banter Srei), whence in turn the sculptors of the 12th century drew inspiration, as also from Dvaravati (southern Siam) in their Buddhist works. The reign of Jayavarman II saw the establishment of a succession of capitals, one at Prasat Ak Yom, another at Kulen and the fourth at Roluos. During the last phase of the 9th century Trapéang Phong (main temple), Prah Ko (879), Bakong (881) and Lolei (893) were erected. These mark the firm establishment of classical Khmer architecture with its groups of buildings on terraced platforms, gradually to be integrated by connecting corridors of increasing complexity (as problems of vaulting were overcome) and by a transition from square to cruciform ground plans for the buildings. The façades are adorned with panels of divine figures, the lintels are more ornate, the Naga theme becomes more prominent and the profiles of the buildings more ambitious. Statuary, too, exhibits the emergence of a Khmer type, freed from the traditions of its Indian originals with their typical *hanchement* (with the weight on one foot and the opposite hip emphasized).

Yaçovarman I moved his capital from Roluos to Siem Réap, where he founded Yasodharapura, the first city of Angkor, with its centre at Phnom Bakheng. The Bakheng period marks the change from brick, with stone embellishments, to stone as the principal building material. Apart from a brief interval when the court moved to Koh Ker (921–944), some 70 mi. N.E. of Angkor, this was to remain the area of the capital for four centuries. To the period immediately after the return from Koh Ker belong the Eastern Mébon and Prè-Rup structures. Bantéay Srei temple follows (967). Next come Ta Kèo, Phimeanakas and the *gopuras* (gateways) of the royal palace (Kléang period). Later in the 11th century the Western Mébon and Baphuon were built, probably by Udayadityavarman II. Suryavarman II celebrated some years of successful, if transitory, campaigning by the construction of the chief masterpiece of Khmer architecture, Angkor Wat itself,

WIDE WORLD

CARVED BUDDHA HEADS ON THE TOWERS OF THE CHAPELS OF THE INNER GALLERIES OF THE BAYON TEMPLE IN ANGKOR WAT PORTRAY JAYAVARMAN VII AS LOKEÇVARA: LATE 12TH CENTURY

a galleried temple complex adorned in low relief with scenes from the Hindu epics and of the royal court and army, the king himself appearing twice. After a period of setbacks at the hands of the Chams (who sacked Angkor in 1177), the situation was restored by Jayavarman VII. He completed Prah Khan, Ta Prohm and Bantéay Kdei, the latter marking, with parts of Ta Prohm, the transition from the Angkor Wat period to that of Bayon, the last great Khmer building, which formed the centre of the precinct of Angkor Thom with its five gateways constructed by Jayavarman VII as his capital. The great Buddha heads which are carved on the temple towers portray the king as Lokeçvara, a Buddhist deity in great favour among the Khmers. The building underwent many transformations during its construction, which already foretells the rapid decay of Khmer craftsmanship, in part, no doubt, exhausted by wars and by the need for continuous and increasingly ostentatious buildings.

The final stages of Khmer architecture are exemplified by Bantéay Chmar and the royal terraces. In addition to these temples, Jayavarman built 121 resthouses and 102 hospitals and numerous roads for the use of pilgrims. A fine statue, almost certainly of this great king, from Angkor Thom, is preserved in the museum at Phnom Penh.

Of Khmer work in bronze, only one example, outstanding in its artistic and technical mastery, can be mentioned here: the head, about 114 cm. high, of a sleeping Vishnu, which can be dated to the middle of the 11th century. This is the only surviving specimen of Khmer monumental work in bronze, but it leaves no doubt as to the technical skill of its founders. In stone the Khmer craftsman rapidly achieved independence from Indian models, as can be seen in the earliest datable statues, those from Phnom Da. Thus, though his work was still governed by the fundamentals of Indian iconography, the treatment cannot be confused with Indian work upon similar themes; nor did he adopt all the Indian repertoire, erotic and macabre subjects being almost entirely absent. At least once, in the portrayal of the horse-headed avatar of Vishnu from Kuk Trap (now at Phnom Penh; ? early 7th century) the artist achieved a harmonious blending of the horse's head with the human trunk which is an astonishing resolution of technical and artistic problems. From the 6th until the beginning of the 9th century the craftsman continued the practice of supporting the limbs of his statues by means of a horseshoe arch or at least a stone bar behind the upper limbs. This requirement seems in part to have been inspired by the reminiscence of Indian work, which seems to prefer high relief to freestanding statuary. But the need to support the multiple limbs with their attributes and a mistrust of the properties of the available material (certainly justified in the case of schist, a favourite stone) also played parts in this practice. In the early period there is a noticeable trend toward naturalism, but a renaissance under Jayavarman II marks a hieratical tendency in which the forms are markedly more architectural. This tendency continues, though there is an astonishingly dynamic phase which coincides with the move to Koh Ker. With the return to Angkor there develops a period of conscious archaism, which evolves stylistically during the 11th century, but at the beginning of the next century hieratica styles reappear, the statuary being richly adorned with jewels and diadems. Under Jayavarman VII, there is a return to austerity: the benign smile and gestures of the hands replace adventitious aids to religious majesty. At this time, too, statues from the life appear, of the highest merit. But even these rely for thei effect upon the traditions of the Khmer artists with their marked preference for hieratical poses and the impressionistic rendering of flesh and musculature. The later statuary shows strong Tha influence, but Thai sculptors in the 16th century were still conten to copy Khmer originals of the classic periods. (*See* also INDIAN ARCHITECTURE: *Malaysia: Cambodia.*) (A. H. CE.)

History.—The earliest Khmer kingdom (*see* KHMER), founded in the 1st century A.D., is known only by its Chinese name, Fu-nan (Fou-nan), which probably is derived from the Khmer word *phnom*, "mountain." Legends ascribe its foundation to the marriage of the daughter of a local chief to an Indian Brahman, one o numerous Indian immigrants who, traveling through the Strait of Malacca, across the Kra isthmus, or via Java and Sumatra brought Indian culture and civilization to create the "hinduized" states of Southeast Asia in the 1st millennium A.D.

Many of the features which distinguished later Khmer kingdom made their first appearance in Fu-nan between the 1st and 6t centuries. Based upon the Mekong delta and a well-develope irrigation system, Fu-nan was prosperous and carried on a flourishing trade with China and India. As a kingdom it was organize in the Indian fashion, with a god-king reigning from a holy mountain in the capital at Vyadhapura (Ba Phnom) over surroundin vassal kingdoms which extended from southern Vietnam in th east to the Malay peninsula in the west and northward over th Korat plateau. Continuous contact with India gave Fu-nan a cultured bureaucratic elite, accomplished in the arts and science and techniques of statecraft and artistic expression, while th social structure, manner of life, and beliefs of the Khmer peasan remained fundamentally unchanged.

Internal dynastic struggles brought about the fall of Fu-nan i the latter half of the 6th century and of its successor state Chen-la, founded on Phum Basac in the middle Mekong valley, i the 9th century. It was Jayavarman II (802–850) who establishe the capital in the region of Angkor, where he and his successor constructed grand monuments. The power of the Khmer Empir reached its height under Suryavarman II (1113–*c.* 1150), wh built the famous Angkor Wat, the ruins of which still stand (se *Architecture and Art* above). His armies ranged as far as Nort Siam in the west, the Bay of Ban Don in the south, and as far nort as the fringe of the Red river delta of Tongking. Khmer strengt was based upon a well-developed system of irrigated rice cultivation and a control over manpower exerted by an elaborate bureaucracy, presided over by the god-king. This power was exercise against the Vietnamese Dai Viet empire and Champa (*q.v.*) to th east and Mon (*q.v.*) states in the valley of the Chao Phraya rive to the west.

Domestic instability caused by the accession of weak ruler to the monarchy left the Khmers open to the attacks of their neighbours, and their difficulties were compounded when Buddhism began to undermine the Brahmanical hierarchy of the state; y Jayavarman VII (1181–*c.* 1218) was able to extend the empir farther afield than any of his predecessors. The empire quickl crumbled in the 13th and 14th centuries; first as the Thai in th west seized power from their Khmer overlords and the Chams expelled an occupying army, and then as the Mongols extended the support to the Thai and Chams, invading Cambodia from Champ in 1283. The decline of the Khmer empire was accelerated a the Thai captured Angkor in 1369, 1388, and 1431; the capit finally moving to the region of Phnom Penh in 1434 as the combination of Thai military pressure with the weakness of the rulin ouse had rendered the capital indefensible and destroyed the ir- gation system on which its prosperity depended. By the 16th ntury Cambodia was reduced to a rump of its former self, shorn its western and northern territories by the Thai and pressed on e east by Vietnamese migration into the Mekong delta. After nturies during which Cambodian kings intermittently were forced recognize the suzerainty of the Thai kingdom of Ayutthaya, ietnamese pressure intensified until, at the end of the 18th cen- ry, Cambodia became a pawn in the struggle between its power- l neighbours, paying tribute to both and maintaining a precarious dependence as a buffer state between them. Only a national sing in 1840 prevented Cambodia's transformation into a prov- ce of Vietnam, following which the condominium was revived.

French Domination.—Apart from a Portuguese and Spanish tempt to seize control in Cambodia at the end of the 16th cen- ry, European influence was not felt in Cambodia until well into e 19th century. The French in 1862 claimed suzerainty over ambodia, ignoring Siam's claim to equal rights. In 1863 they rced King Norodom I (1860–1904) to submit to a French pro- ctorate; Siam consented in 1867, after its continued possession the western provinces of Cambodia, Battambang and Siem éap, held since 1794, was assured. The French were able grad- lly to extend their control over the Cambodian administration, though they had to put down revolts in 1866 and 1885. Its pital moved to Phnom Penh in 1866, and in 1887 Cambodia was aced under a governor-general for Indochina. On the death of orodom in 1904, the French bypassed his son and chose his other, Sisowath, to succeed him. Sisowath was succeeded by s son, Monivong, in 1927.

The occupied western provinces remained an issue which both ench and Cambodians pressed until in 1907 Siam ceded Battam- ng and Siem Réap. In 1941 the Japanese awarded the provinces Siam, but they were restored to Cambodia in 1946.

In 1945 the question arose as to whether the French should or uld resume their former status as the protecting power in Cam- dia. The monarchy had been maintained through the French d Japanese periods, though executive authority increasingly fell to French hands. A new constitution of May 6, 1947, gave engthened executive powers to a constitutionally limited mon- ch, while enabling nationalism to focus on the historic monarchy d the person of Norodom Sihanouk (who had succeeded to the rone in 1941 on the death of his grandfather, Monivong) rather an be drawn to Communism.

Nationalism had been a force in Cambodia for some years, as idenced by the risings in 1866 and 1885. The Cambodian istocracy had maintained an ambiguous position *vis à vis* the ench, exploiting in turn the conflicting interests of Siamese, ench and Japanese. During World War II a Cambodian party lled Khmer Issarak ("Free Cambodia") was established, at first onsored by the Free French to form an anti-Japanese fifth col- nn. After the war the Khmer Issarak emerged as nationalist and onarchist, able to press and resist the French without embarrass- the king and without suggesting revolution, the Khmer Issarak tially having no Communist ties. Its existence was used by anouk to secure concessions from the French, preoccupied in etnam. When independence within the French Union was anted to Vietnam, Cambodia quickly (on Nov. 8, 1949) received nilar status subject to French military control, which ended with e formal transfer of French authority on Nov. 9, 1953.

Later History.—By 1950 the traditional pressure of Annamites ietnamese) in Cambodia took a new form. The Viet Minh mmunists of North Vietnam stimulated the formation of sev- l small Communist groups in Cambodia, linking them with ele- nts of the Khmer Issarak and similar groups in Laos into a ited front aiming at internal revolution rather than the actual ction of the French. The guerrilla war then going on between ench and Viet Minh forces was extended into Cambodia, where rth Vietnamese insurgents appeared. International alarm at se confusions led to the Geneva conference of 1954, at the con- sion of which the Viet Minh and the French agreed to withdraw m Cambodia. Cambodia's frontiers were guaranteed by the utheast Asia Collective Defense treaty on Sept. 8, 1954.

In March 1955 Norodom Sihanouk abdicated and his father, Norodom Suramarit, came to the throne. The former king then led the Socialist People's Community party in a general election. No members of other parties were successful, and the assembly elected contained only supporters of Sihanouk, who became premier in Sept. 1955. His first act was to secede from the French Union, making Cambodia fully independent. In foreign affairs his policy was one of neutralism. Suramarit died on April 3, 1960, and Sihanouk again became head of state (but not king). In 1960 Cambodia's first five-year development plan was launched.

From 1961 on Cambodia's relations with its neighbours, Thailand and South Vietnam, deteriorated, mainly on account of border disputes and incidents. Cambodia's efforts to reconvene a meeting of the signatories of the 1954 treaty, in the hope that its neutrality and territorial integrity might be guaranteed, were unsuccessful. In 1963 Sihanouk accused the U.S. Central Intelligence agency of fostering rebellion in Cambodia, and from the end of that year renounced all U.S. economic, military and cultural aid.

In Oct. 1966 the national assembly chose Lieut. Gen. Lon Nol as premier, with Sihanouk's approval. Later in the year, however, Sihanouk set up a *contre-gouvernement* to watchdog Lon Nol's cabinet, which had proved to be extremely rightist. When Lon Nol announced his resignation on Nov. 4, Sihanouk persuaded him to remain, but he finally resigned in April 1967, mainly because of the *contre-gouvernement*, which had been made "a permanent institution" with the right to criticize all future governments.

During the period 1964–67 Cambodia's relations with France and China improved, but there was continued serious ill feeling against both the United States (with which diplomatic relations were broken off in May 1965) and South Vietnam because of casualties and damage inflicted on Cambodian villages near the border in the course of the Vietnam war.

The political situation in Cambodia moved rapidly to crisis in 1969 under the pressure of worsening economic conditions, dissatisfaction with Sihanouk's refusal to share power, and the loss of territory in the east to Viet Cong and North Vietnamese troops. With difficulty Gen. Lon Nol again was persuaded to become premier in August and Sihanouk to withdraw his resignation as chief of state. This time, with the support of political and military leaders, Lon Nol moved to make his authority real in a *coup* that deposed Sihanouk on March 18, 1970. Cheng Heng was sworn in as temporary chief of state, while Sihanouk, absent on a visit to Moscow, moved on to Peking to set up a government-in-exile on May 5. Meanwhile, on April 30, U.S. Pres. Richard M. Nixon ordered U.S. troops into Cambodia in support of South Vietnamese forces, to uncover and destroy Viet Cong and North Vietnamese sanctuaries and supply lines. By agreement with the South Vietnam government, South Vietnamese troops continued to fight in support of Cambodian operations, with U.S. air support, beyond the June 30 withdrawal deadline President Nixon had announced for U.S. ground forces. Viet Cong, North Vietnamese and insurgent Khmer Rouge forces were established in control of the east and north of the country, including the Angkor ruins, by mid-1970. On Oct. 9 the national assembly declared Cambodia a republic under the name of the Khmer Republic. Political uncertainty continued due to the critical illness of Lon Nol early in 1971. When no other acceptable candidate for his office could be found, he remained premier, with Cheng Heng as chief of state, pending the election of a president.

See also VIETNAM. (E. H. G. D.; D. K. WY.)

Population.—The population was 5,728,711 at the 1962 census. Minority groups included about 350,000 Vietnamese (often called Annamites) immigrants from the coast who pioneered large paddy farms to the south and east, about 230,000 Chinese immigrants who handled the marketing of Cambodian rice and fish, and about 85,000 Chams to the northeast beyond the Mekong, together with primitive, isolated hill tribes (Stieng, Phnong, Por).

The Khmer, or Cambodians proper, constitute about 85% of the population of Cambodia. Most live in houses built on stilts, dispersed on low-grade, largely self-contained paddy farms, and subsist mainly on rice and fish. Physically and culturally they resemble the Siamese and Burmese, with whom they share the practice of Theravada Buddhism as well as centuries of experience with Indian civilization. Their arts, literature and popular scientific ideas are Indian in inspiration, as is much of the vocabulary in which they are expressed. Rendered in a script derived from India in which about 60% of the population is literate, Khmer is one of the Mon-Khmer family of languages and is largely polysyllabic. French is widely spoken, being generally the language of government, commerce and higher education.

Administration.—Cambodia, according to the 1947 constitution, was a hereditary monarchy lineally of male descendants of King Ang-Duong. The constitution was amended in June 1960 whereby parliament could confer the powers of the chief of state on a person chosen by national referendum. Parliament is bicameral and legislative power is vested in a 61-member national assembly (elected for four years by universal suffrage) and the 24-member council of the kingdom.

The country is divided into 19 *khets* (provinces: Battambang, Kampot, Kandal, Koh Kong, Kompong Cham, Kompong Chhnang, Kompong Speu, Kompong Thom, Kratié, Mondolkiri, Oddar Meanchey, Preah Vihear, Prey Veng, Pursat, Ratanakiri, Siem Réap, Stung Treng, Svay Rieng and Takéo) and 4 municipalities. Phnom Penh (*q.v.*), the capital and largest town, grew rapidly after independence, and in 1962 had 403,500 inhabitants. Battambang (*q.v.*) is capital of the lake province.

In the 1960s there were more than 625,000 students at 3,500 primary schools, 67,000 students at about 170 secondary and technical schools, 1,300 in several teachers' training schools, and 2,300 students in institutions of higher education, including the Université Royale Khmère, founded in 1960, and a Buddhist college, founded in 1955, both at Phnom Penh, and a number of other institutions.

The country, which is divided into five military districts, has a small army, navy and air force.

The Economy.—The economic basis of Cambodia has always been the regular and easy productivity of plains round the shallow Tonle Sap which annually floods more than 2,000 sq.mi. of farmland, naturally replenishing fertility and irrigating paddy. Its historic advantage has not been maintained since changing techniques have left the Cambodian yield far below yields in Japan, Italy and many other countries. The wet farming facilitated by the natural floods was originally pioneered by Hindu colonists who found there the optimum rice-growing conditions for their times, enabling them to support large armies and a major monarchy. Fish from the lake provides the protein food fundamental to rice eaters, part of the large annual catch of over 150,000 tons being dried for export.

Annual paddy production in the 1960s (from about 5,000,000 ac.) averaged 2,300,000 metric tons, having fluctuated between 800,000 and 1,530,000 tons during the unstable post-World War II decade. The acreage harvested is from two to three times as great as during the 1930s, with the increase coming largely from Annamite immigrants opening up new lands along the Mekong distributaries. The oldest and main paddy area is around Battambang where a static phase has been reached. Substantial areas are also under maize (corn). East of the Mekong and near Kompong Cham are rubber plantations. Cattle are raised, mainly for draft, and pigs are shipped to the towns and South Vietnam.

After 1960 cotton cultivation was attempted but remained a minor interest. Tobacco is grown widely for home use. Chinese immigrants introduced pepper culture to the south around Kampot. Other spices are casually produced in the humid valleys of the Cardamom mountains in the southwest. There are considerable forest resources. Under the 1960 five-year plan the production of refined sugar, cotton and jute textiles, plywood, paper and cement was developed.

During the 1960s more than two-fifths of Cambodia's total foreign trade was with other far-eastern countries although France remained its largest single supplier and its best customer, accounting for about one-fifth of both imports and exports. Some trade was also carried on with the United Kingdom and with eastern Europe, but by the late 1960s trade with the United States (about 15% of imports and more than 5% of exports in 1963) had practically ceased.

Insecurity in postwar Indochina greatly reduced exports of rice of which Cambodia was the chief Indochinese source before 1940 In the early 1960s the share of rice and rubber (the two major export commodities) in total exports declined from 73% to 51%, but by the late 1960s had risen again to 85%, with maize (corn) accounting for another 8%. Textiles, machinery and transport equipment dominated imports.

The Cambodian monetary unit is the riel, with an exchange rate of 35 riels to the U.S. dollar. In the 1960s the budget was balanced at about 6,245,000,000 riels by means of substantial foreign aid, which also helped to finance the growing balance of payments deficit, estimated at 17,000,000,000 riels.

Domestic trade movements are largely by water. Located at the Tonle Sap-Mekong confluence, Phnom Penh is the junction o 900 mi. of navigable waterways on which shallow craft handl local trade; from Phnom Penh vessels of up to 3,000 tons carry rice through Mekong distributaries across the Vietnamese borde to Saigon and Cholon for reshipment overseas. A new 400-f prestressed concrete cantilever bridge was constructed at Phnom Penh in 1966. To avoid dependence on this outlet a new port Sihanoukville, was built with French aid at Kompong Som on the Gulf of Bangkok in the late 1950s; in the mid-1960s it was bein enlarged and a rail link with Phnom Penh was under construction The railway from Phnom Penh to Battambang continues vi Mongkol Borey into Thailand. Three major roads cross Cambodia, all originally designed by the French for strategic purposes one lies east of the Mekong, linking Laos to Saigon, and the othe two traverse Tonle Sap on the northern and southern sides, providing links with Thailand. A further road, built with U.S. ai links Phnom Penh with Sihanoukville. There are internationa airports at Phnom Penh and Siem Réap.

See also references under "Cambodia" in the Index.

(E. H. G. D.; X.)

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CAMBON, JULES MARTIN (1845–1935), French admi istrator and diplomat who played a part in European politics ambassador to Germany before World War I, brother of Pier Paul Cambon (*q.v.*), was born in Paris on April 4, 1845. was called to the Paris bar in 1866, served as captain in the Franc German War and entered the civil service. He was prefect of t *départements* of Nord (1882) and Rhône (1887) and govern general of Algeria (1891). In 1897 he was transferred to t diplomatic service and appointed ambassador to the United State in that capacity he negotiated in 1898 the preliminaries of peace behalf of Spain, after the war with the United States. In 1902 was sent as ambassador to Madrid and in 1907 to Berlin. In 18 aul Cambon became French ambassador in London, and thenceorth the two brothers worked in close accord to frustrate the degns of the war party in Germany. In Oct. 1915 he became cretary-general of the ministry of foreign affairs, a post specially eated for him. In Jan. 1919 he was appointed one of the five embers of the French delegation to negotiate peace and presided ver the peace conference's committees on Czechoslovak, Greek nd Polish affairs. He was one of the signatories of the treaty of ersailles and afterward was the chairman of the Ambassadors' onference (1919–31). A writer of distinction, Cambon was ected in 1918 to the French Academy. He died at Vevey, Switz., n Sept. 19, 1935.

See J. Cambon, *The Diplomatist* (1931); Geneviève Tabouis, *The ife of Jules Cambon* (1938).

CAMBON, PIERRE JOSEPH (1756–1820), French revutionary leader important for his attempt to stabilize the national nances, was born at Montpellier on June 10, 1756. As representive of Hérault in the Legislative Assembly and in the Convenon, he was at first sympathetic to the Girondins against such men Marat. He voted, however, for the execution of Louis XVI d for measures against the *émigrés* and was vehement in his denciations of Dumouriez, though he opposed the creation of the evolutionary Tribunal in March 1793 and interceded for the irondins in June 1793. Thereafter he put his financial acumen to e service of the Montagnards; and the Grand Livre de la Dette ublique, a register of all the state's creditors, adopted on Aug. 24, 93, after his report of Aug. 15, was a major contribution to stality (for the financial crisis *see* for instance ASSIGNATS). Atcked by Robespierre as a reactionary, he replied so forcefully to precipitate his enemy's downfall (8–10 Thermidor; July 26–, 1794); but in the ensuing persecution of the Montagnards by allien, he was accused of malversation, excluded from the final committee and eventually driven into hiding until the amnesty 4 Brumaire (Oct. 26, 1795). He then retired to his estate at Terl, near Montpellier, where he lived quietly for 20 years. Elected represent Hérault in the Napoleonic chamber of the Hundred ays, Cambon made a final speech against the prospect of a secd Bourbon restoration. Then, exiled as a regicide in 1816, he thdrew to the Netherlands, where he died, near Brussels, on b. 15, 1820.

See F. Bornarel, *Cambon et la Révolution française* (1905); R. naud, *Cambon, 1756–1820* (1926).

CAMBON, PIERRE PAUL (1843–1924), French adminrator and diplomat who as ambassador to London was one of the akers of the Anglo-French alliance, was born in Paris on Jan. 20, 43, the son of a tannery owner. He was called to the Parisian r and became private secretary to Jules Ferry during the Comune. In 1872 he was prefect of the *département* of Aube and in 77 of the Nord. Joining the diplomatic service he was successvely resident-general in Tunisia (1882) and ambassador to Maid (1886) and to Constantinople (1891). In 1898 he became ench ambassador in London after the Fashoda incident had emttered Franco-British relations. Cambon set himself the task of proving those relations, and so successful was he that in 1904 signed with Lansdowne the Anglo-French agreement.

The culmination of his long years of work was reached in ov. 1912 with the exchange with Sir Edward Grey of the famous ters regarding naval and military co-operation between France d Great Britain in the event of war. Despite anxious moments the early days of Aug. 1914, Cambon never wavered in his lief in Great Britain, and its participation in World War I on e side of France crowned his lifework. During the war he laured to smooth away difficulties and allay irritations between e Allied commands. When the peace had been signed at Verlles, Cambon felt that the hour of his retirement had come. He t London in 1920 amid manifestations of regret rarely displayed the ambassador of a foreign power. He was made a member of e Académie des Sciences Morales et Politiques. His *Letters* er insights to the politics and politicians of his time and were blished after his death in Paris on May 29, 1924.

See also CAMBON, JULES MARTIN.

See his *Correspondance 1870–1924* (1940–46).

CAMBORNE-REDRUTH, a large urban district (1934) in the Falmouth-Camborne parliamentary division of Cornwall, Eng. Camborne is about 4 mi. W.S.W. of Redruth, which is 10 mi. N.W. of Falmouth. Pop. (1961) 36,110. Area 34.5 sq.mi. The area is divided into the Camborne, Redruth, Illogan, St. Day and Lanner wards and comprises the villages of Portreath, Four Lanes, Beacon, Troon, Tuckingmill and Carharrack. Richard Trevithick, inventor of one of the first working locomotives, was born in the area, and the safety fuse was invented by William Bickford of Tuckingmill. William Murdoch invented gaslighting in his house in Redruth. At Camborne is the School of Metalliferous Mining. Principal industries are engineering, tin mining, and the making of quarrying and mining machinery and equipment, textiles and safety fuses.

CAMBRAI, a town in northeastern France, the seat of an archbishop and the capital of an *arrondissement* in the *département* of Nord, is 59.5 km. (37 mi.) S.S.E. of Lille, on the main line of the Northern railway and on the Scheldt river. Pop. (1962) 32,601. In World War I the town was occupied by the Germans from Aug. 1914 until Oct. 1918, and suffered much damage from the fighting. In World War II it fell to the Germans in 1940, and suffered damage by bombing. The former cathedral was destroyed after the French Revolution. The present cathedral of Notre Dame was built in the 19th century on the site of the old abbey church of St. Sépulcre. The church of St. Géry (18th century) contains a marble Renaissance rood screen. The triple stone portal, which gave entrance to the former archiepiscopal palace, is also of the Renaissance period. The Tour St. Martin is an old church tower of the 15th century, much restored and turned into a belfry.

Before 1914 Cambrai was a prosperous industrial town, its chief industry being the weaving of fine fabrics (*see* CAMBRIC); there was also wool spinning and weaving, bleaching and dyeing. The town made a remarkable recovery from the two world wars; it is the centre of a rich agricultural district producing sugar beets, grain, fodder, flax, butter and cattle, and its trade and industry are largely linked with these.

Known in Roman times as Camaracum, the place had until the middle of the 10th century an obscure history, which included invasions by Normans and Hungarians; and from the 10th to the 12th centuries the people were dissatisfied with their bishops, foreigners imposed on them by the emperor. In 1227 the citizens obtained rights which were published by the bishop in the *Loi Godefroy;* but the town and its environs, Cambrésis, which at one time constituted a duchy, continued to be a bone of contention among its neighbours—the counties of Flanders and Hainaut and the kingdom of France, the empire and England—and it frequently changed hands until it was assigned to France by the treaty of Nijmegen (1678). The alliance formed in 1508 by Pope Julius II, Louis XII, the emperor Maximilian I and Ferdinand the Catholic of Aragon, against the republic of Venice, was called the League of Cambrai; and the treaty between France and the empire was signed at Cambrai in 1529. The bishopric, dating from the 5th century, was raised in 1559 to the rank of an archbishopric, lasting until the Revolution and later restored. The bishops were made counts by Henry I (919–936) and dukes in 1510.

CAMBRIAN SYSTEM, in geology, is the name applied to the oldest group of rocks in which fossils showing recognizable organic structures have been found in quantity sufficient and widespread enough to serve as a basis for classifying recognizable series of strata. Fossils have been discovered in older rocks; but, with the exception of the fillings of worm burrows, sponge spicules, and masses of lime trapped by primitive algae, all are rare (*see* also PRECAMBRIAN TIME).

The Cambrian period, the time during which these rocks were formed, is estimated to have lasted about 80,000,000 years, beginning about 550,000,000 to 570,000,000 years ago (*see* chart). The Cambrian was named after the Roman name for Wales, Cambria, from pioneer investigations there by Adam Sedgwick (*q.v.*).

The discussion which follows, divided into four main parts, describes the origins of Cambrian rocks, their indexing or classification into series on the basis of their fossils, the record of life preserved in these fossils, and the occurrences of Cambrian rocks throughout the world. A number of cross references to related and supplementary articles are included in the text. Reference to the articles PALEONTOLOGY: *Geological Paleontology* and GEOLOGY: *Paleontology* will provide helpful background material on the identification and classification of series of rocks on the basis of the fossils they contain. For additional information on the forms of life referred to *see* also individual articles, such as ARTHROPODA; CEPHALOPODA, etc.

Following are the main divisions of this article:

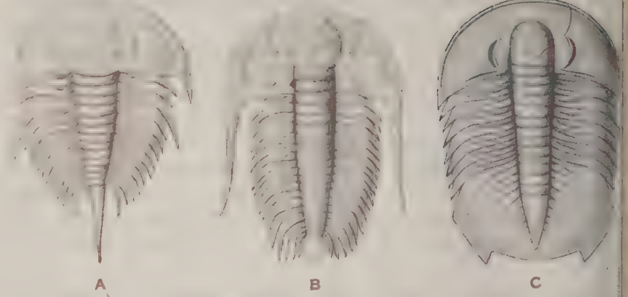
- I. Life of Cambrian Time
    - 1. Fossil Evidence
    - 2. Index Fossils
- II. Subdivisions of Cambrian Time
    - 1. Identifying Subdivisions
    - 2. The Cambrian Realms
- III. Rocks of the Cambrian
- IV. Distribution of Cambrian Rocks
    - 1. North America
    - 2. South America
    - 3. Europe
    - 4. Asia
    - 5. Africa
    - 6. Australia, Tasmania and New Zealand
    - 7. Antarctica

I. LIFE OF CAMBRIAN TIME

1. Fossil Evidence.—Plants and animals probably lived in the earth's oceans for at least 2,500,000,000 years before the beginning of the Cambrian period; but most of the Precambrian animals, and all of the plants except the calcareous algae, lacked shells or skeletons, and consequently left no satisfactory record of their former existence. During the Cambrian period many kinds of invertebrate animals began to encase their bodies in chitinous, calcareophosphatic, or calcareous coverings. Ten or more classes of echinoderms, the brachiopods (*see* BRACHIOPODA), the snails, hyolithids (possibly the pelecypods) among the molluscs; the trilobites and several groups of primitive crustaceans among the arthropods, all had acquired preservable hard parts by the end of the Early Cambrian. Some of the true sponges and an extinct spongelike group of animals (the Archaeocyatha) built internal skeletons of spicules and plates of calcium carbonate. Some Early Cambrian marine worms built calcareous or phosphatic tubes in which they lived. In the Medial Cambrian sponges constructed skeletons of siliceous spicules, and small fishlike creatures (the probable ancestors of the vertebrates) secreted bony plates both within the flesh and on the outer surfaces of the body. By the end of the Cambrian the cephalopods had recognizable calcareous shells, the bryozoa had chitinous and calcareous exoskeletons or coverings, some hydrozoans and the graptolites had chitinous integuments capable of fossilization under favourable conditions, calcareophosphatic conodonts appeared, and brachiopods with articulated shells of calcium carbonate were abundant.

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	Began (Millions of Years Ago)
		CENOZOIC ERA	
Quaternary	Recent (last 11,000 years)		
	Pleistocene	Early man	2+
Tertiary	Pliocene	Large carnivores	10
	Miocene	Whales, apes, grazing forms	27
	Oligocene	Large browsing mammals	38
	Eocene	Rise of flowering plants	55
	Paleocene	First placental mammals	65–70
		MESOZOIC ERA	
Cretaceous		Extinction of dinosaurs	130
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	180
Triassic		Appearance of dinosaurs	225
		PALEOZOIC ERA	
Permian		Reptiles developed, conifers abundant	260
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	300
Lower (Mississippian)		Sharks abundant	340
Devonian		Amphibians appeared, fishes abundant	405
Silurian		Earliest land plants and animals	435
Ordovician		First primitive fishes	480
Cambrian		Marine invertebrates	550 570
		PRECAMBRIAN TIME	
		Few fossils	more than 3,490



FROM VON ENGELN AND CASTER "GEOLOGY" (1952); REPRODUCED BY PERMISSION OF MCGRAW HILL BOOK CO., INC.

CHARACTERISTIC TRILOBITES OF THE AMERICAN CAMBRIAN: (A) OLENELLUS (B) PARADOXIDES, (C) DIKELOCEPHALUS. SPECIMENS WERE ABOUT 6 IN LONG

The shells and exoskeletons of the earliest Early Cambria brachiopods, snails, trilobites, and crustaceans were thin. By th latter part of the Early Cambrian the trilobites had begun to ad more lime to the chitinous base of their exoskeletons which becam thicker. The exoskeletons of other Medial and Late Cambria arthropods remained thin. The shells of Medial and Late Cambria brachiopods, especially the articulates, became increasingly thicke heavier, and larger in size. Among most of the molluscs there wa little change in shell thickness, although the apparent thinness o the snail shell may have been caused by the deposition of aragonit rather than calcite in the shell layers. Late Cambrian cephalopods though simple in structure, had a thicker shell. Many kinds o Cambrian animals, the protozoans, coelenterates, ctenophores, vari ous kinds of worms, and many primitive arthropods, had no har parts at all; and, although the bodies of Cambrian jellyfishe worms, and crustaceans were sometimes preserved, such fossils a rare and were formed only under exceptionally favourable cond tions. A famous example of such preservation occurs in the Mi dle Cambrian Burgess shale of the Canadian Rockies of Britis Columbia. On the bedding planes of this fine black shale th soft bodies of many otherwise unknown invertebrate anima and pieces of soft seaweeds were impressed to form shiny carbo films which have retained perfectly the original structures. Th fossilized remains of Cambrian seaweeds, except for the calcareou algae (stromatolites) are rare; but in Upper Cambrian rocks es pecially, fossil calcareous algae are common and often form larg reefs (*see* also PALEOBOTANY).

The Cambrian fossils give an imperfect picture of the life of th period. Nevertheless, fossils of thousands of different Cambri animals have been dug up by paleontologists, and it is surmised th the seas of that period teemed with life. Many kinds of trilobite arachnids, crustaceans, and worms crawled over the sea floors burrowed in the sands and muds. Brachiopods, bryozoans, cy toids, crinoids, sponges, Archaeocyatha, and primitive coelenterat lived attached to sand grains, pebbles, or shells scattered over th sea bottoms. Other trilobites, crustaceans, jellyfishes, ceph lopods, and arachnids swam or floated in the waters above the se floor.

Cambrian plants and animals were primitive as compared wit most of those inhabiting the earth today. However, all the maj invertebrate phyla and many of the classes of animals were repr sented. The most progressive animals known of that time indica that at least three-quarters of all animal evolution had alread taken place in the marine waters (with some of the forms invadi brackish and fresh waters) before the beginning of Cambrian tim Only land animals are unknown.

The plants had evolved into many kinds of algae or seaweed fungi, and other types living in marine and fresh waters, whi lichens and primitive mosses had probably invaded the shores. B the most spectacular part of plant evolution, the development plants capable of an independent existence on land, took pla after the Cambrian period.

2. Index Fossils.—Trilobites are the best and most abunda Cambrian index or guide fossils, and they are generally used stinguish the faunal zones of the period. Some characteristic dex fossils of Early Cambrian faunas are the trilobite genera: *enellus*, *Paedeumias*, *Wanneria*, *Holmia*, *Callavia*, *Strenuella*, *otolenus*, *Palaeolenus*, *Onchocephalus*, *Antagmus*, *Calodiscus*, *rrodiscus*, and *Bonnia*. The much larger Medial Cambrian as- nblages have a greater number of index genera, including *Poliella*, *bertella*, *Zacanthoides*, *Tonkinella*, *Bolaspidella*, *Clavaspi- la*, *Glossopleura*, *Ptarmigania*, *Bathyuriscus*, *Alokistocare*, *rathia*, *Ehmania*, *Solenopleurella*, *Asaphiscus*, *Agraulos*, *Para- xides*, *Centropleura*, *Anomocare*, *Conocoryphe*, *Ctenocephalus*, *yx*, *Anomocarella*, *Dolichometopus*, *Eodiscus*, *Peronopsis*, *alacroma*, *Goniagnostus*, *Triplagnostus*, and *Ptychagnostus*. te Cambrian faunas have an equally large and varied group of lobite genera, including *Cedaria*, *Crepicephalus*, *Tricrepi- phalus*, *Meteoraspis*, *Coosia*, *Lonchocephalus*, *Dresbachia*, *osina*, *Kingstonia*, *Arapahoia*, *Aphelaspis*, *Labiostria*, *Dunder- rgia*, *Pterocephalia*, *Blountia*, *Elvinia*, *Irvingella*, *Camaraspis*, *rocephalites*, *Dellea*, *Housia*, *Parabolinoides*, *Taenicephalus*, *ychaspis*, *Prosaukia*, *Idahoia*, *Wilbernia*, *Briscoia*, *Saukia*, *ukiella*, *Dikelocephalus*, *Tellerina*, *Illaenurus*, *Plethometopus*, *ethopeltis*, *Entomaspis*, *Rasettia*, *Bowmania*, *Acheilops*, *Olenus*, *rabolina*, *Peltoura*, *Leptoplastus*, *Eurycare*, *Acerocare*, *Agnostus*, *magnostus*, *Kormagnostus*, *Pseudagnostus*, *Litagnostus*, and *yptagnostus*.

In all, there are about 1,500 described genera of Cambrian lobites. The trilobites were more numerous and varied in the mbrian seas than in the seas of any later period. Some were s than a quarter-inch long as adults, while other genera grew to er a foot in length.

About 75% of the fossils found in Cambrian rocks are the re- ins of trilobites, and represent both their numerous molts and actual dead animal. About 20% of the fossils are the phos- atic and calcareous shells of brachiopods, and the remaining 5% ludes all the other animals represented—the snails and ceph- pods, the worm tubes, the echinoderms, the few bryozoan, ptolites, hydrozoans, and other coelenterates, the reeflike de- sits of lime made by the calcareous algae, and the fossil reefs de by the skeletons of the Archaeocyatha, which are abundant ally in Lower Cambrian limestone in Labrador, Nevada, Siberia, d Australia. *See* Fossil.

II. SUBDIVISIONS OF CAMBRIAN TIME

The Cambrian period is subdivided into three parts: Early, edial, and Late Cambrian epochs. Sedimentary rocks deposited ring these three epochs are known as the Lower, the Middle, and Upper Cambrian series. Each series can be recognized by its racteristic fossils, called the guide or index fossils.

1. **Identifying Subdivisions.**—Marine animals can undergo ny changes in shell and body structure as a result of evolution in 000,000 years. Consequently, in any region where a section of ks of any one of these series is present, there occurs a suc- sion of fossils which differ from each other enough so that they be used to distinguish subdivisions (stages and faunal zones racterized by the presence of distinctive fossils) within each ies (*see* Paleontology: *Geological Paleontology*). In the ited States three stages are recognized in the Upper Cambrian ies, Dresbachian (the oldest), Franconian, and Trempealeauan e youngest). The Middle Cambrian Series appear divisible into r stages and the Lower Cambrian Series into two or more. In United States 17 intracontinental faunal zones have been recog- ed. In western Europe 11 such faunal zones are recognized. unal sequences have been worked out for Siberia, western Can- and Alaska, northeastern Asia, southeastern Asia, Australia, thern Africa, and southwestern South America. Approximately faunal zones have been distinguished in the Cambrian System the whole world.

The existence of faunal realms or regions inhabited by distinct ulations of fauna (resulting in biofacies or series of rocks dif- ing in fossil contents from other series of the same age) in the s during Cambrian time can be determined from the distribu- of the various faunal assemblages. Each collection of animals adapted to a particular environment characteristic of the region in which it lived. Most of these animals could live in no other environment, but a few species could move from one environment to another. Such unrestricted species are very valuable fossils, as they can indicate the contemporaneity of the faunas living in different environments. Some of these species were pelagic planktons (*q.v.*) (animals unable to swim, but floating on the open ocean currents) and hence were carried to all parts of the world (*see* also Animals, Distribution of).

2. **The Cambrian Realms.**—Four Cambrian biofacies or realms are recognizable: (1) Tethyan realm extending from the Straits of Gibraltar, through the Middle East to Indochina and north Australia; (2) Extracratonic (open ocean) realm, bordering both sides of the North Atlantic Ocean, along the western border of both North and South America and along the eastern border of China and northeastern Australia, and in central Asia; (3) Cratonic realm encircling the North American continental land—Laurentia; and (4) Boreal realm bordering the northern shore of the Siberian land mass—Angara.

III. ROCKS OF THE CAMBRIAN

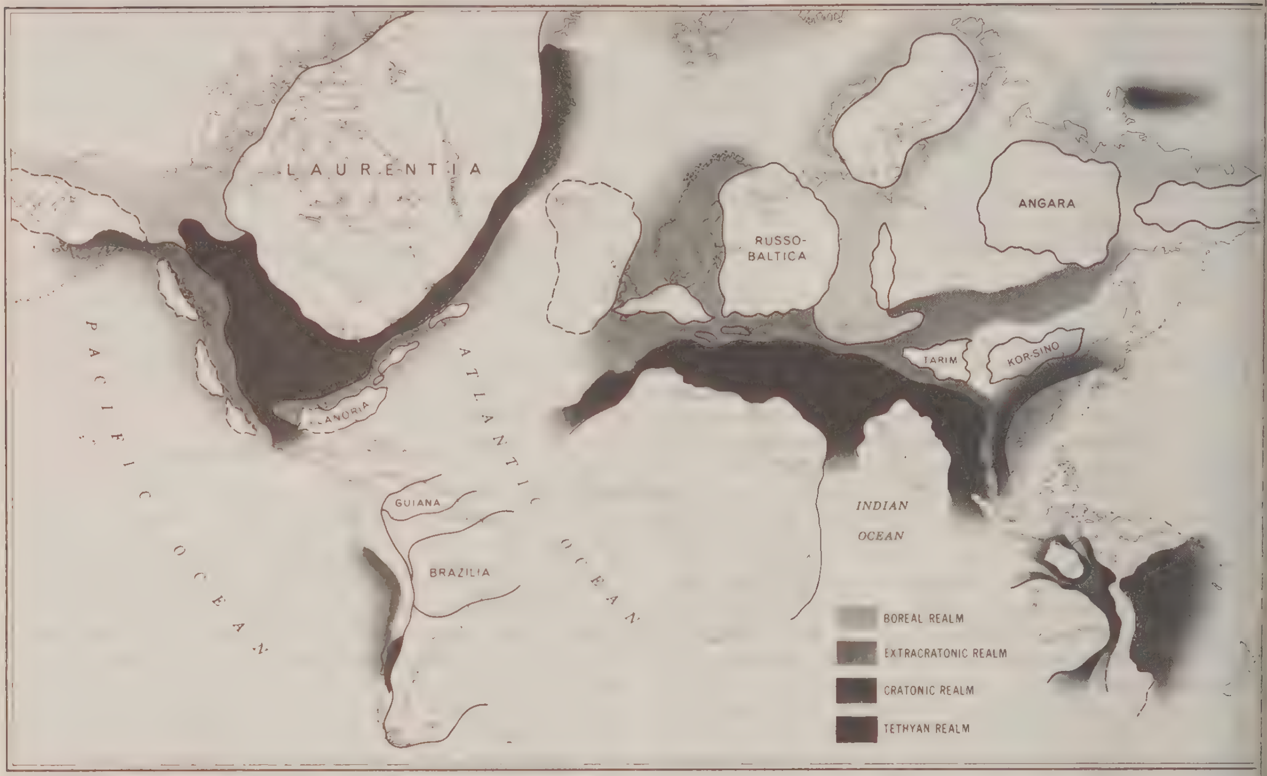
Most known Cambrian rocks were originally deposited in shallow to moderately deep marine waters as gravels, sands, muds, and limy oozes which later were compacted and hardened into conglomerates, sandstones, siltstones, shales, and limestones. In the vicinity of Leningrad and in Estonia there are clays which contain Cambrian fossils but which have never been compacted into shales. In Pakistan there are salt deposits interbedded with marine shales. Few Cambrian fresh-water deposits have been preserved. In Great Britain and New Brunswick, however, there are sandstones and shales which may originally have been deposited in lakes and river channels. Pebbles worn and polished by the wind (*Dreikanters*) are found in Cambrian sandstones in Sweden and the United States (Wisconsin and Texas) which originally formed long sand islands and beaches bordering the seashores.

In Greenland and western North America some Cambrian strata consist of shales in which pebbles and boulders of all sizes are randomly scattered. Such rocks are similar to those formed by glaciers and were thought to indicate Cambrian glaciation. However, they may also be formed by the sliding of masses of mud and broken rocks down steep slopes either on land or below sea level. Some Cambrian rocks of this type are believed formed by submarine mud flows.

Lava flows of Cambrian age are known from Nova Scotia, Labrador, Tasmania, Australia, and southern Siberia. Vulcanism in the Cambrian period was restricted to island archipelagoes situated off the shores of the continental land masses. The surface of these islands experienced oscillatory movements, either rising well above sea level or sinking far below it. The surface of the continents was more stable. Broad low plains bordered the shores and merged inland into rolling uplands. In the interior, resistant rock masses formed scattered steep ridges or weathered mountain ranges. Only in the Southern Hemisphere is there evidence of Cambrian mountain-building.

In the earliest Cambrian time the continental lands, coinciding broadly with the present-day areas of North America, central South America, Siberia, the Indian peninsula, central Africa, and Australia, were large and the shallow seas were restricted to linear basins bordering the margins of the continents. During the Cambrian these seas invaded the borders of the continents, advancing upon the land and retreating sporadically, until in Late Cambrian time marine waters had spread far inland over most of the continents, reducing them to clusters of low islands dotting the shallow interior seas, in which sands, muds, and the shells of many primitive animals slowly accumulated.

Cambrian rocks are found in Greenland, North America, South America, Europe, Africa, Asia, Australia, and Antarctica. In the interior of the continents they are remnants of thin sediments once spread widely over the lands flooded by the seas at times of high sea level. In the border regions there are much thicker series of strata. Here the crust of the earth (the sea floor) sank slowly but continuously during the Cambrian, producing a structural trough or geosyncline in which there was room for more



COMPILED BY CHRISTINA LOCHMAN

THE CAMBRIAN REALMS

and more sediment to be deposited. The amount of sea floor sinking increased progressively outward from the continental interiors to the geosynclines. The strata of the interior range from 0 to 500 ft. in thickness, but many thousands of feet of sediments occur in the geosynclines. They are exposed in the cliffs and canyons of mountain ranges because most of the sedimentary rocks deposited in the geosynclines were later folded into mountains.

IV. DISTRIBUTION OF CAMBRIAN ROCKS

1. North America.—Cambrian sedimentary rocks are exposed in east Greenland, northwest Greenland, Ellesmereland, Newfoundland, Labrador, Cape Breton, New Brunswick, Quebec, Ontario, Maine, Massachusetts, Connecticut, Vermont, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, Tennessee, Georgia, Alabama, Missouri, Arkansas, Oklahoma, Texas, Illinois, Iowa, Wisconsin, Michigan, Minnesota, South Dakota, Alberta, British Columbia, Yukon Territory, the District of Mackenzie, Alaska, Washington, Idaho, Montana, Wyoming, Utah, Colorado, Nevada, California, Arizona, New Mexico, and Sonora and Oaxaca in Mexico. They are also known to be present beneath the surface, buried under younger rocks, in Kentucky, Ohio, Indiana, West Virginia, Nebraska, Kansas, North Dakota, and Saskatchewan.

In most places in eastern North America the rocks are exposed in the belts of the folded Appalachian Mountains. Lower, Middle, and Upper Cambrian strata are all present in these mountains, and many of the outcropping beds are very fossiliferous. In the northern Mississippi Valley and the region west of the Great Lakes the rocks, all of Late Cambrian age, lie nearly horizontally upon the Precambrian base, and over wide areas are covered by Ordovician and younger strata. In South Dakota, Upper Cambrian beds are exposed on the flanks of the Black Hills. In Arkansas and Oklahoma, Upper Cambrian strata only are present, and crop out in the folds of the Ouachita and Arbuckle mountains. In central Texas the Upper Cambrian beds are exposed on the flanks of the Llano uplift. In western Texas, southern New Mexico, southeastern Arizona, Nevada, Utah, southeastern California, and northern Sonora, Lower, Middle, and/or Upper Cambrian rocks a found in folded and faulted sections where the Lower Paleozo rocks have been brought to the surface by crustal movemen and uncovered by erosion. The thick Lower Cambrian sectio of southeastern California carry an abundant fauna of primiti trilobites (like those of Morocco), Archaeocyatha, and many prin tive echinoderms. In the plateau country of northern Arizo and Utah where the Paleozoic strata are still almost horizont Cambrian rocks are exposed in the walls of some of the deep river canyons, as in the Grand Canyon of the Colorado Rive In Colorado, Wyoming, Montana, Idaho, eastern Washingtc British Columbia, Alberta, Yukon Territory, and Alaska th are exposed on the flanks of local uplifts and in the folded a faulted belts of the Rocky Mountains. In the Mackenzie distri Cambrian formations crop out in the hills on the eastern side the Mackenzie River, southwest of Great Bear Lake. In ma of these areas all three divisions of the Cambrian sedimenta rocks are represented. Some of the most complete, best expose and most famous of the known Cambrian sections occur in t mountain ranges of the Canadian Rockies. At Burgess Pa British Columbia, is found the outcrop of the unique fossil locali in the Burgess shale previously referred to.

2. South America.—Relatively few outcrop areas of Ca brian rocks have been discovered in South America. All are cated on the eastern flanks of the Andes Mountains and in t northeastern ranges of the Andean chain. Cambrian rocks known at a few localities in Colombia. One area of Cambri strata is known in northwestern Bolivia. In southern Bolivia a southward through northwestern Argentina (Jujuy and Mendoz Middle and Upper Cambrian strata are exposed.

3. Europe.—Cambrian rocks are widely distributed in Euro They occur in Norway, Sweden, Bornholm Island in the Bal Sea, Scotland, western England, Wales, Ireland, Ardennes regi of north-central France, Montagne Noire region of southe France, the Pyrenees and elsewhere in Spain, Sardinia, Portug the Black Forest of Germany, Bohemia, southern Poland, Eston and the vicinity of Leningrad. Cambrian strata are known nderlie the north German plain and to extend under parts of orthern Poland, and into western Russia.

In Norway, Scotland, western England, Wales, and southeastern eland, Cambrian beds are exposed in the folds of the ancient ountains. They contain many fossils. In Sweden, Bornholm sland, Estonia, and western U.S.S.R. the strata at many localities ill lie in the horizontal position in which they were deposited, nd their fossils are exceptionally well preserved. In southwest-n Germany, the Ardennes and Montagne Noire regions of rance, in Sardinia, in the Spanish provinces of León, Asturias, ragon, and Sevilla, and in the Portuguese province of Alentejo, ne Cambrian beds have been folded and the fossils are usually adly distorted by movement of the strata.

In the U.S.S.R. fossiliferous Upper Cambrian rocks have been scovered in the Arctic Novaya Zemlya Islands and strata with arly Cambrian fossils occur in the southern Urals. The faunas these sections show relationships with the Siberian realm.

4. Asia.—Much of Siberia is underlain by Cambrian strata. aunas of the fossiliferous Middle and Upper Cambrian beds of ne Kazakh Soviet Socialist Republic belong to the boreal biofacies nd show affinities with the North American cratonic realm. Mid-e Cambrian strata are known on one of the New Siberian lands (Bennett Island) and on the islands of Severnaya Zemlya ormerly Emperor Nicholas II Land) in the Arctic Ocean. Across orthern Siberia, Lower and Middle Cambrian strata outcrop ex-nsively in and near the major river valleys from the Yenisei the Lena. Cambrian rocks, especially Lower Cambrian, are so widely distributed across southern Siberia. They have been ound over a wide area in the upper Lena drainage basin, eastward Lake Baikal and thence northeastward to the Amur Valley and ne shores of the Sea of Okhotsk. Soviet geologists have described me faunas from these strata. Some of the limestones are exten-ve reefs of Archaeocyatha. Dark shales are common and are naracterized by large numbers of trilobites related to the faunas the extracratonic open ocean realm of western Europe.

Cambrian rocks are found in Korea and in several of the prov-ces of China—in southern Manchuria, Inner Mongolia, the nantung Peninsula, Shansi, Sinkiang, Hunan, and Yünnan. In orea, Manchuria, and Shantung large faunas have been dis-overed from all three divisions of the Cambrian period which are presented by thick sections of strata. Medial and Late Cam-ian faunas are known from Shansi. In Yünnan well-preserved arly Cambrian fossils are known, and there is a Late Cambrian unal sequence showing affinities to the north China assemblages. he few Late Cambrian fossils reported from Hunan are related the faunas of Late Cambrian age from the eastern Tienshan ountains of Sinkiang—assemblages in dark shale which belong the extracratonic biofacies. In North Vietnam Lower, Middle, nd Upper Cambrian rocks are known, and many of the beds con-in large numbers of excellently preserved fossils.

Cambrian rocks are less common in southern Asia. Middle ambrian, and possibly Lower and Upper Cambrian rocks occur Kashmir. Lower, Middle, and Upper Cambrian strata are esent in the Spiti Valley in the Himalayas. Lower Cambrian line deposits are found in the Salt range of western Pakistan. Iran, north of the Persian Gulf, fossiliferous Lower, Middle, nd Upper Cambrian strata have been found. In Israel, near e southern end of the Dead Sea, Lower and early Middle Cam-ian strata are exposed in a narrow belt.

5. Africa.—In Morocco in the Anti-Atlas ranges of the south-est, and in the Atlas Mountains near Casablanca, Lower and iddle Cambrian rocks are known. Scattered occurrences have een reported elsewhere in northwestern Africa. The Lower ambrian sandstones, shales and sandy limestones of the Anti-tlas are richly fossiliferous—with Archaeocyatha reefs and ex-llently preserved trilobite assemblages containing the most imitive genera. The faunas belong to the Tethyan biofacies, it also contain a few genera from the western European biofacies, abling a correlation between the two realms. Rocks of un-oubted Cambrian age are unknown elsewhere in Africa.

6. Australia, Tasmania and New Zealand.—Lower Cam-ian strata occur in Northern Territory and South Australia. These beds are famous for their thick and extensive Archaeocyatha reefs. Fossiliferous Middle and Upper Cambrian rocks are known in Western Australia, Northern Territory, South Australia, Queensland, and Victoria. These fossils have their closest affinities with the southern Asiatic and western European assemblages. Metamorphosed sediments, apparently unfossiliferous, outcropping in New South Wales are considered of probable Cambrian age. Fossiliferous Middle and Upper Cambrian beds and associated volcanic rocks occur in Tasmania; and very late Middle Cambrian strata are known from one area on South Island, N.Z.

7. Antarctica.—Early Cambrian oolitic limestones and carbonate breccias with Archaeocyatha occur as erratics near Mt. Buckley on Beardmore Glacier and elsewhere throughout the Beardmore Glacier drainage area. Erratics with Archaeocyatha occur in the Weddell Sea and in moraines from the Whichaway Nunataks, southeast of Filchner Ice Shelf. Medial Cambrian fossils occur in limestones in the Pensacola Mountains and massive bioclastic, abundantly fossiliferous marbles in the Heritage Ranges are possibly Late Cambrian.

See GEOLOGY; PRECAMBRIAN TIME; *see* also references under "Cambrian System" in the Index.

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CAMBRIC, a plain-woven, staple cotton fabric first made in Cambrai (Flemish: Kameryk), France, and originally a fine linen fabric. Printed cambric was used in London by 1595 for bands, cuffs and ruffs. Modern cambric is made from choice American or Egyptian cotton with textures running from 92 ends and 88 filling picks to 100 ends and 100 picks. Yarns range from 60 to 80 in size or count both ways. Cambric is similar to and often indistinguishable from muslin.

Cambric may be bleached or dyed in the piece. Lower qualities have a smooth, bright finish. It is light in weight, well adapted to sewing, has good body, is well sized and presents a neat, appealing hand and finish. Since cambric launders easily and well, it is ideal for handkerchief linen, children's dresses, slips, underwear and nightgowns.

French cambric is fine textured and is used in neckwear and scarves when dyed or printed. Superior cotton yarns are used. Irish cambric is an all-linen, plain-woven cloth used for underwear, dresses and handkerchiefs. "Green" (unbleached) yarns are usually used to make the fabric; the product is made completely white by boiling and bleaching. Irish cambric is used for handkerchiefs with coloured yarns employed for border effects. Kid-finished cambric, a soft-finished fabric, is used for dress linings. (G. E. L.)

CAMBRIDGE, EARLS, DUKES AND MARQUESSES OF. Under the Norman and early Plantagenet kings of England the earldom of Cambridge was united with that of Huntingdon, and held, among others, by King David I of Scotland as the husband of Earl Waltheof's daughter Matilda. As a separate dignity the earldom dates from 1340 when Edward III bestowed the title on his brother-in-law, William, count (afterward duke) of Juliers (Jülich). In 1362 (the year after William's death) Edward created his own son, Edmund of Langley, earl of Cambridge (*see* YORK, EDMUND OF LANGLEY, Duke of). Edmund's elder son, Edward, earl of Rutland (*see* YORK, EDWARD, Duke of), who succeeded his father as duke of York and earl of Cambridge in 1402, appears to have resigned the latter dignity in or before 1414 because in this year his younger brother Richard (*c.* 1375–1415) was made earl of Cambridge. In 1415 Richard conspired with Henry, Lord Scrope of Masham, and Sir Thomas Grey to assassinate Henry V. The plot was discovered and the earl of Cambridge was executed on Aug. 5, 1415. His title was forfeited, but it was restored to his son Richard (*see* YORK, RICHARD, Duke of), who in 1415 became duke of York in succession to his uncle Edward. Subsidiary to the dukedom of York, the title was held by Richard until his death in 1460, and then by his son Edward who became king as Edward IV in 1461, when all his honours merged in the crown.

In 1619 James I, wishing to bestow an English title on James Hamilton, 2nd marquess of Hamilton (d. 1625), created him earl of Cambridge, and the title was inherited by his son and successor James, 3rd marquess and 1st duke of Hamilton, who was executed in 1649. In 1651, when William, 2nd duke of Hamilton, died without male issue, his title became extinct (*see* HAMILTON, MARQUESSES AND DUKES OF).

The title of earl of Cambridge was again bestowed on a member of the royal house when it was granted by Charles II to his brother Henry, duke of Gloucester, in 1659, only to become extinct on Henry's death the next year. Between 1661 and 1677 four sons of James, duke of York (afterward James II), were designated or created earl of Cambridge, but they all died in infancy. When the Act of Settlement was passed in 1701 an English title was needed for George Augustus, electoral prince of Hanover, who became third in succession to the English throne. In 1706 he was created marquess and duke of Cambridge. The title merged in the crown when he became king in 1727, but it was revived in 1801 in favour of Adolphus Frederick, the seventh son of George III.

ADOLPHUS FREDERICK (1774–1850), duke of Cambridge, was born in London on Feb. 24, 1774. Having studied at the university of Göttingen, he served in the Hanoverian army and with the British army in the Low Countries, being severely wounded in 1793. He was created earl of Tipperary and duke of Cambridge in Nov. 1801 and became a privy councilor in 1802. In 1813 he was promoted field marshal and in 1816, after the electorate of Hanover had been raised to the rank of a kingdom, the duke was appointed viceroy. He held this position until the separation of Great Britain and Hanover in 1837. He died in London on July 8, 1850. In 1818 he had married Augusta (1797–1889), daughter of Frederick, landgrave of Hesse-Cassel. He left three children: his successor, George; Augusta Caroline (1822–1916), who married Frederick William, grand duke of Mecklenburg-Strelitz; and Mary Adelaide (1833–97), who married Francis, duke of Teck.

GEORGE WILLIAM FREDERICK CHARLES (1819–1904), duke of Cambridge, was born at Hanover on March 26, 1819, the son of Adolphus Frederick, from whom he inherited the dukedom in 1850. After serving briefly in the Hanoverian army, he became a colonel in the British army (Nov. 1837), served in Gibraltar and Ireland, and in 1842 was appointed colonel of the 17th light dragoons (later lancers). In 1854, on the outbreak of the Crimean War, he wa given command of the 1st division of the Crimean army and wa present at the battles of the Alma, Balaklava and Inkerman and a the siege of Sevastopol. He was appointed general commandin in chief in 1856, field marshal in 1862 and (by letters patent commander in chief in 1887. The Crimean War had exposed th need for reform in the army, but only minor reforms were mad before 1868 when Edward (afterward Lord) Cardwell, secretar of state for war, undertook a large-scale reorganization. Cambridge opposed many of his reforms, in particular the abolition the dual system of control with the subordination of the commander in chief to the secretary of state. The duke was undoub edly a major obstacle to reform, although he was forced to accep many changes. He disposed of army patronage in the traditiona way, promoting men for social rank and seniority rather than f ability. Finally in 1895 Henry Campbell-Bannerman, secretar for war, secured his unwilling resignation. Cambridge was an e perienced commander, and concerned with the welfare of his me but he could not adapt himself to new conditions. He died London on March 17, 1904.

In 1917 ADOLPHUS CHARLES (1868–1927), duke of Teck, r nounced his German titles and was made marquess of Cambridg He was the grandson of Adolphus Frederick, duke of Cambridg and the brother of Queen Mary, consort of George V. He wa succeeded by his son, GEORGE FRANCIS HUGH (1895–   ), 2n marquess.

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CAMBRIDGE, RICHARD OWEN (1717–1802), Englis poet and essayist and author of the *Scribleriad,* was born in Londo on Feb. 14, 1717, and died at Twickenham, Middlesex, on Sept. 1 1802. Educated at Eton and at St. John's college, Oxford, went into residence at Lincoln's Inn in 1737. Four years later married and went to live at his country seat of Whitminste Gloucestershire. In 1751 he moved to Twickenham, where entertained a brilliant circle of his famous contemporaries, i cluding Thomas Gray, Charles James Fox and the earl of Chatha Horace Walpole in his letters makes many jesting allusions Cambridge in the character of newsmonger. Cambridge co tributed 21 papers to the *World* (1753–56), but his chief work the *Scribleriad* (1751), a mock epic poem satirizing false learnin the hero of which is the Martinus Scriblerus of Alexander Pop John Arbuthnot and Jonathan Swift.

See *The Works of Richard Owen Cambridge, Esq.,* ed. by his so George Owen Cambridge (1803).

CAMBRIDGE, a city (from 1951) and a municipal and pa liamentary borough, the seat of a university and the county tow of Cambridgeshire and Isle of Ely, Eng., 56 mi. N.E. of Londo and 80 mi. N.E. of Oxford by road. Pop. (1961) 95,527, inclu ing members of the university in residence. It lies immediatel south of the fen country, being itself only 20 to 80 ft. above se level. Most of the city is built on the east bank of the Cam, tributary of the Ouse. Suburbs extend across the river but mo ern development to the west has been largely restricted to unive sity expansion; access to open country on that side is quick an easy. Slight hills rise gently on the south (chalk) and west (heav clay). The borough returns one member to parliament.

Modern Cambridge has been described as "perhaps the onl true university town in England." University and college buil ings provide nearly all the outstanding features of the architectur scene. The wealth of beauty is great and is no more than hinte at by such outstanding examples as the old court of Corpus Christ the 15th-century combination room of Peterhouse, the 16t century President's lodge of Queens' college, the restored 17t century hall of Clare, the 18th-century Gibbs' building of King college and Wilkins's early 19th-century layout of Downing colleg

The beauty of the city is enhanced by a large number of con mons and other open spaces, including Jesus green and Midsumm common, Sheep's green, Lammas land, Christ's pieces, Parker piece, the university botanic garden (much developed, extende nd improved) and the Backs. The Backs are the landscaped wns and gardens through which the Cam winds behind the main ne of colleges, including Queens', King's, Clare, Trinity, St. ohn's and Magdalene, and under a series of magnificent bridges which the Bridge of Sighs (St. John's, 1827–31), the stone ridge of Clare with thick stone balls on the parapets (1638–40) nd the Mathematical bridge of Queens' are among the best known. ast of the Cam is King's parade where the 15th-century univer- ty and parish church of Great St. Mary and a line of attractive hops face King's college with its chapel and the university senate ouse (built between 1722 and 1730 from designs by James ibbs). King's college chapel (1446–1515), the best-known uilding in Cambridge, was designed by Henry VI as part of an nmense and never fully realized conception. Great buttresses, fty spires and turrets, a high vaulted roof, heraldic devices and agnificent stained glass windows are notable features of the hapel which is one of the greatest monuments of English medieval chitecture.

Among other churches are St. Benet's, with its notable Saxon ower; the restored Norman St. Sepulchre's (one of the four round hurches in England); and St. Edward's King and Martyr, notable ot only as a "peculiar" with a parish but also as the church of the ambridge reformers. It was closely associated with Hugh Lati- er and his colleagues and, three centuries later, with Frederick enison Maurice. The Fitzwilliam museum (1837–41) and the ost-World War II engineering laboratory are in Trumpington reet, a continuation of King's parade, and the postwar chemistry boratory and the Scott polar research institute are in the adjoin- g Lensfield road. The university library building (1931–34) lies est of the river; its design in red brick is a subject of keen local ontroversy. The Folk museum is in Castle street near Magdalene ollege.

Cambridge, which is reached by London trains from King's ross and Liverpool Street stations, has good rail access to the stern counties and, via Ely and March, to the north. Road ac- ss is easy but the city centre is usually thickly congested with affic. The river is extensively used for pleasure boating, punting nd canoeing; larger craft are available for private hire and or- nized public trips. There is a small airfield, with charter services nd flying school, on the Newmarket road. The American me- orial cemetery is near the village of Madingley (3½ mi. N.W.).

Cambridge industry is extensive but, from the city centre, is un- otrusive. It includes industries which have depended to con- derable extent on university and college connections and orders, diverse as building, printing and instrument making and others hich have also had close links; *e.g.*, radio and electronics. Flour illing, asphalt manufacture and cement making are also impor- nt. Several of the large new and secondhand bookshops enjoy ternational reputations and there are numerous establishments ecializing in the sale of antiques.

History.—The site of the earliest settlement was probably at e spot on the Cam river nearest to the sea (at King's Lynn) at hich it was possible to cross from the dry land of the midlands to y land adjoining the fens of the east. The crossing would have en made originally by ford or ferry but a great bridge has existed om a very early date and has been the key to important road nctions. It is the only bridge in England which has given name a county. The name Cambridge derives from a corruption of e earlier Grantebrycge or Grantabridge. Norman influence dis- aced *Gr* in favour of *C* and, from the form Cantabrigia, which s commonly used during the early period of university and llege development, has come the abbreviation Cantab., still used distinguish a Cambridge degree or a Cambridge graduate. ranta is the earlier and still alternative river name. Early rthworks, including Castle hill, and Roman remains suggest the istence of a fort on the road between Colchester and Godman- ester and almost certainly there were later two settlements, one Castle hill which was under Mercian jurisdiction in the period the Heptarchy, and the other around Market hill, in East nglia. The Market hill settlement probably grew more rapidly; e Castle hill development reflected the need to control and main- in the great bridge. The progress of amalgamation, which was spread over several centuries, was thus stimulated by the need for common defense in the face of the Norse invasions. The first written reference to Cambridge, before A.D. 700, is in Bede's *Ecclesiastical History.* Two important monastic foundations date from the 11th and 12th centuries respectively: Barnwell priory and the Benedictine nunnery of St. Radegond, which was dissolved and replaced by Jesus college in 1496. Cambridge had a castle and a mint by 1086 and received its first charter in 1201. It has had municipal buildings on part of the modern guild hall site since 1224, a mayor at least since 1231, a coroner since 1256, burgesses in parliament since 1295, a commissioner of the peace since 1380, a town clerk since 1418, a recorder since 1494 and a high steward since 1529. The modern city council consists of a mayor, 14 aldermen and 42 councilors, 6 of the councilors being elected by the colleges and university and 2 of the aldermen elected by the council from among the university and college representatives. Cambridge had an unusually interesting guild history (Corpus Christi college was founded in 1352 by the guilds of St. Mary and of Corpus Christi).

Since the mid-19th century the town has played a pioneer role in the provision of social services, including public libraries, labour exchanges and school dental services and, since World War II, accident prevention. The city council is also represented on the governing body of the Arts Theatre trust which is responsible, *inter alia,* for the theatre, built and presented in 1936 by Lord Keynes. The trustees have carried on his declared intention of making available to a large theatreless region of England the five arts of drama, opera, ballet, music and film.

During the medieval period the Cam was extensively used for water transport, the local wharfing facilities (which have gradually disappeared) being in heavy demand during the annual period of Stourbridge fair. This was held at riverside Barnwell from about 1200 and was one of the greatest of the English fairs. Daniel Defoe wrote a classic account of it, but by the beginning of the 18th century its importance had greatly diminished although it was not finally extinguished until 1934, by which time it was much decayed. The usually four-day Midsummer fair, controlled by the corporation since 1505, is still held.

Outstandingly important additions to the literature of the city's history were made in 1959 by volume III, "The city and University," of the *Victoria History of the County of Cambridge . . . ;* and in 1960 by the *Inventory of the Historical Monuments in the City of Cambridge.*

Cambridge faces all the problems of a thriving modern city built around an ancient centre. The *Cambridge Planning Proposals* of 1950 considered, among other topics, traffic and housing problems and formed the basis of part of the *County of Cambridge Plan* approved in 1954. *See* also CAMBRIDGE UNIVERSITY.

(W. A. MD.)

CAMBRIDGE, a city of Massachusetts, U.S., on the Charles River, opposite Boston, one of two seats of Middlesex County (the other is Lowell), is a university city (Harvard; Massachusetts Institute of Technology) and centre for scientific and industrial research. The population in 1970 was 100,361; in 1960, 107,716; and in 1950, 120,740. The decline in population, as in most other cities, was attributed largely to the movement of industry and people to the suburbs. (For further comparative population figures *see* table in MASSACHUSETTS: *Population.*)

History.—The original settlement, at first called New Towne, was established by the Company of Massachusetts Bay in 1630 on a site now in the vicinity of Harvard Square. In 1638, two years following the founding of Harvard College, the name was changed to Cambridge, after the English university town. Gov. John Winthrop and others intended the town to be the capital of the Massachusetts Bay Colony, but Boston was regarded as offering more advantages for both commerce and defense.

The shaded, irregular streets around Harvard Square are full of historic and literary associations. General synods of the New England churches met there in 1637 and 1647 to settle disputed points of doctrine, and from there in 1636 Thomas Hooker's congregation departed for Connecticut. At the outbreak of the American Revolution, the first American army camped on what is now the Cambridge Common, and from there went most of the detachment which fought at Bunker Hill. Under an elm which stood near the common until 1923, George Washington (according to tradition) took command of the Continental forces on July 3, 1775.

The convention which drafted the original constitution of Massachusetts met in Cambridge in 1779–80. In Apthorp House (1760) Gen. John Burgoyne and his officers were lodged as prisoners of war in 1777. Vassall, or Craigie House (1759), on Brattle Street was occupied by Washington in 1775–76, and later was the home (1837–82) of Henry Wadsworth Longfellow. In Elmwood (1767), James Russell Lowell was born and lived all his life. Many other notable figures had Cambridge associations. Among them were Oliver Wendell Holmes, Richard Henry Dana, Louis Agassiz, Asa Gray, Charles Eliot Norton, William James, John Fiske, William Dean Howells, and Bernard De Voto.

Old Cambridge, centring at Harvard Square, has been to Americans a symbol of culture since the founding of Harvard College. Adjoining the college and residential areas, however, there has developed in the 20th century a commercial centre which ranks high among the cities of the state.

Up to mid-19th century there were no factories other than those manufacturing glassware, a few small brickyards, and the printing shops around Harvard Square. Stephen Daye had set up the first printing press in the colonies in 1639 and the first books printed in the U.S. came from this press. In the early 1870s was begun the reclamation of two square miles of tide-covered marshes for a manufacturing district. Rapid industrial expansion, however, did not begin until 1912 when the opening of the subway to Boston brought the business section of that city within a few minutes of Cambridge; it was further stimulated by the development of motor trucking.

Industry and Research Activities.—As the city became an increasingly important centre for scientific and industrial research, the processing and experimental operations of the many research organizations became a principal activity. This development was stimulated by the close proximity of Harvard and MIT, with their numerous scientists, laboratories, and special facilities. Although the emphasis was on nondurable goods, there was a remarkable diversity in the nature of products manufactured. The leading industries were professional and scientific instruments; food and kindred products; chemicals; electrical machinery; printing and publishing; rubber products; leather goods; and fabricated metal products. Although manufacturing provided work for the largest number of employees, the total payroll of the educational institutions was more than twice the sum of the payrolls of the six leading industries.

The industrial growth of the 20th century was advantageous to city finances as an offset to the large proportion of tax-exempt property; at the same time, encroachment on the historic, residential, and educational areas was checked to a considerable degree by zoning regulations originally adopted in 1924 and completely revised in 1943. A planning board was appointed in 1913; it was provided with a full-time staff in 1945.

The presence of the educational institutions helped to stabilize real estate values and to slow down urban blight. Private redevelopment resulted in Technology Square, a complex of residential and commercial buildings replacing one of the most blighted areas adjacent to MIT.

Cambridge is often referred to as the university city. In addition to Harvard University (*q.v.*), there is Radcliffe College for women (1879), which has its own endowment, plant, and separate corporate organization but is affiliated with Harvard. All instruction at Radcliffe is by members of the Harvard faculty and since 1943 most of the students at both institutions have attended the same classes under the plan of joint instruction. Another older educational institution of higher learning is the Episcopal Theological Seminary (1867).

In 1916 MIT moved from the site it had occupied in Boston for 50 years to a 115-ac. campus extending for more than a mile along the Cambridge side of the Charles River basin. This is an independent, endowed institution which offers both undergraduate and graduate programs in all branches of engineering and architecture, as well as broad programs in the humanities and social sc ences. It also engages in a vast amount of basic research as major part of its activities. Its research facilities, which are u usual and in some cases unique, include a nuclear reactor, a r search laboratory of electronics, a servomechanisms laborator supersonic wind tunnels, and centres for international, urban, a regional studies and for communications sciences. The headqua ters of the Smithsonian Astrophysical Observatory, formerly Washington, D.C., is in Cambridge. Its major activity is th optical tracking and analysis of satellites.

Government.—Until 1846 Cambridge was governed by the tr ditional New England town-form of government. In that year was chartered as a city. In 1940, following a reform movemen the voters accepted the council-manager form of government; th council, which appoints the city manager, is elected at large b proportional representation. The school committee is also elect by proportional representation, Cambridge being one of the fe U.S. cities using this form of ballot.

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CAMBRIDGE PLATONISTS, a group of 17th-centu philosophico-religious thinkers, who hoped to reconcile Christia ethics and Renaissance humanism, religion and the new scienc faith and rationality. Their leader was Benjamin Whichco (1609–83), who expounded in his sermons the Christian humanis which unites the group. His principal disciples at Cambridge we Ralph Cudworth, Henry More (*qq.v.*), and John Smith (1616 52); Joseph Glanvill (*q.v.*) was an Oxford convert. Nathana Culverwel, Richard Cumberland (*qq.v.*), and the mystic Pet Sterry (1613–72) at Cambridge and John Norris (*q.v.*) at Oxfo were influenced by Cambridge Platonism without wholly accepti its moral and religious ideals. Educated as Puritans, the Car bridge Platonists reacted against the Calvinist emphasis on t arbitrariness of divine sovereignty. In their eyes, Hobbes a the Calvinists both made the mistake of supposing that morali could consist in obedience to a will. Morality, they said, is e sentially rational; the good man's love of goodness is at the sam time an understanding of its nature, which neither God nor ma can alter by the exercise of sovereign power. Against both Arc bishop Laud and the Calvinists, they denied that ritual, chur government, or detailed dogmas are essentials of Christianit To be a Christian is to participate in divine wisdom; men shou be left free to choose whatever forms of religious organizati they find helpful. The width of their tolerance won them th nickname "latitude men"; they were often condemned as Un tarians or atheists because they placed so much stress on moralit and so little on dogma. Their metaphysics derives from Renai sance Platonism, which interpreted Plato in a Neoplatonic ligh their more systematic works are clogged with uncritical schola ship. They learned much from Descartes' critique of empiricis but, fearing that the new "mechanical" theories might unde mine the religious conception of the world, they supporte against Descartes, a teleological interpretation of natural pro esses.

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CAMBRIDGESHIRE AND ISLE OF ELY, an easte county of England, bounded north by Lincolnshire, east by No folk and Suffolk, south by Essex and Hertfordshire, and west b Bedfordshire and by Huntingdon and Peterborough. On April 1965, the formerly separate administrative county of the Isle ly was amalgamated with Cambridgeshire. Boundary changes educed the area to 830.6 sq.mi. (2,151 sq.km.).

Physical Features.—All but the southernmost part of the ounty lies within the fen district, a flat alluvial tract only a few eet above sea level, intersected by innumerable drainage chan-els. (For its reclamation and physical characteristics *see* FENS.) n a level country, such minor chalk hills as the Gogmagogs, outheast of Cambridge, or the hillock upon which stand the athedral and city of Ely, assume an importance far beyond their ature. The scenery of the rolling southern part of the county more varied, with many villages, farms, and scattered woodlands.

The two principal rivers are the Ouse and its tributaries and, n the north by Wisbech, the Nene (Nen). For the greater part f their courses within the county these rivers flow slowly between aised banks, the most spectacular of which are two great parallel uts, the Old and the New Bedford rivers, running northeast for 0 mi. from Earith to Denver sluice in Norfolk. The area between hem acts as a flood reservoir; but a new channel constructed fter 1960 around the rim of the fen basin, analagous to a ring oad, was designed to receive surplus water from all the rivers nd convey it into the tidal Ouse below Denver. The dry chalk plands east and southeast of Cambridge have beech belts and lumps, as seen near Newmarket heath; farther west the clays and reensand flanking the Bourn brook and Cam valleys favour ash nd elm; while willows are characteristic of the fens, where buried oaks" and peat beds bear witness to former forests. Wicken fen s a famous nature reserve; a large mere was made in 1957 to enance the natural amenities.

The rocks in general strike northeast-southwest and gently dip outheast, the oldest member of the series being the Jurassic Oxford clay of the higher ground running northwest from Cam-ridge toward Peterborough, where the landscape cowers below he great chimney clusters of its brick pits; to the east it forms the oor of the fen basin or, as at Whittlesey, rises in low "islands" hrough the black fen peat. Above it lies either the Coralline Elsworth rock (of which a notable—oolite—exposure, full of shell ossils, occurs at Upware) or Ampthill clay; and above this again, Kimmeridge clay, exposed on the border near Gamlingay, Bed-ordshire, and in the north near Ely. Lower greensand comes ext; its appearance at the surface (for it is commonly overlaid y the stiff leaden-gray Gault) is especially beneficial for orchards, s at Eversden (noted for its greengage plums), Cottenham, and Haddenham in the Isle of Ely. Two industrially important beds overlay the Gault (which is itself worked at Burwell for bricks): he Cambridge greensand, worked for phosphate coprolites a entury ago; and the chalk marl for cement. Large pits are worked at Shepreth, Barrington, and southeast of Cambridge. Finally there is the chalk, the key to landscape, soil, and crop alike n south Cambridgeshire; and the boulder clay, the mantle of ludge and debris left long ago by the retreating ice.

Early Settlement and History.—Neolithic types of flint im-plements are very common in parts of the county, implying a prolonged period of occupation in the areas bordering the fens, round Mildenhall (Suffolk, part of the East Anglian heathlands) nd along the Cam River southwestward. Beakers, a type of pot-tery introduced from the European continent after 2000 B.C., occur n the Anglian River valleys and on the edge of the fens. Through-out the Bronze Age, settlement seems to have been mainly concen-trated in the strip east of the Cam from Royston, Hertfordshire, northeastward to Soham, including the chalk escarpment. Hoards of the late Bronze Age come mainly from the borders of the fens and from the Cam Valley; several were found in the fens. Inland waterways were evidently important. There is also evidence that aw material (copper and tin) was brought to the region from the outhwest along the Icknield Way. The forested valleys in the halk of the southeast were penetrated to some extent.

Invaders reached the region during the early Iron Age, in the La Tène, and possibly in the preceding Hallstatt period. Penetra-ion took place by the Wash and also from the south, and the La Tène culture influenced provincial Roman craftsmanship. Popula-ion was densest in the fertile valley of the Cam; the southern ens and the forests west of Cambridge were barren. Several hill forts were occupied in the south.

A remarkable feature of the Roman-British period is the widespread occurrence of finds in what had been marshland as well as on the fen islands. A good deal of drainage was probably done (the Car dike between the Cam and the Great Ouse is of Roman construction), and the forested claylands were also penetrated. Southern Cambridgeshire lay athwart the main Roman road to the north (Ermine Street) from which Akeman Street branched northeastward, west of the Cam, to Cambridge and Norfolk.

The earliest English settlements were made in the 5th century. The Anglo-Saxon conquest was followed by a period of contraction but by the time of the Domesday survey the range of settlement was in its essentials that of modern times. The districts corresponding to the counties of Huntingdon and Cambridge were distinguished as the lands of the North Gyrwas and the South Gyrwas respectively. At this period the fen district stretched southward to within a few miles of Cambridge; its essential unity is still preserved by its inclusion under one sheriff, chosen in successive years from Cambridgeshire proper, the Isle of Ely, and Huntingdon. The district was part of the Danelaw (*q.v.*). On the conquest of the Danes by Edward in the 10th century it was included in East Anglia (*q.v.*), but in the 11th century was again overrun by the Danes, who burned Cambridge. The Saxon Chronicle records the valiant resistance of the men of Cambridge to the invaders in 1010, when the rest of the East Anglians had fled. The shire system of East Anglia was not definitely settled before the Norman Conquest, but during the Danish occupation of the 9th century the district possessed a certain military and political organization around Cambridge, its chief town, from which probably originated the constitution and demarcation of the shire. At the time of Domesday Book (1086) the county was divided as now, except that the Isle of Ely, which then formed two hundreds, meeting at Witchford, is now divided into four (apart from Ely city)—Ely, Wisbech, North Witchford, and South Witchford. Cambridge formed a hundred by itself.

Cambridgeshire was in the diocese of Lincoln until, on the elevation of Ely to a bishop's see in 1109, almost the whole county was placed in that diocese. The Isle of Ely formerly constituted an independent franchise but its privileges were abridged in the reign of Henry VIII, though the bishop still retains certain rights.

From the time of Hereward the Isle of Ely was intimately concerned with the great political struggles of the country. It was defended against Stephen by Bishop Nigel of Ely, who fortified Ely and Aldreth, and in 1144 Geoffrey de Mandeville held Aldreth for the empress Matilda. The Isle of Ely was seized by Simon de Montfort's followers in 1266, but in 1267 was taken by Prince Edward. The county showed much sympathy with the Reformation. In the Civil War Cambridgeshire was one of the associated counties in which the king had few supporters, but the university helped him with plate and money.

The county is rich architecturally in styles from Norman onward. The magnificent cathedral of Ely (*q.v.*) and the college buildings and chapels of Cambridge (*q.v.*) are outstanding. Swaffham Prior has the remains of two churches in one churchyard, the tower of one being good Transitional Norman, the other mainly Perpendicular. Among many Early English examples Cherry Hinton Church near Cambridge may be mentioned. Trumpington and Bottisham churches are fine examples of the Decorated style. Monastic remains are few. Apart from Cambridge there are no notable domestic buildings except Sawston Hall (1557–84).

Domesday Book mentions more than 90 mills and numerous fisheries, especially eel weirs in the fens, and as early as the 14th century a flourishing wool industry was noted for its worsted cloths. Both the Black Death (1349–50) and the Wars of the Roses brought grave depressions, several Cambridgeshire towns obtaining remission of taxation in 1439 on the plea of poverty. In the 16th century the chalklands of the south were growing malting barleys of exceptional quality, as they do today. Activities which have not survived include the weaving of osier baskets, the growing of woad and of saffron, and the holding of fairs. Stourbridge Fair was once reckoned the largest in Europe, its chief goods being wool, hops, and leather; Reach Fair was equally renowned for horses. Both are now gone, although the sale and training of bloodstock is still the mainstay of Newmarket (a Cambridgeshire town until transferred to West Suffolk in 1894), where the annual Cambridgeshire horse race is run in October. Racing on the heath dates from Charles II's reign, a traditional association with horses existing from at least four centuries earlier. The drainage of the fens, virtually completed by the middle of the 17th century, brought large new areas under pasturage and cultivation.

Population and Administration.—The population of the administrative county of Cambridge was 190,384 in 1961; that of the Isle of Ely was 89,180, making a total for the new administrative county of 279,564. This was reduced by border changes to 274,250 (1965 est.). The main centres of population (1961) are: Cambridge (95,527), Wisbech (17,528), March (13,144), Ely, Whittlesey, Chatteris, Soham, and Littleport. The municipal boroughs are the city of Cambridge, which is the county town, and Wisbech. The urban districts are Chatteris, Ely (an ecclesiastical city), March, and Whittlesey. There are 6 rural districts and 148 civil parishes in the county.

The county is in the southeastern circuit, and assizes are held at Cambridge. Quarter sessions are held at Cambridge, Ely, and Wisbech, and there are 12 petty sessional divisions. The county, the city of Cambridge, and the Isle of Ely each return one member to Parliament. The county is in the diocese of Ely.

Economy.—With most of its area under cultivation the county's main interests are agricultural. Wheat comes first, with heavy yields on the fen soils; barleys and a few oats are grown on lighter land. Low rainfall and maximum sunshine favour production of seed. Clover, sainfoin, brassicas, and mustard are, therefore, important crops; the latter is also commonly grown as a catch crop to plow in green. With a large factory at Ely; sugar beets are grown extensively; also potatoes and, on light sandy land, carrots; kale and mangels are grown as cattle feed. Market gardening is common around the borders of the peat fens and the fen "isles"; fruit growing is found especially in the Wisbech, Cottenham, and Willingham districts, associated with canning, dehydration, and jam-making interests. Other enterprises include pest control and silage production; and farm mechanization is favoured by the large field units of the area. Lime, cement, and brick manufacture is carried on, and light industries include the production of scientific instruments, radio sets, furniture, containers, paper, and books.

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CAMBRIDGE UNIVERSITY. The history of the university may be said to begin in 1209 when, following disturbances at Oxford between the scholars and townspeople, a number of the scholars migrated to Cambridge. The majority probably returned to Oxford when order was restored there in 1214, but there is mention of a chancellor at Cambridge in 1226 and when in 1229 Henry III offered asylum in England to the scholars who dispersed that year from Paris, Cambridge was one of the towns to which they repaired. In 1231 the king informed the mayor and bailiffs of the town that the influx of scholars from foreign parts brought honour and profit to the kingdom and that they should be pleased to receive them; to prevent disorder among the scholars he ordered the sheriff to have it proclaimed that no scholar could remain in the town who was not under the supervision of a master.

With its chancellor, masters and scholars the university followed the pattern of Paris and Oxford. The main course of study was based on the traditional trivium and quadrivium. The study of the trivium (Latin grammar, rhetoric and logic) lasted four years and led to the degree of bachelor of arts; the study of the quadrivium (arithmetic, geometry, music and astronomy) lasted three years and led to the degree of master of arts. Degrees in divinity, law and medicine were obtained after further study. The learning and ability of a candidate were tested by disputation.

There were at first no colleges. The students lived in lodgings, or in hostels where a number boarded together, and the maintenance of order was a constant problem. It was partly to provide a remedy that the first college, Peterhouse, was established i 1284. Founded by Hugh de Balsham, bishop of Ely, it was modeled on Merton college, Oxford. Two hostels and an adjoinin church were vested in a master and a body of scholars. Certai revenues were appropriated for their maintenance and statute were made for the regulation of their affairs. Seven more college (some of them now extinct or merged with others) were founde in the next 70 years.

During the 13th and 14th centuries, however, the universit remained comparatively insignificant. In 1318 Pope John XXI recognized it as a *studium generale* (*see* University) but i boasted no teachers of the order of Oxford's Robert Grosseteste It was not until Lollardy tainted Oxford's reputation in the 14t century that the tide turned. In 1441 Henry VI founded h splendid college of St. Mary and St. Nicholas (King's college), an three more colleges were founded in the next 60 years. In 150 Lady Margaret Beaufort, mother of Henry VII, founded a pro fessorship of divinity, the oldest professorship in the universit and appointed John Fisher as the first professor. With his advic she proceeded to refound one college, Christ's, and to found another, St. John's, and through Fisher's influence Erasmus wa persuaded to come to Cambridge. In 1511 Erasmus was appointe to the Lady Margaret's professorship and he did much to wi Cambridge to the new learning of the Renaissance. The spirit o the Reformation found early expression in the preaching of suc men as Hugh Latimer and Thomas Bilney, and after the electio of Thomas Cromwell as chancellor in 1535 the university becam staunchly Protestant. In 1540 the king founded the professorships of divinity, Hebrew, Greek, medicine and civil law, and i 1546 he founded what was and still remains the largest college i the university, Trinity college. The university suffered a sever setback under Mary but revived rapidly on the accession of Elizabeth I. In 1570 she gave the university a revised body of statut and in the following year the university was formally incorporate by act of parliament. The new statutes, which remained in forc for nearly three centuries, vested the effective government c the university in the heads of colleges. Membership of the university was no longer envisaged without membership of a colleg

Elizabeth's reign saw the growth of a strong Puritan party i the university and two new colleges founded at this time, Emmanuel and Sidney Sussex, had a marked Puritan bias. Admission to the university were increasing and after a setback at the turn o the century they averaged 400 a year in the period 1610 to 163 At the outbreak of the English Civil War, however, the number c admissions declined and it was almost two centuries before the regained their former level.

In 1663 the Lucasian professorship of mathematics was found under the will of a former member of the university, and six yea later the first holder resigned in favour of Isaac Newton, then young fellow of Trinity. Newton held the chair for over 30 yea and gave the study of mathematics a unique position in the university. When the first honours examination in the universit

A. F. KERSTING

KING'S COLLEGE CHAPEL, BEGUN 1446, CAMBRIDGE UNIVERSITY

F. KERSTING

THE RIVER CAM, WITH ST. JOHN'S COLLEGE IN THE BACKGROUND

ame into being in the 18th century it was primarily mathematical. t was called the tripos, after the three-legged stool used formerly t disputations, and candidates placed in the first class were known s wranglers from the style of argument at a disputation.

The 18th century was in many ways a period of stagnation in ne university, but the tripos was increasingly respected as a test f ability and to be senior wrangler came to be regarded as a con- derable achievement. Until the institution of a classical tripos n 1824 it was the only honours examination in the university and ntil 1850 the only honours examination that led to a degree. The niversity became a nursery of mathematicians and many who ere senior wrangler in their year were afterward illustrious; for xample, Sir George G. Stokes, Arthur Cayley and John C. Adams *qq.v.*). In 1851 the university instituted tripos examinations in atural sciences and moral sciences.

Other changes were urgently necessary but the reforming party n the university was hampered by vested interests and by the tatutes of 1570 which the university had no power to alter. Fol- owing the advice of a royal commission of inquiry, which reported n 1852, parliament passed an act in 1856 which put the effective overnment of the university in the hands of a new body (the ouncil of the senate), appointed commissioners to frame new tatutes for the university and colleges and abolished the religious ests for all except divinity degrees. A period of rapid develop- nent followed. New lecture rooms and museums were erected, ew triposes instituted and new professorships established.

In 1871, with the assistance of the chancellor, William Caven- ish, duke of Devonshire, the university established the Cavendish rofessorship of experimental physics and the building of the avendish laboratory was begun. James Clerk Maxwell (second rangler in 1854) was the first professor. In the same year the niversities Test act removed the religious tests for all lay offices n the university and colleges. Meanwhile there was a marked icrease in the number of admissions. From an average of under 00 a year in the 18th century they rose to 400 in the 1820s, 600 n the 1870s and 900 in the 1890s. In 1873 the first college for omen, Girton, opened its new buildings in Cambridge.

Expenditure on these developments strained the university's nances. Under the provisions of an act of 1877 statutes were nade compelling the colleges to contribute to the university, but ne agricultural depression of the last quarter of the century re- uced the colleges' rental and they were unable to contribute as nuch as had been hoped. In 1897 the university resorted to a ublic appeal for funds but it proved only moderately successful nd in March 1914 support was sought from the government. A rant was received the following year. The application had been o the board of education for a grant for the medical school but Vorld War I and its aftermath restricted the university's re- ources still further and in 1919 application was made to the treasury for a grant for general purposes. A condition of the grant which the university then received was that there should be a comprehensive inquiry into the resources of the university and colleges and the uses made of them. A royal commission was appointed and reported in 1922. In accordance with the recommendations of the report, commissioners were appointed under an act of 1923 to make new statutes for the university and colleges. Among the results of their work were the introduction of a retiring age for university and college officers and the grouping of the teaching staff of the university by faculties.

The period following World War I was remarkable for the number of distinguished men who held university or college appointments; among them may be mentioned Sir Joseph J. Thomson, Lord Rutherford, J. M. Keynes and G. M. Trevelyan (*qq.v.*). The flow of admissions, which had fallen to a mere trickle during the war, rose to 2,400 in 1919 when those whose education had been interrupted resumed their studies. Although the number fell in the following year, the award of scholarships by the government and local education authorities enabled many to come to the university who would not have been able to come before, and the number of admissions remained substantially higher than before the war. In 1938 and 1939 admissions numbered more than 1,900.

During World War II the national need for trained scientists of all kinds led to large numbers of science students coming to Cambridge for short courses lasting one to two years, and the number of admissions rose rather than fell. The retention of conscription after the war prevented an immediate upswing such as occurred in 1919, but in 1948 the number of admissions rose to 2,500, and in contrast with what happened after 1919 admissions in subsequent years remained at a high level. The increase in the teaching and research staff of the university was proportionately even greater.

Constitution of the University.—The university is a self-governing body with the government vested in its own senior members. It cannot amend its statutes without the sanction of the privy council, but subject to the statutes it is free to make ordinances for the management of its affairs. All proposals of any moment are referred to one of two houses, the senate or the regent house. The senate, roughly speaking, consists of all graduates of the university, whether resident or nonresident, above the standing of bachelor. A bachelor of arts who has not previously become a member of the senate by proceeding to any other higher degree may become a member by taking the degree of master of arts, for which he is normally eligible without examination as soon as six years have passed since his first term of residence. University and college officers are eligible for this degree by virtue of their offices. Altogether, the senate includes a large proportion of the university's alumni. The regent house is much smaller, consisting only of members of the senate who hold offices or posts in the university and colleges. The main business of the university is referred for ratification to the regent house and proposals, if opposed, are accepted or rejected by a straight vote, but if the minority is large enough appeal may be made to the senate. The senate considers all proposals for the conferment of degrees and appoints to a number of offices, notably that of chancellor.

The proposals submitted to the regent house and senate originate with a large number of special boards or syndicates, but all proposals to be submitted must have the sanction of the council of the senate, a body consisting of the chancellor, the vice-chancellor, and 16 other members elected by the regent house from among themselves. Of these, four must be heads of colleges and four must be professors or readers. In the absence of the chancellor, who is customarily a distinguished nonresident, the chairman of the council is the vice-chancellor. The vice-chancellor is also chairman of the general board of the faculties, which is responsible for advising the university on educational policy and for maintaining the standard of teaching and research, and of the financial board, which is responsible for the management of the property of the university and for the control of expenditure. The vice-chancellor is elected by the regent house, on the nomination of the council, from among the heads of colleges, and holds office normally for two years.

A. F. KERSTING

KING EDWARD'S TOWER AND TRINITY COLLEGE CHAPEL, CAMBRIDGE UNIVERSITY

The Colleges.—The statutes of the university recognize 18 colleges for men and 2 for women. The men's colleges in order of foundation are: Peterhouse (1284), Clare college (1326), Pembroke college (1347), Gonville and Caius college (1348), Trinity hall (1350), Corpus Christi college (1352), King's college (1441), Queens' college (1448), St. Catharine's college (1473), Jesus college (1496), Christ's college (1505), St. John's college (1511), Magdalene college (1542), Trinity college (1546), Emmanuel college (1584), Sidney Sussex college (1596), Downing college (1800) and Selwyn college (1882). The women's colleges are Girton college (1869) and Newnham college (1871). Four other foundations may present students for matriculation in the university: Fitzwilliam house (1869), a noncollegiate institution for men, administered by the university; Hughes hall (1885), a foundation for women graduates who propose to become school teachers; New hall (1954), a foundation for women which is intended to become in time a full college of the university; and Churchill college (1960), a foundation for men with a bias toward science and engineering, also intended to become a full college.

No one can become a student in the university except through membership of one of these institutions and no one can remain a student in one of these institutions without matriculating in the university. The teaching and research staff of the university are not required to belong to a college but the great majority have a college connection. The relationship between the university and the colleges is therefore very close and it is impossible to imagine them existing in isolation. But the colleges, like the university, are self-governing institutions and they remain legally independent of the university. They are subject to university control only to the extent that they cannot make a statute affecting the university without obtaining the consent of the university (besides that of the privy council) and the statutes of the university impose on them certain obligations, for example the payment of an annual contribution for university purposes.

The governing body of a college consists usually of the master (or provost or president) and fellows. The fellows are elected by the governing body and (except at Trinity, Magdalene and Churchill) the master is elected by the fellows. Tenure of a fellowship is usually conditional on the holder engaging in research or occupying a qualifying office in the college or in the university Such persons are elected as are deemed fittest to become fellow of the college "as a place of education, religion, learning and research."

Apart from the master, the chief officers in a college are the bursar, the dean and the tutors. In most colleges the dean is responsible for the conduct of services in the college chapel and also with the tutors, for maintaining discipline among the students The selection of students is largely in the hands of the tutors Every student in residence is under the supervision of a tuto who stands to him *in loco parentis* and represents him in all hi dealings with the university. For the purpose of instruction ever student is also under the direction of one or more supervisor concerned with his subject of study. They advise him on his reading and he brings work to them to be corrected and discussed.

Courses of Study.—The normal course for the degree of bachelor of arts (B.A.) lasts not less than three years. There are triposes, or examinations for honours, in 19 subjects. Most of th triposes are divided into two parts which are taken in differen years, and in general a candidate must pass both parts of a tripo or two parts of different triposes to qualify for an honours degree In the case of the natural sciences tripos and the mechanica sciences (engineering) tripos it is possible to qualify by passin only part I. The names of successful candidates are arranged i three classes. A candidate who does not reach the standard fo honours may be allowed an ordinary B.A. degree.

There are also courses of study and examinations for the degrees of bachelor of laws (LL.B.), bachelor of music (Mus.B., bachelor of medicine and surgery (M.B., B.Chir.) and bachelor o veterinary medicine (Vet.M.B.). The courses for the degrees c M.B., B.Chir. (which are taken together) and Vet.M.B. last si years. During the first three years candidates take appropriat papers in the natural sciences tripos. Veterinary students remai in Cambridge for their subsequent clinical training but medica students go to recognized hospitals elsewhere. In each case th final examinations are taken in Cambridge.

The degrees of doctor of philosophy (Ph.D.), master of scienc (M.Sc.) and master of letters (M.Litt.) are obtained through submission of a dissertation. A candidate must have pursued a cours of research lasting three years in the case of the Ph.D. degre and two years in the case of the other degrees. It is not necessar to obtain one of the other degrees before proceeding to th Ph.D. degree.

The degrees of doctor of laws (LL.D.), doctor of medicin (M.D.), doctor of music (Mus.D.), doctor of science (Sc.D. and doctor of letters (Litt.D.) are awarded to graduates of th university of not less than eight years' standing. Candidates f the LL.D., Sc.D. and Litt.D. degrees must give proof of distinction by some original contribution to their subject. Candidate for the M.D. degree must submit a thesis and may be require to take an examination. Candidates for the Mus.D. degree mus give proof of distinction in musical composition. The universit also awards the degrees of bachelor and doctor of divinity (B.D and D.D.), master of surgery (M.Chir.), master of law (LL.M. and master of music (Mus.M.).

Buildings and Benefactions.—The buildings of the unive sity and colleges, the architectural legacy of seven centuries, for a magnificent setting for the life of the university. Mention ma be made of King's college chapel, begun in 1446; the Great cour Nevile's court and the library at Trinity, dating from the 16t and 17th centuries; the Senate house, finished in 1730; the Fit william museum, begun in 1837; and the University library, opene in 1934. The gardens of five of the colleges along the river Ca are known as the "Backs," and together they form a unique con bination of large-scale architecture, natural and formal garde and river scenery.

The Fitzwilliam museum was founded under the will of the 7t viscount Fitzwilliam who in 1816 bequeathed to the university h collection of pictures, manuscripts and books, with the sum

100,000 for the erection of a museum. The collection has been nlarged by many other benefactions and is now one of the finest Great Britain outside London.

The University library building was erected with the help of a enerous grant from the Rockefeller foundation. It contains bout 2,000,000 volumes, including many early printed books, and ver 10,000 manuscripts. After 1662, with two short interrup- ons, the library was able to claim a copy of every book published the United Kingdom.

The roll of the university's benefactors is a long one and, in oite of high taxation in the years following World War II, the um received annually did not diminish. Many of the larger enefactions, however, now come from firms rather than indi- iduals. While the availability of treasury support is a major ictor in determining the university's plans for the future bene- ictions continue to play an important part in initiating or assist- ig new developments. *See* also references under "Cambridge niversity" in the Index.

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(R. M. Ry.)

CAMBYSES, the Greek form of Old Persian Kanbujiya, the ame of two kings of the Achaemenid dynasty of Persia.

Cambyses I, son of Cyrus I and father of Cyrus the Great ee Cyrus), ruled over Anshan as a vassal of Media from about 0 to 559 B.C. According to Herodotus, he married a daughter Astyages (*q.v.*).

Cambyses II, son of Cyrus the Great, reigned from 530 to 522 c. During the lifetime of his father he was in charge of Baby- nian affairs. In 538 B.C. he performed the ritual duties of a abylonian king at the new year festival and in 530, before Cyrus t out on his last campaign, he was appointed regent in Babylon.

The conquest of Egypt, planned by Cyrus, was the major chievement of Cambyses' reign. Apart from the inscription of Egyptian, Udjahorresne, who served under him, the activities Cambyses in Egypt are known mainly from Greek writers, in rticular Herodotus, who drew on Persian and Egyptian sources, th of which were hostile to him. The invasion took place in 25 B.C., during the reign of Psamtik III. Cambyses received ssistance from Polycrates of Samos, from Phanes, a Greek gen- al in the Egyptian army who gave him valuable military in- ormation, and from the Arabs who provided water for the crossing the Sinai desert. After Cambyses had won a battle at Pelusium nd captured Heliopolis and Memphis, Egyptian resistance col- psed. Upper Egypt was subdued without difficulty and the ibyans and Greeks of Cyrene and Barca made their submission. samtik was at first treated leniently but having attempted to ise a revolt was executed.

While in Egypt Cambyses planned expeditions against Ethiopia, e oasis of Amon (Siwah) and Carthage. He himself set out ainst Ethiopia but after annexing the northern part of the untry had to retire because of shortage of supplies. A detach- ent sent from Thebes captured Al Kharijah (Kharga) oasis it perished in a sandstorm before reaching the oasis of Amon. he attack on Carthage was never attempted as the Phoenicians fused to use their fleet against kinsmen.

Herodotus accuses Cambyses of many atrocities in Egypt, at- ibuting them to madness, but contemporary Egyptian sources iggest that his accusations must largely be discounted. Certainly at the beginning of his rule Cambyses pursued a conciliatory policy. He adopted an Egyptian titulary and visited Sais, the seat of the dynasty he had displaced, to obtain official recognition from the goddess Neith. He sacrificed to the gods of Sais and restored the revenues to their temples.

According to Darius the Great, Cambyses, before going to Egypt, had secretly killed his brother, Bardiya, whom Herodotus calls Smerdis. The murdered prince was, however, impersonated by Gaumata, a Magian, who in March 522 B.C. seized the Persian throne. Herodotus states that Cambyses heard of this revolt in Syria, while returning from Egypt, and there he died in the summer of 522 B.C., either by his own hand or as the result of an accident.

See G. Posener, *La première domination Perse en Egypte* (1936).

(J. M. M.-R.)

CAMDEN, CHARLES PRATT, 1st Earl (1714–1794), lord chancellor of Great Britain, who opposed the taxation of the American colonies, was born in London in 1714, the third son of Sir John Pratt, chief justice of the court of king's bench from 1718 to 1725. He was educated at Eton and at King's college, Cambridge. He had been entered at the Inner Temple in 1728, and in 1738 he was called to the bar. After 12 years of struggling practice he sprang into prominence in 1752 with his successful defense of a bookseller charged with libel. All his life he was to fight for the principle that in libel it is for the jury to decide the general issue of guilt, and not merely publication. Two years later the elder Pitt appointed him attorney general, whereupon he was elected to parliament for Downton in Wiltshire. In Dec. 1761 he succeeded Sir John Willes as chief justice of the court of common pleas and was knighted, and in 1763 he delivered his memorable judgment in John Wilkes' case, declaring in firm language that general warrants were illegal. Two years later he was created Baron Camden.

On July 30, 1766, Camden became lord chancellor. He was, however, uncompromisingly opposed to the government's treatment of the American colonies, and ultimately on Jan. 16, 1770, he was dismissed. He continued steadfastly to oppose the taxation of the colonists, and in 1778 he signed the protest of the lords in favour of an address to the king on the manifesto of the commissioners to America. In 1782 he became president of the council under the second marquis of Rockingham, but resigned next year. The younger Pitt restored him to his office in 1784, and he held this until his death in 1794. He was created Earl Camden and Viscount Bayham in 1786.

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(R. E. My.)

CAMDEN, JOHN JEFFREYS PRATT, 2nd Earl and 1st Marquess (1759–1840), English statesman, whose inflexible policy as lord lieutenant of Ireland led to the rebellion of 1798, was born on Feb. 11, 1759, the only son of the 1st earl, the lord chancellor. Educated at Trinity college, Cambridge, he entered parliament as M.P. for Bath in 1780, and was a lord of the admiralty in the earl of Shelburne's ministry (1782–83) and under William Pitt (1783–89). Thereafter he was a lord of the treasury until 1794 when he succeeded his father as Earl Camden. He was appointed lord lieutenant of Ireland in 1795 and his term of office was noteworthy for the stern repression of revolutionary agitation. After the suppression of the rebellion in which this policy culminated, Camden resigned (1798). In Pitt's last ministry he was secretary of state for war and the colonies (1804–05) and lord president of the council (1805–06). He was again lord president (1807–12) and for a few months he remained a cabinet minister without portfolio. He was created Marquess Camden in 1812 and died in Kent on Oct. 8, 1840. (A. Al.)

CAMDEN, WILLIAM (1551–1623), English antiquary, a pioneer of historical method, and author of *Britannia,* the first comprehensive topographical survey of England, was born in London on May 2, 1551. Educated at Christ's Hospital and St. Paul's School, he was admitted to Magdalen College, Oxford, but moved first to Broadgates Hall (later Pembroke College) and then to

Christ Church, becoming B.A. in 1573. In 1571 he had moved to London and in 1575 was appointed second master of Westminster School and in 1593 headmaster. In 1595 he published a Greek grammar. In 1589 he was granted the prebend of Ilfracombe and in 1597 was appointed Clarenceux king-of-arms. He was thereby relieved of a schoolmaster's chores and given more time for writing.

From the time he left Oxford, Camden had devoted his leisure to antiquarian studies and spent his vacations traveling the country, collecting material for his *Britannia* (1586), dedicated to Lord Burghley. A topographical survey of England in Latin, *Britannia* was an immediate success. It was attacked by Ralph Brooke, York herald, who, motivated by professional jealousy, impugned Camden's scholarship. Camden refuted his critic in the preface to the fifth edition (1600), but issued an improved edition in 1607. The first English translation, that of Philemon Holland, appeared in two parts (1610), and of those that followed, the best are by Richard Gough (1789 and 1806).

Camden planned to write a general history of England, but only published a number of medieval chronicles (*Anglica, Hibernica, Normannica, Cambrica, à veteribus scripta;* 1602), and some of his commonplace collections (*Remaines;* 1605). In 1607 he began his *Annales rerum Anglicarum et Hibernicarum regnante Elizabetha,* a history of the reign of Queen Elizabeth I. The first volume, which took the story down to 1588, was published in 1615. The second, completed in 1617, was not published until two years after Camden's death. Camden's work has been the basis of most later accounts of the reign. Some criticism has been leveled at his treatment of the Mary Queen of Scots episode, and it was alleged that he altered his account to please James I. The work is based on manuscripts in the Cotton collection. The first English editions of the first and second parts appeared in 1625 and 1629 respectively. The best edition is T. Hearne's (1717).

Camden suffered from poor health, and in 1618 he retired to Chislehurst, Kent. He died there on Nov. 9, 1623. Before his death he founded a chair of history at Oxford University. The Camden Society, founded in 1838, published many historical documents and was merged with the Royal Historical Society in 1897.

Camden has a special place among English antiquarians. He was the leading historical writer for a generation influenced by the Renaissance and eager to learn of its Roman past, and for a public which included statesmen and ecclesiastics who, for the first time, saw historical precedent as a guide to present action. Whereas his only precursor, Leland, was a solitary eccentric whose work was little known, Camden was an active member of the Society of Antiquaries, founded *c.* 1585, that laid the foundations for the school of 17th-century historians. Camden was the first to realize the importance of ancient languages in the study of place names, and to make known the existence of Romano-British coins. His work was a model for later writers and his dispute with Brooke was to prove the first of a long line of historical controversies.

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CAMDEN, one of the 32 London boroughs constituting Greater London, Eng., is bounded by Islington, Haringey, Barnet, Brent, Westminster, and the City. This inner London borough was established on April 1, 1965, by the amalgamation of the former metropolitan boroughs of Hampstead, Holborn, and St. Pancras, under the London Government Act 1963 (*see* LONDON). Its parliamentary constituencies comprise Hampstead, St. Pancras North, and Holborn and St. Pancras South. Area 8.4 sq.mi. (21.7 sq.km.). Pop. (1965 est.) 240,970. Topographically, Camden is dominated by the Northern Heights of Hampstead (443 ft. [135 m.]) and Highgate (424 ft. [129 m.]). Open spaces comprise 843 ac. (341 ha.), of which 176 (71) (Primrose Hill and Regent's Park) are crown lands. Parliament Hill, Kenwood, Hampstead Heath, Golder's Hill Park, Lincoln's Inn Fields, and Waterlow Park are controlled by the Greater London Council. Public gardens and enclosures maintained by Camden comprise 54 ac. (22 ha.). The Fleet River rises in Hampstead and Highgate and then flows underground as a sewer through the borough; in the south it was called Holebourne, "the stream in the hollow," whence Holborn.

From north to south the main districts of Camden are Hampstead, Highgate, West Hampstead, Swiss Cottage, Belsize Park, Chalk Farm, Gospel Oak, part of Kilburn, Kentish Town, Camden Town, Regent's Park, Somers Town, Bloomsbury, and Holborn. The "villages" of Hampstead and Highgate retain much of their old 18th-century charm. Both are almost entirely residential. Several small-scale industries occur in Kentish Town and Camden Town, while the Tottenham Court Road area has for long been associated with the furniture and upholstery trades. Piano making has been long established in Camden Town. Immediately to the north of Euston Road are three important railway terminals: Euston (completed 1849), King's Cross (1852), and St. Pancras (1874). To the south of Euston Road lies Bloomsbury, a district characterized by learned institutions, private hotels and several fine Georgian squares. Holborn, to the southeast, is renowned as a legal centre with Gray's Inn and Lincoln's Inn (*see* INNS OF COURT AND CHANCERY), and solicitors' offices. It also has a variety of commercial undertakings and department stores. Hatton Garden, leading north from Holborn Circus, is the centre of the diamond, gold, and silver trades.

Adjoining Hampstead Heath is Ken Wood House (reconstructed *c.* 1767 by Robert Adam), former home of the Mansfields; bequeathed to the nation by Lord Iveagh in 1927, it is notable for its collection of masterpieces by 18th-century British painters. Other old houses include: Heath House (centre of Abolitionist activity in the late 18th century); Fenton House (*c.* 1693) in Hampstead Grove, now owned by the National Trust, has a notable collection of china and early keyboard instruments; the house of the painter George Romney (*c.* 1797) on Holly Bush Hill, Vane House on Rosslyn Hill, (once the home of Sir Henry Vane, the Civil War parliamentarian); "Admiral's House" featured in John Constable's painting "The Romantic House of Hampstead") Burgh House (*c.* 1703) in New End Square, now used as a cultural centre; and perhaps the most renowned, Keats House and Museum, built in 1815–16, where the poet John Keats resided from 1818 to 1820. Fine domestic architecture is also found in Highgate, notably in The Grove. In the Regent's Park district are Park Village East, Park Village West, and the Regent's Park Terrace, designed by John Nash. In Holborn there are many 18th-century houses (now mostly used as offices) built around squares. Of the former Inns of Chancery the most noteworthy building is Staple Inn, with its unique timbered Elizabethan front.

Several fine modern buildings in and near Euston Road include Friends' House (1926), the Town Hall (1937), the Wellcome Foundation Building (1932), and the British Medical Association House (1929). Buildings erected since World War II include State House in High Holborn, Holborn College in Red Lion Square, Congress House, two central libraries (one in Holborn and one at Swiss Cottage), and the Post Office Tower (1964; the tallest building in London [620 ft.]). The vast British Museum is bounded by Montague Place, Montague Street, Great Russell Street, and Bloomsbury Street. To the north is the Senate House of the University of London (1932), Birkbeck College, the Royal Academy of Dramatic Art, and University College, founded by Jeremy Bentham and others in 1826. Other educational and cultural establishments (approximately from south to north) include Sir John Soane's Museum, City Literary Institute, Central School of Arts and Crafts, Working Men's College, Royal Veterinary College, Cecil Sharp House (home of the English Folk Dance and Song Society), North Western Polytechnic, the Central School of Speech and Drama, the Medical Research Institute, Westfield College, and University College School. Notable grammar schools are the William Ellis School (boys) and the Camden School for Girls. In Highgate is the Literary and Scientific Institution.

Hampstead Parish Church dedicated to St. John the Evangelist (rebuilt 1745–47) is a fine example of Classic style in keeping with the elegance of the Georgian Church Row; in its churchyard lie buried many celebrities including Constable, George du Maurier and Sir Herbert Beerbohm Tree. St. Pancras Old Church dates from the 13th century, and its churchyard, now St. Pancras Gar-ens, is also notable for its distinguished dead, who include Sir ohn Soane, John Flaxman, the sculptor, and Johann Christian ach. The St. Pancras New Church in Euston Road, the "queen Regency Churches in London," dates from 1822. To the south the church of St. Giles-in-the-Fields (1734). St. George's hurch, Bloomsbury (1724), was one of 50 churches proposed Queen Anne's Commission. St. George-the-Martyr Church, ueen Square, dates from 1706 and was restored in 1868. White-eld's Tabernacle in Tottenham Court Road succeeded that built r George Whitefield in 1756. Well-known hospitals are the ational Hospital for Diseases of the Nervous System, the Hos-tal for Sick Children (Great Ormond Street), and the Moorfields estminster and Central Eye, the Royal Free (Gray's Inn Road), niversity College, and the Elizabeth Garrett Anderson hospitals. Benjamin Disraeli was born in Theobald's Road, Holborn. eats, who lived in Wentworth Place (now Keats House), fre-uently met Charles Lamb, Percy B. Shelley, William Hazlitt, and her contemporaries at Leigh Hunt's home in the Vale of Health. muel Taylor Coleridge made his last home in Highgate. There e also associations with Francis Bacon (who died at Arundel ouse, Highgate), George Bernard Shaw (who was a St. Pancras stryman and borough councillor 1897–1903), H. G. Wells, and H. Lawrence. Charles Dickens lived (1837–39) at 48 Doughty reet; it is now the Dickens House and headquarters of the Dick-ns Fellowship. The Fitzroy Square area has been noted for its sociation with artists, who have included Roger Fry, Constable, alter Sickert, and Augustus John. Many French *émigrés* settled Somers Town, and the Abbé Carron founded St. Aloysius Church 808) for their use. Karl Marx, who spent the last 27 years of s life at 46 Grafton Terrace and 41 Maitland Park Road, is uried in Highgate Cemetery.

The roads are predominantly north-south. Tottenham Court oad in the south (leading to Hampstead Road) and Southampton ow (leading via Woburn Place to Eversholt Street) meet in Cam-en High Street, which then branches off in three directions—Cam-en Road to the northeast, Kentish Town Road, and Chalk Farm oad, which proceeds via Haverstock Hill to Hampstead. Gray's n Road extends from High Holborn to King's Cross. To the est, Finchley Road emerges from St. John's Wood, proceeds rough Swiss Cottage and leaves the borough south of Child's ill. Two main east-west routes in the south are Euston Road nd High Holborn.

The Roman association with Kilburn is embodied in Watling reet, a section of which (Kilburn High Road, Shoot-up Hill, nd Cricklewood Broadway) skirts the western edge of the bor-ugh. The Holborn district covers an area once occupied by two edieval villages (Holborn and St. Giles) and three landed estates he manor of Blemundsbury, the Soke of Portlepoole, and the berty of Ely Place). In Ely Place the Chapel of St. Etheldreda a remnant of a 13th-century palace. St. Pancras at Domesday as held by St. Paul's Cathedral and divided into three manors—ancras, Tothele or Totenhall and Rugmere, and a portion of nd identified as Kennistoune or Cantelowes. Hampstead was a llage in Anglo-Saxon times and was mentioned in a charter at-ibuted to King Edgar (d. 975). In 986 its manor was bestowed St. Peter's Monastery, Westminster, and revoked at the Dis-lution of Monasteries (1536); the submanor of Belsize became parate. Eton College obtained the smaller Chalcots Estate which gave its name to Chalk Farm) and still owns much prop-ty in the area. Manors became the properties of wealthy fami-s, notably the dukes of Bedford, Lords Southampton, and the omers family. Rugby and Bedford School also own property in olborn. Various wells were popular at that time and there were as at Hampstead, Kilburn, St. Pancras, St. Chad's, and Bagnigge. ypical of efforts to deal with social evils were the establishment the Foundling Hospital (1741) by Thomas Coram in Guilford reet, Robert Owen's Infant School (1816), and the National quitable Labour Exchange (1832) in Gray's Inn Road. The ispensary for the Relief of the Infant Poor was opened in Red on Square in the second half of the 18th century.

With the great increase in population in the 19th century, vil-ges expanded and farms north of Holborn were built upon. The development of Somers Town and Camden Town was accelerated by the advent of the railways. Camden Town, from which the borough derived its name, was so called after Charles Pratt, Earl Camden, who in 1791 gave land for building on his Camden estate. An example of modern development is the Regent's Park Estate. (W. R. MA.; G. D. GR.)

CAMDEN, a city in New Jersey, U.S., and seat of Camden county, is on the Delaware river opposite Philadelphia, Pa., with which it is connected by a suspension bridge that was opened to traffic in 1926. The site was originally known as Cooper's Ferry. In 1681, the year Philadelphia was founded, William Cooper built a home near the mouth of the Cooper river and named the tract Pyne Point. In 1689 he assumed control over the ferry to Philadelphia. Two other prominent settlers were John Kaighn and Archibald Mickle, for whom streets have been named. Settlement, which was largely by Quakers, was slow, however, and for decades it was claimed that Camden existed out of the necessity for crossing the Delaware in order to reach Philadelphia.

In 1773 interest in real estate grew when Jacob Cooper, a descendant of William, laid out 40 ac. as a townsite. He named the location Camden for Charles Pratt, 1st earl of Camden, whose outspoken opposition to British taxation policies made him popular with the American colonists. The development of the new village was impeded by the American Revolution, as Camden was often held by the British when they occupied Philadelphia.

In the 19th century improvements in transportation brought new growth. While ferry services increased, the advent of the railroad provided the greater impetus. In 1834 the cross-state Camden and Amboy railroad was built and for six years Camden enjoyed better railroad facilities than Philadelphia in reaching the New York city market. By this time, too, the town had achieved its political independence. In 1828 it was set apart from Newton township and incorporated as a city; in 1844 it was selected as a seat of the newly formed Camden county.

Expansion occurred in the years following the American Civil War, a period marked by the inauguration and growth of the town's important industries. The oldest steel pen company in the U.S., established in 1858, developed in these years, as did a canning plant which opened in 1867 and started marketing condensed soups in 1897. The Victor company, founded in 1894, developed the talking machine. A shipbuilding company was established in 1899 on the south Camden waterfront. Other industries include furniture, chemical products, paper industries machinery, bookbinding, leather, plastics, automobile accessories, plumbing fixtures and electrical appliances.

Pop. (1970) 102,551. For comparative population figures *see* table in NEW JERSEY: *Population.* (H. F. WI.)

CAMDEN, a city of South Carolina, U.S., 32 mi. N.E. of Columbia; seat of Kershaw county. The first settlers in the area established farms along the nearby Wateree river about 1733. In 1758 Joseph Kershaw established a country store and the community came to be known as Pine Tree Hill. Ten years later the colonial assembly established a court there and the name was changed to Camden, honouring the Englishman Charles Pratt, 1st earl of Camden, a colonial hero by virtue of his fight against the Stamp act. Camden was a major British garrison during the American Revolution and the scene of two of the greatest American defeats. On Aug. 16, 1780, Gen. Horatio Gates, with forces vastly outnumbering those of Cornwallis, lost over 2,000 men, including Gen. Johann Kalb (*q.v.*), in a vain effort to seize the town. On April 25, 1781, a second colonial army under Gen. Nathanael Greene, camping on Hobkirk's hill just outside the town, was caught by surprise and routed by a smaller British force. Andrew Jackson, then 14 years old and a prisoner of the British, watched the battle from the stockade jail. The following month the British, harassed by guerrilla raids, burned and evacuated the town.

Camden prospered as a plantation centre and resort area after the American Revolution. During the American Civil War it was an important Confederate railroad terminus, supply base and hospital. On Feb. 24, 1865, Gen. William T. Sherman entered the town and again much of it was burned. From the American

Revolution until well after the Civil War Camden was famous for its duels and provided a school for young men seeking instruction in the code of honour.

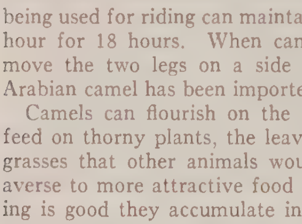
Industries include textiles, man-made fibres, pulpwood, veneer, lumber and cottonseed oil.

For comparative population figures *see* table in SOUTH CAROLINA: *Population.* (G. H. CT.)

CAMEL, two species of the genus *Camelus* belonging to the suborder Tylopod (*q.v.*) in the order Artiodactyla (*q.v.*). The Arabian camel, *C. dromedarius,* has only one hump, but the Bactrian camel, *C. bactrianus,* has two. The limbs are long and the feet have no traces of the second and fifth toes; the wide-spreading soft feet are adapted for walking upon sand or snow. Horny pads on the chest and knees support the weight when kneeling. Although camels ruminate (chew the cud) they are not classified in the suborder Ruminantia because, among other anatomical differences, the stomach differs from that of ruminants. Its third chamber is vestigial and its first, the rumen, has smooth (not papillose) walls, with diverticula, wrongly called "water cells," communicating with it.

Camels are known only as domestic animals and are not found in a truly wild state. The Bactrian camel occurs throughout the highlands of central Asia from Turkistan to Mongolia and although some "wild" herds inhabit various remote districts they are probably descended from animals escaped from domestication. All through that region it is an important beast of burden. Although it travels at a slower rate (two to three miles per hour) than the Arabian camel, the Bactrian can maintain this pace for a longer time in caravan, usually averaging 30 mi. per day while carrying a 400-lb. load. The height of the Bactrian is about seven feet at the top of the humps. The Arabian camel, characteristic of India, the near east and north Africa, is likewise primarily important as a beast of burden, though like the other species it also provides wool, milk, hides and meat. It is longer-legged, lighter-built and shorter-coated than the Bactrian camel. The Arabian camel stands about seven feet tall at the shoulder and when being used for riding can maintain a speed of eight to ten miles per hour for 18 hours. When camels run they pace; that is, they move the two legs on a side forward at the same time. The Arabian camel has been imported into many parts of the world.

Camels can flourish on the coarsest of sparse vegetation and feed on thorny plants, the leaves and twigs of shrubs, and dried grasses that other animals would refuse, though camels are not averse to more attractive food if it is available. When the feeding is good they accumulate in their humps stores of fat, which they are able to draw upon when conditions are adverse not only for sustenance but also for the manufacture of water by the oxidation of the fat, but they do not store water in the miscalled water cells. They are thus able to fast and go without drinking for several days; they have been known to go without water for 17 days and survive. Camels can carry a load of 500 lb. 25 mi. a day for three days without drinking. They lose their body water slowly and can lose up to 25% of their weight by dehydration without ill effects—a much higher percentage loss than man and other mammals can tolerate. They can then regain their lost weight in ten minutes by drinking as much as 25 gal. of water. Other adaptations that enable them to survive in deserts and other unfavourable environments include double rows of heavy protective eyelashes, haired ear openings, the ability to close their nostrils and keen senses of sight and smell.


W. SUSCHITZKY

BACTRIAN CAMEL (CAMELUS BACTRIANUS)

In the winter camels, especially the Bactrian species, grow thick shaggy coats, which they shed in the spring so that they are almost naked until the new coat starts growing. The female produces one young at a birth after a gestation of 11 months and suckles it for a year; maturity is reached at the age of 10 to 12 years and the life span is 30 to 40 years. Camels are docile and patient when properly trained and handled but are liable to sudden fits of rage, especially in the rutting season. Breeding has been so specialized that the riding camel forms a type quite distinct from the common baggage camel.

Camels originated in North America about 40,000,000 years ago and by 1,000,000 years ago had spread to South America and Asia. They later vanished from the continent of origin and were not seen there again except in zoos until introduced from Asia by the U.S. army in the 1850s as beasts of burden for frontier garrisons in the southwest. The experiment was abandoned, however, and the animals were turned loose. The last wild ones were seen about 1900.

See also references under "Camel" in the Index. (L. H. M.)

CAMELLIA, a genus of more than 80 species of broad-leaved evergreen trees and shrubs belonging to the tea family and native to Asia. Most garden varieties belong to *C. japonica* but a considerable number belong to *C. sasanqua* and *C. reticulata.* They are esteemed for their dark green foliage and handsome flowers in many forms—single, semi-double, incomplete double and complete double—and colours—white, rose, red or variegated. Different flower forms have been produced by the conversion o stamens into petal-like parts. Th blooms open in autumn and winter, and those of *C. sasanqua* ar sweet scented.

J. HORACE MCFARLAND CO.

COMMON CAMELLIA (C. JAPONICA), HORTICULTURAL VARIETY MAGNOLIAEFLORA

Two other species are sources of commercial products. Th leaves of *C. sinensis,* grow mostly in China, Ceylon and India, furnish tea (*q.v.*). A domestic oil used in China and Japan i pressed from seeds of *C. oleifer* and several other species.

Camellias are propagated from seeds to secure new varieties and to furnish stocks for grafting. Largely they are grown from cuttings, best made when the summer growth has matured, and t a lesser extent by grafting, shortly before growth starts in spring. They are favourite plants in gardens wherever soil and climate are congenial and in greenhouses.

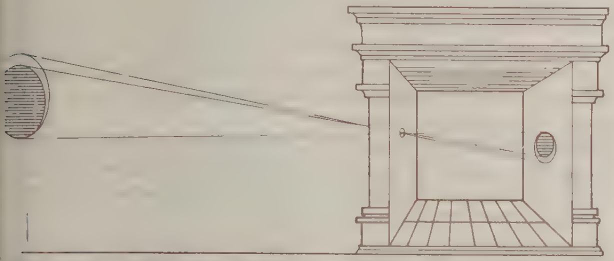
Good drainage is essential and a mulch of peat, leaves or other coarse vegetable matter three to four inches thick is desirable. Water-spraying the leaves and supplying an even amount of soil moisture are valuable aids in securing good growth and flowering. A soil mixture of good loam, sand, peat and well-rotted manure i suitable. During winter it is best to maintain greenhouse o indoor temperatures of 45° to 55° F. during daylight and 5° t 10° lower at night. (H. H. HU.)

CAMELOT, the legendary seat of King Arthur's court (*see* ARTHURIAN LEGEND), variously identified with Caerleon-upon-Usk in Monmouthshire (*see* CAERLEON), with Queen's Camel in Somerset, with the little town of Camelford in Cornwall and with Winchester.

CAMEO, a term commonly applied to engraved work executed in relief on hard or precious stones, as well as to imitations of such stones in glass, called "pastes," and on the shells of molluscous animals. The cameo is therefore the converse of the intaglio, which consists of an incised or sunk engraving in the same class of materials.

See also references under "Cameo" in the Index.

CAMERA LUCIDA AND CAMERA OBSCURA, tw simple optical devices used by artists, scientists and others to aid them in drawing, viewing or demonstrating an object by projecting an image of it onto a suitable screen. The camera obscura (Latin for "dark room") was the first to be introduced and it has been known in one form or another for many centuries. Essentially i consists of a darkened chamber having in one wall a small apertur r a lens, by means of which an image of external bright objects is ormed on a screen at the opposite end of the darkened chamber ig. 1). Artists having difficulty with perspective drawing have sed the device from early times to project outdoor scenes or profiles of persons onto a sheet of paper so that they could trace the orrect outline before proceeding to paint the scene or the portrait. stronomers have used the device for projecting images of the clipsed sun, the moon and brighter stars. Showmen have made rofitable use of it, erecting a room-size camera obscura at a vacaon resort before an attractive view. The popularity of the camra obscura began to wane after photography was introduced in 339 by Louis Daguerre and William Fox Talbot, in whose hands e camera obscura became the familiar photographic "camera."



G. 1.—DIAGRAM ILLUSTRATING A SOLAR ECLIPSE THROUGH A SIMPLE MERA OBSCURA (AFTER RAINER GEMMA-FRISIUS, 1545)

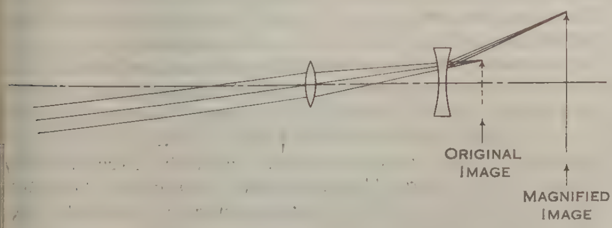
The camera lucida (Latin for "light room"), invented in 1807 ee below), essentially consists of a small prism of special conruction mounted in front of the observer's eye and used in full aylight. By means of this device an image of chosen objects aced in front of the prism is made to appear to be lying on the aper, enabling an artist, naturalist or microscopist to trace the tline of his subject in correct proportions.

THE CAMERA OBSCURA

Early History.—The invention of the original camera obscura, which a small hole was used to project an image of external ojects on a screen in a darkened room (fig. 1), is lost in antiquity. ertainly Aristotle (384–322 B.C.) is known to have been familiar ith the fact that an image of the sun could be projected onto a reen through a small aperture in a wall, and that the image would e circular no matter what shape the aperture might have. (The orrect explanation of this phenomenon was given by Maurolycus 1521.) Alhazen (965?–1038), Vitello (d. *c.* 1290), Roger Bacon . 1220–*c.* 1292) and several other writers of the 13th, 14th and th centuries demonstrated familiarity with the principles of the mple camera obscura and many of its applications. Bacon sugsted the addition of an inclined plane mirror outside the aperture that persons passing below the window could be imaged on the reen.

John Peckham, archbishop of Canterbury (1279), commented n the possible use of a camera obscura for observing solar clipses. Leonardo da Vinci (1452–1519) made accurate drawings the camera obscura, and seems to have thoroughly understood s action.

Introduction of the Lens.—The substitution of a lens for the nall aperture in the camera obscura, thus converting it into a actical instrument, was apparently first suggested by Girolamo ardano (Jerome Cardan; 1501–76) in his book *De subtilitate* (1551), then by Daniello Barbaro in *La Pratica della perspettiva* (Venice, 1568), and also by Giovanni Battista Benedetti in 1585.



G. 2.—THE USE OF A CONCAVE LENS IN A CAMERA OBSCURA TO MAGNIFY E IMAGE

Nevertheless, credit for the introduction of a lens in the camera obscura is generally given to the Neapolitan Giovanni Battista della Porta (*c.* 1535–1615), who in 1558 wrote a very popular four-volume book on natural science called *Magia Naturalis* in which he described, among other things, the camera obscura with a small aperture. In the 20-volume second edition of this book (1589), he added as a "great secret which he had intended to keep," a note on the advantages which result from the use of a lens in place of a simple hole.

The image in a camera obscura is, of course, inverted. If a translucent screen is used to catch the image, the observer being on the far side of the screen, then the image will be right-handed and inverted. However, if an opaque screen is used, the observer must either be inside the camera himself or looking into it through a hole at one side, in which case the image he sees will be both inverted and left-handed. It was early recognized that if a plane mirror is used in front of or behind the lens, the left-handedness of the image on an opaque screen will be reversed, giving a correct image.

Modifications and Improvements.—Johann Kepler (1571–1630) well understood the action of the camera obscura, and in fact it was he who introduced the name. In 1600 he began to use the instrument for solar observations, and greatly improved it for this purpose by introducing a negative lens at a suitable distance behind the positive lens to enlarge the projected image (fig. 2). This is the principle of the modern telephoto lens. He is reported to have observed the transit of the planet Mercury across the sun's disk in 1607 by this means.

Even though the telescope was introduced in 1609, astronomers continued to use a camera obscura for solar observations because of the danger to their eyes when looking directly at the sun. In 1611 Johannes Fabricius used a camera obscura without a lens to observe sunspots for the first time.

Robert Boyle (1627–91) seems to have been the first to construct a small portable box-type camera obscura about 1665. It could be extended or shortened like a telescope to focus the image on a sheet of paper stretched across the back of the box opposite the lens. A similar device with an internal mirror to reflect the image onto a screen at the top of the box was described by Johann Zahn in 1685.

A somewhat larger portable camera obscura in the form of a tent was used by Kepler about 1620, and during the following two centuries this form was employed extensively by artists as an aid to perspective drawing. It was made from a pyramidal framework of rods covered with cloth, with the lens at the top surmounted by a plane mirror to reflect a scene onto a horizontal sheet of drawing paper laid on a table inside the tent. The artist would then draw round the objects in the scene and thus determine accurately their relative shapes and sizes. The perspective in many of the paintings made during the past 300 to 400 years is so accurate that some form of camera obscura was most probably used.

A somewhat larger form of camera obscura was built in the form of a small cabin in which a lens was mounted in a hole in the roof, with a plane mirror above it at 45° to reflect distant scenes down into the lens, the image of distant objects being projected on a white table inside the cabin. Several people could see the image by standing around the table, and to change the scene it was merely necessary to rotate the mirror holder about the vertical axis of the device. A few camera obscuras of this type are still in existence at popular vacation resorts as amusement devices.

In 1812 W. H. Wollaston realized that the image quality in the outer parts of the field of this device could be improved by using a meniscus-shaped lens in place of the usual biconvex lens, with a diaphragm or stop on the concave side of the lens to force the oblique rays to pass more normally through it. In this way he developed the flat-field landscape lens, millions of which are manufactured every year for use in box cameras (fig. 3).

The early inventors of photography naturally made use of the box-type camera obscura, since their aim was to "fix" or render permanent the beautiful and interesting views they saw on the

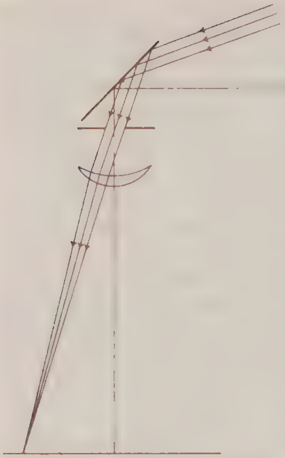


FIG. 3.—DIAGRAM SHOWING WOLLASTON'S APPLICATION OF A MENISCUS LENS TO THE CAMERA OBSCURA

translucent screen. Fox Talbot merely laid a sheet of light-sensitive (photogenic) paper on a piece of glass in the plane of the image, and allowed the light to be recorded by a blackening of the paper.

Since Daguerre used a plain camera without an internal mirror, his positive daguerreotypes were left-handed, and various inventors proposed that a reflecting prism or plane mirror should be mounted in front of the lens to rectify this defect. For the further development of the photographic camera, *see* Photography.

THE CAMERA LUCIDA

This is a small instrument invented in 1807 by William Hyde Wollaston (1766–1828). It consists of a small four-sided prism mounted on a simple stand at a convenient height above a sheet of paper. By placing the eye close to the upper edge of the prism so that half of the eye pupil is over the prism, the observer is able to see a reflected image of objects situated in front of the prism, apparently lying on the paper (fig. 4); he can then trace the image with a pencil and thus record its appearance accurately. The optical distinction between the camera obscura and the camera lucida is that in the former a real image of external objects is actually projected on the paper by the lens, whereas in the latter a virtual image of the distant object is made to appear to lie on the paper.

The actual use of this instrument is, unfortunately, not as simple as the above brief outline might indicate. For example, if the observer's eye moves as little as $\frac{1}{18}$ in. from its correct position, the light beam reflected by the prism may miss the pupil of his eye entirely. Furthermore, if the distance of the object happens to be different from that of the paper, it will be impossible for the observer to focus both the object and the paper equally sharply at the same time; also, if he were to move his head slightly, there would be a small relative movement between the image and his drawing.

To avoid these difficulties, a selection of weak spectacle lenses is usually provided with the camera lucida which may be inserted between the prism and the paper, as shown in fig. 4, to make the paper appear at the same distance from the eye as the reflected image of the object. It will be readily understood that the camera lucida can be used to copy a drawing at its original size, or enlarged or reduced, without distortion, the degree of enlargement being given by the ratio of the distances of the paper and the original drawing from the eye.

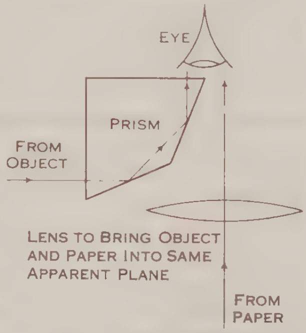


FIG. 4.—DIAGRAM SHOWING THE PRINCIPLE OF THE WOLLASTON CAMERA LUCIDA

In order to give the eye a greater freedom of movement, several modifications of the original Wollaston system were proposed during the 19th century, mainly for use as an aid in drawing the magnified images seen in a microscope. In these devices, a small transparent plane mirror is mounted in front of the eye at an angle of 45° to the direction of the light, so that a reflected image of the subject is seen superposed upon a direct view of the drawing paper, allowing a greater freedom of movement of the observer's eye. Unfortunately, when a single mirror is used the image is inverted and left-handed, but the use of a second mirror in the reflected beam will rectify this. In the original Wollaston form of the camera lucida (fig. 4), the two reflections are combined within a single prism so that no external mirrors are necessary.

In the Abbe form (fig. 5), which was introduced about 1880, particularly for use with a vertical microscope, the diagonal transparent mirror is cemented into a small glass cube and mounted close to the microscope eyepiece, the second mirror being supported over the paper by a projecting arm. No equalizing lenses are required because a touch on the fine-adjustment screw of the microscope will serve to bring the microscope image to the same apparent distance as the paper.

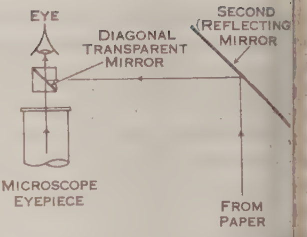


FIG. 5.—DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE ABBE CAMERA LUCIDA

See also Optics.

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CAMERARIUS, JOACHIM (1500–1574), German classical scholar and Lutheran theologian who mediated between Protestants and Catholics at the Reformation, was born at Bamberg on April 12, 1500. He joined the humanist circle of Helius Eobanus Hessus at Erfurt in 1518 and later became the pupil and friend of Philipp Melanchthon at Wittenberg (1521). He was made professor of classics at Tübingen in 1535. In 1541 Duke Ulrich of Württemberg summoned him to reorganize the University of Leipzig. His classical publications include editions with commentaries of Sophocles, Herodotus, Homer, Plautus and Xenophon, as well as Latin translations of Greek authors. He also wrote a catechism about the classics in Latin verse (*Praecepta honestatis atque decoris puerilis*, 1528) and Latin biographies of Hessus (1553) and Melanchthon (1566). He was present with Melanchthon at the reading of the *Confutatio pontificia* at Augsburg in 1530, and also at a diet there in 1555. In the same yea he was the mediator in the dispute over Osiander at Nürnberg Maximilian II summoned him to Vienna in 1568 to give advice and to order Austrian church affairs. He died at Leipzig on April 17, 1574.

His posthumously published *Epistolarum familiarum libri v* (1583) and *Epistolarum familiarum libri v posteriores* (1595) ar valuable sources for the period.

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CAMERON, RICHARD (1648–1680), Scottish Covenanter founder of a religious sect called Cameronians (*q.v.*) and one o the first to insist on separation from those Covenanters who accepted the indulgence of 1672, was born at Falkland, Fife, and was schoolmaster of his native village until he became chaplain and tutor to Sir William Scott of Harden. In 1673 he began t preach in the open air, under the influence of the Covenanter John Welch, and refused to recognize the rule of an "uncovenanted" king or to accept Charles II's indulgence, which suspended the laws against nonconformists. The number of hi followers was severely reduced by their defeat at Bothwell Bridg (1679), though many joined him in exile in Holland.

Cameron returned at the end of the year and on June 22, 1680 he and his friends, including Donald Cargill, Thomas Douglas and David Hackston, issued the Sanquhar Declaration, callin for war on Charles II and the exclusion of James, duke of York With only a small group of men he was easily taken and kille by royal troops at Airds Moss in Ayrshire on July 22. The praye he had made before the brief fighting became one of the covenanters' songs—"Lord, spare the green and take the ripe."

See J. Herkless, *Richard Cameron* (1896).

CAMERON, SIMON (1799–1889), U.S. businessman and olitician, was born in Lancaster county, Pa., on March 8, 1799. rphaned at the age of nine, Cameron received little schooling d soon began earning his own livelihood. By the age of 25 he d risen from printer's devil to newspaper owner and editor and a position of influence in the state Democratic party. Varied isiness interests—iron manufacturing, banking, insurance and ilroads—received his chief attention until 1845 when through s own shrewd manipulations and with the support of Whigs and gh-tariff Democrats he was elected to the United States senate. hereafter his chief business was politics and he became one of e most powerful political bosses the United States has ever own.

In 1857, as the candidate of the new Republican party, but with e aid of Democratic votes which, according to rumour, had been cured by questionable means, Cameron was again elected to the nate. In 1860 he was Pennsylvania's favourite son candidate r president in the Republican national convention and threw his pport to Lincoln in exchange for a cabinet post. He was apinted secretary of war but served only 10 months. Despite his monstrated business acumen and organizing ability he proved equal to his new responsibility. He administered the war dertment with such favouritism that in Jan. 1862 President Linln transferred him to the post of minister to Russia.

Cameron returned to the United States in 1863 and unsuccesslly sought election to the senate. Four years later he won a at in the senate and was re-elected in 1873. He served until 77 when he resigned to make way for his son, JAMES DONALD MERON (1833–1918), who had just completed a brief term as cretary of war in Grant's cabinet. "Don" Cameron not only ok over his father's senate seat but also assumed control of the ate Republican machine—a position and a control that he tained for 20 years.

Upon his withdrawal from the senate, Simon Cameron retired his farm at Donegal Springs, Pa., where he lived until his death, ne 26, 1889.

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CAMERON, VERNEY LOVETT (1844–1894), English plorer in central Africa, the first European to cross equatorial frica from sea to sea, was born at Radipole, near Weymouth, on ly 1, 1844. He entered the navy in 1857, taking part in the Abysnian campaign of 1868 and in the suppression of the east African ave trade. He was selected in 1872 to command an expedition nt by the Royal Geographical society to attempt to make conct with and assist Livingstone and to make independent exorations. But soon after leaving Zanzibar the expedition met vingstone's servants bearing his body. Cameron continued to jiji on Lake Tanganyika and recovered some of Livingstone's pers. He then explored the southern part of the lake and estabhed its outlet by way of the Lukuga river. From there he went est to Nyangwe on the Lualaba, rightly believing this to be the ain stream of the Congo system, but he was unable to procure noes to continue its exploration.

Turning southwest he traced the Congo-Zambezi watershed for ndreds of miles, discovered the sources of the latter river and ally reached the west coast near Benguela, Angola, on Nov. 7, 75. His book *Across Africa* (1877) made suggestions for openg up the continent, and he later claimed to have originated the ea of a "Cape to Cairo" railway. Cameron was promoted comander, made a companion of the Bath and awarded gold medals the Royal and Paris Geographical societies. During the rest his life he was associated with the development of commercial ojects in Africa. He was in the middle east in 1878–79 to dermine the value of an overland route to India, and advocated e building of a railway from Tripoli to Karachi. With Sir chard Burton (*q.v.*) he visited West Africa and was joint author *To the Gold Coast for Gold* (1883). He was killed near ighton Buzzard, Eng., on March 27, 1894, by a fall from his rse.

See Robert Brown, *The Story of Africa,* vol. ii, pp. 266–79 (1893), a summary of Cameron's own account of his journey. (R. M. P.)

CAMERONIANS, those of the Scottish Covenanters (*q.v.*) who followed Richard Cameron (*q.v.*) in adhering to the perpetual obligation of the two Scottish covenants of 1638 and 1643 as set out in the Queensferry Paper (1680). On Cameron's death they began in 1681 to organize themselves in local societies all over the south of Scotland, in 1687 they published *The Informatory Vindication,* and by 1690 they numbered several thousands. Though their three ministers then entered the church of the Revolution Settlement, they themselves for the most part remained outside. In 1706 they again obtained a minister, John Macmillan, through whose active itinerant ministry the name Macmillanite came to supersede Cameronian. In 1743 under his leadership they set up a presbytery at Braehead, calling it the Reformed Presbytery; and as Reformed Presbyterians they not only grew in Scotland but also had a considerable effect on Scottish communities overseas, still refusing to take any part in the civil affairs of an "uncovenanted" nation. In 1863 they decided to refrain from taking disciplinary action on those who intended to exercise the franchise. A minority, however, stuck to the strict interpretation of their principles and still do so. Within Scotland the majority united with the Free Church in 1876 and thus became incorporated in 1929 in the reunited Church of Scotland. (*See* also SCOTLAND, FREE CHURCH OF.)

In the British army the Cameronians (Scottish Rifles) are a direct descendant of the "Cameronian guard," which was first used to restore order in the Highlands after the battle of Killiecrankie (1689).

See J. K. Hewison, *The Covenanters* (1913); M. Hutchison, *The Reformed Presbyterian Church in Scotland* (1893). (H. WA.)

CAMERON OF LOCHIEL, SIR EWEN (1629–1719), Scottish Highland chieftain and a strong supporter of the Stuart cause in Scotland, was the eldest son of John Cameron and the grandson of Alan Cameron, the head of the clan Cameron, which was able to trace its ancestry from the times of King Robert I and King David. Having lost his father in infancy he passed part of his youth with the marquess of Argyll at Inveraray. He left his guardian about 1647 to take up his duties as chief of the clan Cameron, succeeding his grandfather.

In 1653 he was engaged in the earl of Glencairn's rising on behalf of Charles II. In this campaign he won great distinction particularly in his defense of the Pass of Tulloch, at Braemar, against the English forces. For his valour he received a special letter of thanks from the king. After the failure of the campaign Lochiel aided the royalist cause by harassing Gen. George Monck's forces. He came to terms with Monck in 1658, accompanied him to London and was there when Charles II entered the city. He was knighted by Charles in 1681. In July 1689 he was with Viscount Dundee at the battle of Killiecrankie against the forces of William III (a Scots victory, although the rising was soon suppressed). He was too old to join the Jacobite rising in 1715, but his sympathies were with the Stuarts, and his son led the Camerons in battle. He died in Feb. 1719.

Lochiel was of enormous strength and size, and many stories were told of his exploits. Macaulay called him the "Ulysses of the Highlands." It was said, falsely, that he killed, with his bare hands, the last wolf ever seen in Scotland. One who met him when he was 87 reported that "he wrung some blood from the point of my fingers with a grasp of his hand." An incident showing his strength and ferocity in single combat, in which he slew his foe by biting into his neck, was used by Sir Walter Scott as a model for his description of the fight between Roderick Dhu and FitzJames in *The Lady of the Lake* (canto v).

His son and successor, John, attainted for sharing in the rebellion of 1715, died in Flanders in 1748. John's son Donald (*c.* 1695–1748), sometimes called "gentle Lochiel," succeeded his grandfather as head of the clan in 1719. He fought for Charles Edward, the young pretender, and captured Edinburgh in Sept. 1745. He was severely wounded at the battle of Culloden on April 16, 1746, but escaped with the prince to France, where he died in 1748.

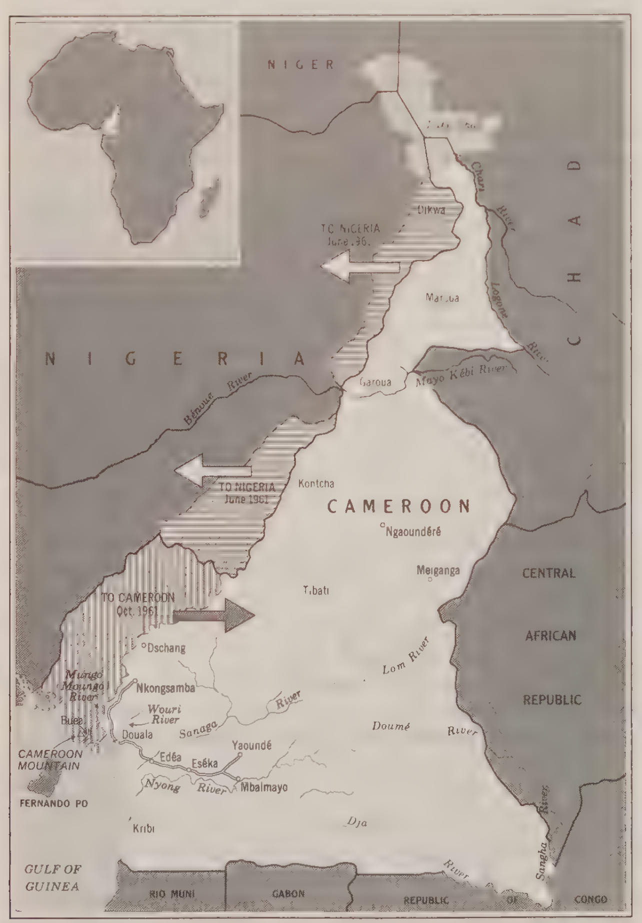
See Bannatyne Club, *Memoirs of Sir Ewen Cameron of Lochiel* (1842); A. MacKenzie, *History of the Camerons* (1884).

CAMEROON, FEDERAL REPUBLIC OF, in West Africa, comprises West Cameroon in which English is spoken and East Cameroon the language of which is French. Roughly triangular in shape, with a total area of 183,591 sq.mi. (475,500 sq.km.), it is bounded west for over 220 mi. (354 km.) by the Bight of Biafra, then by the eastern frontier of Nigeria, north and east by the Republic of Chad, east by the Central African Republic, southeast by the Republic of Congo, and south by Gabon and Equatorial Guinea. The Federal Republic of Cameroon was inaugurated on Oct. 1, 1961, when the former French territory of Cameroun (which achieved independence on Jan. 1, 1960) combined with the former British trusteeship territory of Southern Cameroons.

Physical Features.—Cameroon belongs to the Central African Shield in which two series of rock formation are distinguished: the Precambrian formation, which corresponds to an area of granite-gneiss covering the south and another extending as far as latitude 8° N and to the metamorphic rocks, and a second granitic formation. These ancient terrains have been affected by the so-called "huronian" folds which determine the country's relief.

A great rift valley cuts across Cameroon from Fernando Po to Chad, along which Cameroon Mountain (13,353 ft. [4,070 m.]), Mont Koupé, the Massif du Manéngouba, Monts Bambouto, Alantika, Namebi, and Mandara jut out.

Immediately succeeding the tertiary and quaternary coastal plain are hills, ranging to 2,297 ft. (700 m.) at Yaoundé and from 3,281 to 3,937 ft. (1,000–1,200 m.) at Ngaoundéré before reaching Bénoué Valley. Northward, west of Garoua toward Mokolo, extend Monts Mandara, while to the east a plain runs into Chad.



DISPERSION OF THE CAMEROON REGION AFTER THE PLEBISCITES OF FEBRUARY 1961

The hydrography of Cameroon is divided between the Atlantic Basin with the Wouri River, which waters Douala, the Sanaga River, which rises in Adamaoua, and the Nyong and Ntem rivers; the Niger Basin with the Bénoué River and its tributary Mayo Kébi; the Chad Basin with the Logone River, the lower course of which acts as a frontier with Chad; and the Congo Basin with the Ngoko River, which flows into the Sangha River.

Climate.—Because of its relief and geographical situation between the Gulf of Guinea and Chad, Cameroon—tropical in the north and subequatorial in the south—is subject to an extremely variable climate, or multitude of climates. The harmattan, a dry dust-laden wind, crosses the Sahara to northern Cameroon, and a humid monsoon wind blows from the Gulf of Guinea bringing tornadoes in its wake. Rainfall varies and is substantial in the south. At Manoka at the mouth of the Wouri River, it reaches 252 in. (6.4 m.), at Douala 150 in. (3.8 m.), at Edéa 98 in. (2.5 m.), and at Kribi 118 in. (3 m.). The rest of southern Cameroon has an annual rainfall of some 59–79 in. (1.5–2 m.) with a great deal of rain in October and dry seasons in July and December. In the north a long dry season stretches from November to May followed by rains of 47–63 in. (1.2–1.6 m.).

Temperatures vary from the uniform yearly average of 26° C (78.8° F), with a humidity of 91% at Douala and 95% at Edéa to wide-ranging differences at the frontier with Chad. They are modified by higher altitude, *e.g.*, Ebolowa (24° C [75.2° F]), Yaoundé (23.5° C [74.3° F]), and Batouri (24° C), with minimum readings very much more marked, Ebolowa (11° C), Yaoundé (14° C), and Batouri (10.9° C). Gradually diminishing over the Adamaoua Plateau, temperatures rise again in the Garoua and Maroua regions.

Vegetation.—The contrast between northern and southern Cameroon reflected by the climate and the rivers is repeated in the flora where latitude 5° similarly divides two worlds. In the south there are mangrove forests, primary forests on the banks of the Nyong River, secondary forests, which have sprung up after burning, and gallery forests which run along the rivers. Gallery forest particularly stands out in the first evidences of savanna, with whole expanses of vegetation in the rocks of the Monts Mandara and the hills of the Bamiléké country.

Animal Life.—Elephants and gorillas exist in the south as do the rarer antelopes sitatunga. Short-horned forest buffalo, savanna buffalo (more to the north), bubals, and elks are found between the "cliffs" and Bénoué River; also gazelles, dog-faced baboons, panthers from Mandara, and lions from between Fort-Foureau and Mora. The richness of the fauna is particularly remarkable with anteaters, pangolins, hyraxes (damans), and otter shrews. Insect (among them the tsetse fly) are numerous, as are snakes, many species of which are dangerous.

People.—Numerous prehistoric remains attest the importance and age of settlements in Cameroon, in which pygmies play a very important part. The original inhabitants, sometimes called "Old Bantus," made up of the Beti, or Bati, once stretched as far as the Sanaga River and its tributary, the Mbam, but were ousted by the incursions of the Fang (*q.v.*). The Basso occupy a centra position, while the Bassa and Bakoko inhabit the lower valleys o the Sanaga River. The Bamiléké (*q.v.*), who number more than 400,000 in the mountainous regions, are in a constant state o demographic pressure. In northwest Cameroon the Tikar (*q.v.*) little more than 10,000 strong, cover a vast area. With them may be linked the Bamum (*q.v.*), who came from the upper reaches o the Mbam and who subdued the northern fringe of the Bamiléke country.

Among the most important immigrants are the Duala (Douala (*q.v.*) who came from the upper reaches of the Sangha and who after settling on the banks of the Dibamba, reached the coas along which they spread to halfway between Cameroon Mountain and the Calabar. The Maka and Djem also reached the coast.

The Pahouins, who number more than 700,000, make up one of the most important ethnic groups. Originating near the upper reaches of the Sanaga, they began to be forced southwes by Fulani (*q.v.*) invaders a century before the arrival of the firs European explorers.

In the north some of the so-called Kirdi came from the east take refuge in the Monts Mandara. Apparently the Mbom, Ioundang, Fali, and, near Chad, the Sao-Kotoko, established ingdoms which were transformed in the 18th and 19th centuries y the arrival of Muslims in the north.

History to 1922.—It was probably the Portuguese navigator ernão do Pó who discovered the shore and estuary of the Wouri iver to which its abundance of prawns gave the name Rio dos amarões, of which the Spanish form Camerones prevailed to ive the German Kamerun, the English Cameroon, and the French ameroun.

Dutch settlers followed the Portuguese into the region to be hemselves succeeded by the English, who came with antislavery ruisers at the beginning of the 19th century. Liverpool and ristol companies anchored pontoons to the banks of the Wouri serve as shops, and in 1832 John Beecroft established a busiess at Bimbia. In 1849, when the Spanish occupation of Fernando o seemed likely, Beecroft was appointed consul and representave of the king to the Bights of Benin and Biafra, and actively ngaged in negotiations with local chiefs.

In February 1845, the Baptist missionary Alfred Saker (1814–0) settled in Cameroon and on April 29, 1852, signed with ohn Beecroft and King Akwa and Charles Dido a treaty which oreshadowed the abolition of slavery, the prevention of human acrifice, the granting of religious liberty, and the protection of issionaries. In order to settle differences between chiefs and uropeans in 1850 the British set up the Court of Equity which ter adapted itself to French and German rule. In 1858, when ie strictures of Catholic Spain began to affect the Protestant amaicans in Fernando Po, Saker installed them at Ambas (which called Victoria) and founded many more settlements, notably Deido and Bonabéri. He also succeeded in transcribing the uala language.

In 1868 the Woermann Company of Hamburg built a warehouse the estuary, an example soon followed by several other firms, nd from 1874 (when the Duala were seeking British protection nd the Malimba had already concluded a treaty with France) ben to demand the appointment of a German consul. Despite the ipport of British businessmen, requests for British protection ade by Duala chiefs in 1882 were forestalled by the German eaty of July 16, 1884, between King Bell and Gustav Nachtigal *q.v.*). An English annexation mission led by Commodore Hevett as similarly belated. German occupation marked by the appointent of Max Buchner as consul had little effect on Britain and rance but locally took a far more serious turn. On Dec. 15 the iefs of Jos and Hickory, seeing themselves partially dispossessed, tacked Bell's village and took down the German flag. Three ays later Adm. Knorr arrived in the "Bismarck" and took so ern a reprisal that Woermann's representative was murdered and s mutilated body thrown into the river. Baron von Soden, who as appointed governor of Cameroon on July 4, 1885, with Jesko on Puttkamer his successor, set up the first administrative divions and organized explorations. The French renounced their ghts as far as the Campo River with the Berlin Agreement of ec. 24, 1885, while on May 7, 1886, Britain agreed to the transfer Victoria to Germany in exchange for St. Lucia in South Africa nd Forcados in the Niger Delta.

The expeditions of such early explorers as Dixon Denham (*q.v.*), ho was probably the first to cross the interior in 1823, Heinch Barth (*q.v.*), and Adolf Overweg, who visited Adamaoua in 351, and the Rev. George Grenfell (*q.v.*), with those of their erman and French successors helped Germany to define new ontiers with Britain on Oct. 15, 1893, and with France on Feb. 1894. Furthermore, in 1911, in return for assenting to France's otectorate over Morocco, Germany absorbed some 105,000 .mi. (272,000 sq.km.) of former French Equatorial Africa to nstitute the territory of Neu Kamerun. The German adminration did not, however, have time to get into its stride. When e territorial borders were defined in 1913 the governor had no eans of enforcing his decisions. The recruitment of soldiers in ahomey and Nigeria had serious effects and the ensuing mutiny gendered the Kaiserliche Schutztruppe, a police force which dominated the country, although its western regions were not entirely subdued until the second half of the century.

HECTOR ACEBES—PHOTO RESEARCHERS, INC

THATCH-ROOFED HUTS ON A HILLSIDE NEAR THE VILLAGE OF RUMSIKI

Initially, chiefdoms were reinforced, a system of indirect administration was set up, and concessions were granted to commercial companies. The Gesellschaft Sud Kamerun governed the south and the Gesellschaft Nord-West Kamerun controlled the territories of the Bamiléké and the Bamum.

However, the number of officials increased, and direct administration to a large extent replaced indirect administration, which was, however, maintained in the Muslim regions of the north.

In World War I joint action by French and British troops forced the Germans to retreat to Spanish Guinea, where they were confined. Early in March 1916 a temporary partition, which gave France about nine-tenths of the territory, was agreed upon, and the section adjoining Nigeria came under British control. On July 10, 1919, the Cameroons was formally divided by the London Declaration signed by Great Britain and France. In 1922 the League of Nations conferred mandates on France and Britain for the administration of the two zones on which they had previously agreed, subject to the supervision of the League's Permanent Mandates Commission, and on July 20, 1922, the mandates were approved by the Council of the League of Nations.

Although the administration of the British Cameroons was integrated with that of Nigeria, French Cameroun constituted a separate entity and the former German Neu Kamerun was returned to French Equatorial Africa.

British Cameroons.—The British trust territory consisted of a strip of land bisected by the Bénoué River along the eastern border of Nigeria. The capital of Southern Cameroons was Bouéa while Northern Cameroons comprised the Tigon-Ndoro-Kentu region, the Adamaoua districts, and Dikwa in the extreme north.

Although the area allotted to Great Britain in 1919 was small, it nevertheless contained most of the German plantations (bananas, rubber, palms, and cocoa). These were reclaimed by their owners in 1924, but were sequestered at the outbreak of World War II. After World War II, the Nigerian government absorbed them into the Cameroons Development Corporation, which employed several thousand workers and played an important part in the prosperity of Southern Cameroons.

French Cameroun.—The administrative system of French Cameroun was based on that of other territories in French Equatorial Africa. Residing in the capital, Yaoundé, a commissioner (later high commissioner) with the rank of governor, assisted by a secretary-general, initiated and coordinated all governmental activities. The country was divided into 18 administrative regions which were themselves made up of further subdivisions. Its elected territorial assembly exercised wide powers. Personnel remained in the country for some time, thus assuring administrative continuity. Sleeping sickness was eradicated. Education along French lines was vigorously pursued. During World War II the territory joined the Free French Movement in August 1940 and Douala was for a time the headquarters of Gen. Charles de Gaulle.

On Dec. 13, 1946, the first General Assembly of the UN approved Cameroun's status as an "associated territory" within the French Constitution of 1946 which instituted ARCAM (Assemblée Représentative du Cameroun). This body approved taxes and controlled almost all aspects of the territory's life. As the electoral body increased, from 16,088 in 1946 to 685,059 in 1956, this assembly, composed of 40, then 50 or more members, became the voice of the people and the representative of diverse ethnic groups. In 1952 it was transformed into ATCAM (Assemblée Territoriale du Cameroun) and in 1957 was reformed into ALCAM (Assemblée Législative du Cameroun).

From 1941 the municipal regime applied to two urban communities, then to five others in 1947 and 1950, and in 1952 was extended to all urban and rural areas of Southern Cameroun in an initiative unique in Africa. Cameroun's constitution, approved by a decree of the Legislative Assembly on April 16, 1957, provided for the transfer of power to a legislative assembly with finance, defense, and the diplomatic service the remaining responsibilities of the tutelary power. The government presided over at that time by André Marie Mbida wielded executive power. In March 1959 the UN adopted the French proposal to end its trusteeship and on Jan. 1, 1960, the territory of Cameroun became the Republic of Cameroun.

Republic of Cameroun.—Political life did not really begin to take shape until the end of World War II when first JEUCAFRA (Jeunesse du Cameroun Français), then UNICAFRA (Union du Cameroun Français), later RACAM (Rassemblement Camerounais), were formed. In April 1948 the Cameroun section of the Rassemblement Démocratique Africain (RDA) took the title of the Union des Populations du Cameroun (UPC). In 1955 an extremist splinter group of the UPC led by Ruben Um Nyobé whipped up unrest in Douala but failed to prevent the northern peoples from regrouping into the Bloc des Démocrates Camerounais (BDC) of Ahmadou Ahidjo. In 1958 Ahidjo founded the majority party Union Camerounaise and in February 1958 assumed governmental control. After independence had been achieved on Jan. 1, 1960, the constitution was approved by 60% of the electorate on Feb. 21, 1960, and on April 10 the National Assembly was elected with Ahidjo's party in majority.

The Federal Republic.—In the British Cameroons the question of reunification was put to a plebiscite. On Feb. 11, 1961, the northern regions voted in favour of joining the Federation of Nigeria and the Southern Cameroons decided to join the Cameroun Republic, which then, on Oct. 1, 1961, became the Federal Republic of Cameroon. The federal capital is Yaoundé.

Administration and Social Conditions.—The lay, social, federal republic which came into force on Oct. 1, 1961, provides for an executive president, a vice-president, and a cabinet of nonparliamentary members. The president is simultaneously chief of state and commander of the armed forces. He is elected for five years and may be reelected. The National Federal Assembly, which is elected to a five-year term by universal adult suffrage, comprises 40 representatives for East Cameroon and 10 for West Cameroon. Two annual parliamentary sessions, each of 30 days, allow the deputies to approve federal laws by a simple majority vote. The first federal elections took place on April 26, 1964.

Despite such difficulties as unrest in the Bamiléké country in the late 1960s, the authority of President Ahidjo was considerably reinforced and in March 1970 he was reelected to his third five-year term.

In the late 1960s the total population exceeded 5,100,000 with East Cameroon 4,050,000 and West Cameroon 1,050,000: 37% of the population was aged less than 15, 38% from 15 to 40, and 25% 40 or more. The population density of West Cameroon was 24 inhabitants per square mile, that of East Cameroon 9.5: 80% of the population was rural. The most important towns were Douala (210,000), Yaoundé (110,000), and Nkongsamba (50,000).

Area and Population of Cameroon

Department	Area (sq.km.)*	Population (1964 est.)	Capital
East Cameroon			
Nyong and Sanaga	29,000	465,000	Yaoundé
Wouri	1,200	125,000	Douala
Adamaoua	67,000	180,000	Ngaoundéré
Bambouto	1,100	86,000	Mbouda
Bamoun	7,500	102,000	Foutan
Bénoué	61,600	280,000	Garoua
Boumba Ngoko	42,000	42,000	Yokadouma
Diamaré	8,900	300,000	Maroua
Dja and Lobo	21,000	98,000	Sangmélima
Haut-Nkam	1,200	77,000	Bafang
Haut Nyong	39,100	83,000	Abong Mbang
Kribi	13,000	60,000	Kribi
Logone and Chari	8,800	82,000	Fort Foureau
Lom and Kadir	50,000	56,000	Batouri
Margui Wandala	7,200	286,000	Mokolo
Mayo Danal	4,900	150,000	Yagoua
Mbam	31,900	104,000	Bafia
Ménoua	1,000	125,000	Dschang
Mifi	1,200	160,000	Bafoussam
Mungo	4,500	160,000	Nkongsamba
Ndé	2,100	66,000	Bangangté
Nkam	5,000	41,000	Yabassi
Ntem	15,700	100,000	Ebolowa
Nyong and Kélé	6,000	85,000	Eséka
Sanaga Maritime	1,800	120,000	Edéa
West Cameroon	42,900	850,000	Bouéa
districts: Victoria, Kumba Bamenda, Wum			

*1 sq.km. = 0.386 sq.mi.

Approximately 40% of the population observed traditional b liefs. From 35 to 40% were Christian (Catholic 1,000,000 ar Protestant 400,000) and from 20 to 25% were Muslims, most them in the north.

In the late 1960s, of the 2,900,000 people of working ag 1,350,000 were men and 1,550,000 were women. East Camerou had only 100,000 salaried workers, 50,000 of whom were wome although the figure was increasing in the private sector, especial in the number of teachers.

The educational standard was among the highest in Africa. 1966–67 approximately 634,000 children were educated at primar schools, 345,000 of them privately. In secondary schools the were 28,600 students, 19,500 of whom had private tuition, a 8,100 technical students, 5,700 of whom were privately educate 60% of the children of school age were educated.

The central establishment for further education at Yaoun was soundly based in the late 1960s with more than 500 student 1,000 or so students continued their studies in France.

Claims to an authentic national literature were substantiat by more than 40 indigenous writers, among them Mongo Beti, ar by the bilingual cultural review *Abbia*.

Economy.—The physical diversity of Cameroon is reflected the variety of its agricultural production. Subsistence farmi consists of marabo and taro in the south, manioc in the cent maize in the west, and in the north millet and more recently ric

The discovery of bauxite near Edéa encouraged aluminum p duction, particularly after the foundation of ALUCAM on De 23, 1954. Almost entirely exported before 1966, from 1967 o ward part of the produce was laminated locally in order to man facture sheet metal (socatral) and household products (alubassa All industrial expansion in Douala is fed by current from t Sanaga River dam. A project was also under way for anoth dam at M'Cakou-Tibati 435 mi. (700 km.) from Edéa.

Almost all exports go to France. In 1964 Cameroon export some 50,000 tons of cocoa, 70,000 tons of wood, 250,000 to of bananas, 110,000 tons of coffee, and 17,000 tons of oil produc

In August 1969 the French franc was devalued by 12.5%: CFA franc = 0.02 French francs; 277.71 = U.S. $1.

Except for the western regions in which cotton is grown, mo produce is grown in the south where a railway system exten from Douala to Nkongsamba and from Douala through Yaoun and Otélé to Mbalmayo.

The roads extend for over 12,117 mi. (19,500 km.) in Ea Cameroon, 578 mi. (930 km.) of which are bituminized. In We Cameroon they stretch for over 2,010 mi. (3,235 km.) with 211 m (340 km.) bituminized. The economy made a fresh start wh the Union Douanière et Économique de l'Afrique Centra (UDEAC) and the Transcameroon rail routes made it possible port produce from Chad and the Central African Republic.

In 1966 a second five-year plan established programs in line ith a planned liberal economy. (Ro. C.)

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Current history and statistics are summarized annually in the *ritannica Book of the Year.* (X.; Ro. C.)

CAMILLO, SAINT, de Lellis (Camillus of Lellis) 550–1614), founder of the Ministers of the Sick, was born at ucchianico in the Abruzzi, Italy, son of an impoverished noble- an, on May 25, 1550. He became a soldier of fortune and was inveterate gambler. In 1575 he was converted and became a rvant and later an assistant at St. James's hospital for incurables Rome, where he had himself been a patient with the ulcerated g and the rupture which impeded him all his life. As in all hos- tals of the period, conditions were appalling: dirt, neglect and en cruelty on the part of the paid attendants. Camillo was dained in 1584, and in 1586 he obtained approval for the con- egation of priests he had founded, devoted to hospital service. first there were 12 members, without vows, working in the spital of the Holy Spirit, but in 1591 they became a congrega- m of vowed religious clerks regular, called Ministers of the Sick Iinistri degli infermi), wearing a red cross on their cassocks.

Camillo was general of the order until 1607. He insisted on e utmost care for both soul and body of his patients. Though s own health grew worse, he spent himself in superhuman efforts. hen he died in Rome on July 14, 1614, there were nearly 300 his order. He was canonized in 1746, and his feast day is July . Members of St. Camillo's order were nursing on the battle- ld of Solferino (1859) when J. H. Dunant conceived the idea the Red Cross.

See C. C. Martindale, *Life of St. Camillus* (1946). (E. I. W.)

CAMILLUS, MARCUS FURIUS (d. 365 b.c.), Roman ldier and statesman who held a triumph four times, was five nes dictator and was honoured as the second founder of Rome. s greatest victory was as dictator in 396 b.c. when he conquered e Etruscan city of Veii (*q.v.*): he dedicated to Apollo in the asury of the Massiliotes at Delphi a golden bowl which survived o later times. In 394 he reduced Falerii (mod. Civita Castel- na), contemptuously rejecting the proffered treachery of a liscan schoolmaster. Exiled for misappropriating some booty, millus is said to have withdrawn to Ardea until he was appointed tator when the Gauls had captured Rome (390). He is said have raised an army and defeated them (and even recovered e gold with which the Romans had bought them off), but his tory was probably invented to counterbalance Rome's defeat the Gauls at the Allia river in 390. He is said also to have op- sed a proposal that the Romans should migrate to Veii. There- er he fought successfully (possibly as a result of some reforms the army) against the Aequi, Volsci, Etruscans and Gauls. ough a patrician (he had, in the interest of the patricians, de- ated the rising of M. Manlius), he was not a diehard; he intro- ced pay for the army at the siege of Veii, and realizing the need make concessions to the plebeians, he accepted the Licinian- xtian laws in 367 (*see* Roman History). Although Roman iters may have exaggerated his achievements, Camillus clearly yed a predominant role in Rome's recovery in the decades er the Gallic sack of the city.

See Plutarch, *Lives*, "Life of Camillus"; R. M. Ogilvie, *A Commen- y on Livy, Books 1–5* (1965). (H. H. Sd.)

CAMILLUS and **CAMILLA,** terms of uncertain derivation used in ancient Rome, originally for freeborn boys and girls, later for the attendants on certain priests and priestesses, especially the *flamen Dialis*, the major priest of Jupiter. Such attendants had to be freeborn, under the age of puberty and have both parents alive. They could be children of the priests or priestesses they served.

See Festus, *De verborum significatu*, 93, 2 and 3; Dionysius of Halicarnassus, *Roman Antiquities*, 11, 22.

CAMINO, DA (Caminesi), an Italian feudal family of the middle ages who ruled for a time in Treviso and adjacent towns. They were probably related to the Collalto, counts of Treviso, and possessed many fiefs—imperial, episcopal and others—in the mark of Treviso, notably in the districts of Belluno, Cadore and Ceneda, of which they became counts. By 1200 they had submitted formally to the commune of Treviso and been accepted as citizens, but since they retained and even increased their feudal patrimony they soon claimed a prominent place among the ruling families of the city, assuming leadership of the Guelf faction. Had it not been for the rival presence of the Ghibelline Da Romano family, the Caminesi might have come to dominate straightway. As it was they first seized power in 1283, after a street fight which ended in defeat for the Ghibellines. With the support of the Collalto and the Avogari (hereditary advocates of the bishop of Treviso), Gherardo da Camino, count of Ceneda and from 1265 captain general of Feltre and Belluno, was then elected captain general of Treviso as well. Gherardo's government was later condemned as tyrannical, especially because of heavy taxation, but that of his son Rizzardo II, who succeeded him on his death in 1306, provoked revolt. In 1311 Rizzardo purchased the office of vicar of Treviso from the German king (later emperor) Henry VII, after which he dropped the popular title of "captain" and began to favour the Ghibellines. This offended the Guelf families and was partly responsible for his murder in April 1312. His brother Guecellone VII, count of Ceneda, who took his place, proved no more acceptable and was expelled in Dec. 1312 at the instigation of the Collalto and the bishop. In 1313 he also lost Feltre and Belluno. By the 15th century the family had died out in all its principal branches.

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(P. J. J.)

CAMISARDS, the name given to the French Protestant peasantry of the Cévennes and of Bas-Languedoc who from 1702 to 1705 and for several years afterward carried on an organized military resistance to the government's revocation of the Edict of Nantes. The Camisards (from Languedocian *camisa*, "shirt"; Fr. *chemise*) were so called either because they wore a white shirt over their ordinary clothes for recognition purposes in night fighting, or because, out of concern to symbolize purity, they made a point of changing their linen whenever they halted at a village. They were also called Barbets ("water dogs," a term also applied to the Waldenses), Assemblants, Fanatiques and Houssards or Ozards (as the Hungarian rebels of the same period, led by Ferencz Rakoczy II, were sometimes called "hussars"). They belonged to that Romance-speaking people who made the south of France the most fertile nursing ground of heresy in the middle ages (*see* Cathari).

In 1686 the pastor Pierre Jurieu had published in Rotterdam his work *L'Accomplissement des prophéties* and his *Lettres pastorales*, a series of brief tracts which were secretly circulated in France.

Speaking of the Apocalypse, Jurieu predicted the end of the persecution of the Huguenots and the fall of Babylon, by which he meant Roman Catholicism, for 1689. The revolution in England seemed a striking corroboration of his prophecies, and apocalyptic enthusiasm took a strong hold on people's minds. In Dauphiné (1688) and in Vivarais (1689) children took to prophesying and whole crowds fell into convulsions and paroxysms of sobbing.

Twelve years later this strange illuminism reappeared in the valley of the Ardèche. In spite of ruthless repressive measures it spread with extraordinary rapidity among the Protestants of

Bas-Languedoc and of the Cévennes, whom the intendant Nicolas Lamoignon de Basville was treating with increasing severity. From appeals to repentance the enthusiasts proceeded to swearing revenge, and the "awakening" gave way to revolt. On the night of July 24, 1702, about 40 Cévenols released some young Protestants from the prison at Pont-de-Montvert and assassinated the abbé du Chayla (François Anglade), whom they considered as an odious torturer. They then went through the Cévennes, setting fire to churches and massacring "wicked priests." Their first leader, Esprit Séguier, was caught and burned alive (July 28).

Séguier was succeeded by Gédéon Laporte, an old soldier who, as his troop increased, assumed the title of "colonel of the children of God" and named his camp "the camp of the Eternal." He would lead his followers to battle singing Clément Marot's version of the 68th psalm, "Que Dieu se montre seulement," to the music of Claude Goudimel. The movement was essentially a popular one, its leaders including the goatherd André Castanet, the wool carders Abraham Mazel and Jacques Couderc and the soldiers Catinat (Abdias Maurel, who assumed the name of the great marshal Catinat), Nicolas Jouany and Laurent Ravenel. A sheep gelder, Pierre Laporte, Gédéon's nephew, born at Mas-Soubeyran, proved a determined and astute commander in chief in the Basses-Cévennes, his continual changes of position earning him the nickname of "Pierre Roulante" (rolling stone), abbreviated to Roland or Rolland. Jean Cavalier (*q.v.*), a baker's boy, operated mainly in the lower country; a born strategist, he pinned down successively the armies of Victor Maurice de Broglie and the marshal de Montrevel (N. A. de La Baume). Regular taxes were raised, arsenals were formed in the great limestone caves of the district, the Catholic churches were burned and sometimes the clergy were driven away. Occasionally routed in regular engagements, the Camisards, through their desperate valour, clever tactics and rapid movements, were constantly successful in skirmishes, night attacks and ambuscades. The rising was far from being general and never extended to more than 4,000 or 5,000 men, but was made dangerous by the support of the people, whether secret or, as it sometimes was, open. Their knowledge of the mountainous country, covered with forests and without roads, gave the insurgents an enormous advantage.

Montrevel adopted a policy of extermination. Women and children perished in the flames at Moulin de l'Agau near Nîmes (April 1703), and 466 villages were burned in the Hautes-Cévennes alone, the population being for the most part put to the sword (Oct.–Dec. 1703). Recruited mainly at St. Florent (whence the term Florentins), the Catholic militiamen, who took a white cross as their emblem, intensified the massacres and the pillaging. Appointed commandant in Languedoc on March 27, 1704, the marshal de Villars took advantage of the feelings of horror with which the quiet Protestants of Nîmes and other towns regarded the war. The Huguenot baron d'Aigaliers (Jean Jacob de Rossel), undertook to negotiate. Cavalier, who made his submission at Nîmes (May 16, 1704), demanded a large measure of toleration, but Louis XIV granted only an amnesty, giving the rebels the choice of entering the king's forces or of leaving the country. Most of the Camisards, insisting that the Edict of Nantes should be restored, continued the war. Then Roland was betrayed and killed (Aug. 1704), Jouany surrendered and Ravenel was executed in the sanguinary crushing of the so-called Conspiracy of the Children of God in April 1705. Mazel, having escaped into Switzerland, returned to Vivarais in July 1709 where he made a vain effort to rekindle the revolt. After his death (Oct. 1710) the last of the Camisards were either captured or dispersed.

Shaken by violent convulsions, the prophets of the Cévennes would fall into ecstasies and utter words which they believed to be inspired by the Holy Ghost. The supernatural was part of their life: lights in the sky guided them to places of safety and voices sang encouragement to them. Yet the Camisards were not all visionaries or fanatics, and the prophetic influence, often exaggerated, diminished greatly during the course of the war.

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CAMMAERTS, ÉMILE (1878–1953), Belgian poet and writer who as a vigorous royalist interpreted Belgium to the British public, was born in Brussels on March 16, 1878. When he was 30 he settled in England and his writings on English and Belgian themes included translations of John Ruskin and G. K. Chesterton into French, *Discoveries in England* (1930), *The Laughing Prophet: the Seven Virtues and G. K. Chesterton* (1937) and *Albert of Belgium, Defender of Right* (1935). During World War I he became known for his poems among which were *Chants patriotiques et autres poèmes* (trans. as *Belgian Poems*, 1915) and *Poèmes intimes* (1922). In 1947 he was made professor emeritus of Belgian studies and institutions at London university. His enthusiasms also embraced nonsense verse, art and religion, on which he wrote *The Poetry of Nonsense* (1925), *Rubens, Painter and Diplomat* (1931), *Flemish Painting* (1945), *The Cloud and the Silver Lining* (1952), etc. He died at Radlett, Hertfordshire, on Nov. 2, 1953.

CAMÕES (Eng. CAMOËNS), **LUÍS VAZ DE** (1524–1580), the greatest of Portuguese poets, was born in Lisbon, according to the expression *natural deste cidade* ("native of this city") used in 1613 by Pedro de Mariz, his first, but ill-informed, biographer. In 1607, however, Domingo Fernandes, the bookseller, had dedicated his edition of the poet's *Rimas* to the University of Coimbra, stating that Camões was born in Coimbra. Successive biographers of various nationalities have enshrouded the little that is known of his life in a bewildering complexity of fantasy and theory unsupported by concrete evidence. A noteworthy exception is the date generally accepted as that of the poet's birth, 1524, which was deduced from the records of the Casa da Índia brought to light in the 17th century by Camões' over-zealous commentator, Manuel de Faria e Sousa. The most important document extant, however, is the *Carta de perdão a Luís de Camões*, granted in Lisbon on March 7, 1553. This states that the poet was *mancebo* ("a young man"), a gentleman of the king's household and the son of Simão Vaz; that he was then living in Lisbon but was very poor and was going that year to serve in India. He had been arrested for inflicting a sword wound on Gonçalo Borges, one of the king's servants, on the Feast of Corpus Christi, and the *Carta* announced his pardon.

Of Simão Vaz, the poet's father, little is known. He was long confused with his cousin and namesake, whose life is fully documented, and who was the son of João Vaz of Vila Franca, whereas Camões' father, according to Pedro de Mariz, was the son of Antão Vaz de Camões and D. Guiomar Vaz da Gama, of the well-known Algarvian Gamas. The same biographer described Camões mother as a gentlewoman of Santarém, Ana de Macedo, but othe documents give her name as Ana de Sá. The earliest record of a Camões yet discovered relates to Vasco Pires de Camões, a Galicia gentleman who settled in Portugal during the reign of King Ferdinand and fought for the latter's unpopular widow during the conflicts preceding the accession of King John I. If the genealogy is reliable, he was the poet's great-great-grandfather.

The tradition that Camões studied in Coimbra has persiste unchallenged and the sonnet "Doces e claras águas do Mondego," and, even more, the *canção*, "Vão as serenas aguas/do Mondego descendo," bear adequate testimony to his having lived there He did not, however, study under Bento de Camões, another so of João Vaz, as was at one time thought, for it has now been prove that the Bento who was the first chancellor of the university an the first prior of the famous Augustinian College of Santa Cruz an who died in 1547 was Bento de Almeida or de Abrantes and tha Bento de Camões did not become an Augustinian monk until 154 It seems unlikely, therefore, that he could have had any influenc on the poet's development, even if the latter were still in Coimbra in 1545.

After finishing his studies Camões went to Lisbon and entered court circles under the patronage of the Conde de Linhares, D. Francisco de Noronha, whose son, António, was his friend and perhaps his pupil. Sometime later, having chosen a military career, he set out for North Africa where he lost an eye. Because of his reference to the *furia rara de Marte* in his well-known *canção*, "Vinde cá, meu tão certo secretário," it has been concluded that he lost it during a battle. From the elegy, "Aquela que d'amor descomedido," it has been deduced that he spent part of this period at Ceuta. His *fuga* ("flight") from Lisbon inspired his earliest biographers to create the hypothesis of a Camões exiled from the court by love. Commentators who allow their imagination to outrun their critical sense will always be able to subscribe to it because in the poems of this period Camões frequently uses the word *desterro* ("banishment") and describes with poignant sincerity the sufferings caused by love.

He returned to Lisbon but in 1553 he was again overseas, this ime in India. A letter written after the premature death of D. António de Noronha at Ceuta on April 17, 1553, proves that he went there shortly after receiving the *Carta de Perdão*. In this etter, Camões alludes to the 3,000 days of venomous tongues, worse deeds and biting calumnies, all born in pure envy, that he had spent in Lisbon, and congratulates himself on having known how to escape from the many snares that circumstances laid for him. He adds that in India he finds himself more honoured than the bulls of Merceana and in a quieter atmosphere than that of a preaching friar's cell. His first impression of India was that it was an indulgent mother to the unworthy and a cruel stepmother o the worthy. With time, the impression must have deepened.

He had arrived in Goa after what he describes as six months of very unpleasant life at sea and had to embark again almost immediately with the viceroy to make war on the *Rei da Pimenta* in Malabar. Reference is made to this event in his elegy, "O Poeta Simónides falando." He also took part in one of the expeditions ent to the Straits of Mecca (Bab el Mandeb) according to his most famous *canção*, "Junto de um sêco, fero e estéril monte." Later he was appointed *provedor-mor dos defuntos e ausentes* official responsible for the property of dead and absent Portuuese) in China, but was almost forcibly deprived of this position y the captain of a boat who had previously held it and who tried o take him back to Goa under arrest. Camões escaped this fate s a result of the shipwreck at the mouth of the Mekong river to which he refers in Canto X, stanza 128 of his epic, *Os Lusíadas*. n the same stanza he alludes to the *Injusto mando* ("unjust command") which has baffled all his commentators.

In 1570, Camões was on his way home to Portugal, having served nder no less than eight viceroys or governors while he was in ndia, and just as poor as when he had left Lisbon. He lived for some time in Mozambique where he was visited by the chronicler, Diogo do Couto, who described him as so poor that his friends had to give him food. To enable him to embark for home they had to gather together the clothing he needed and, probably, to pay some debts. He took back with him the manuscript of *Os usíadas* which he had only with great difficulty saved from the hipwreck. In Lisbon there were still vestiges of the plague hich had ravaged the city during the previous year but this did ot deter Camões who had *Os Lusíadas* to publish. This he chieved in 1572, afterward receiving a pension of 15,000 reis, hich was not as paltry as has been suggested by some of his ographers, and was transferred to his mother after his death n June 10, 1580, in Lisbon. According to Pedro de Mariz, he as buried in the church of Santa Ana.

Camões' poetical works may conveniently be discussed under hree headings: lyric, epic and dramatic. (There was also a manuript entitled *Parnasso de Luís de Camões* on which the poet had orked during the winter of 1568–69 in Mozambique. It was decribed by Diogo do Couto, who later tried in vain to trace it, as a ook of much learning.)

The first edition of Camões' *Rimas* was published in 1595, 15 ears after his death. The editor, Fernão Rodrigues Lobo Soropita, had exercised scrupulous care in collecting the poems from manuscript songbooks, but even so he could not avoid the inclusion of some apocryphal poems. The increasing fame of Camões' epic during the political crisis of 1580 to 1640 also swept the lyrics into fame and in the 17th century many efforts, not all of them praiseworthy, were made to unearth more poems. Prominent in this enterprise, but in a manner condemned by modern criticism, was Manuel de Faria e Sousa. Even in the 19th century, the Visconde de Juromenha added to the already excessive collection of lyrics, introducing into his edition of 1860–69 many poems from the songbooks, which were still comparatively unstudied. As a result the sonnets increased from 65 in the first edition to 352 in the Juromenha edition; the *canções* from 10 to 21; the *sextets* from 1 to 5; the odes from 5 to 14; the octets from 3 to 9; the eclogues from 8 to 16; the elegies from 3 to 29; the *redondilhas, motos, esparsas* and *glosas* from 74 to 147. From 170 in the first edition, the number of poems had risen to 593 by 1860.

With Wilhelm Storck, and more especially with Carolina Michäelis, in the late 19th and early 20th centuries there began a critical reaction which led to the elimination of many apocryphal poems. Although a complete restoration of Camões' lyrics appears impossible, scholars continue the work of purifying the texts. Fortunately there are sufficient authentic poems to confirm his position as Portugal's finest lyric poet. If he had remained at court, he would not have reached this high pinnacle despite his consummate artistry. But he exchanged the vanity of court life for the hardships of a soldier's life in Africa and India and this immeasurably enriched his poetry. For he no longer needed to conform to the standards of brevity required in court circles, and, more important still, so profound was the anguish he experienced because of his exile from home and the trials he underwent, that it became an integral part of his being, enabling him to give to *saudade-soledade* ("yearning fraught with loneliness") a new and convincing undertone unique in Portuguese literature. His best poems vibrate with the unmistakable note of genuine suffering and deep sincerity of feeling. It is this which places him far above the other poets of his era.

Although the *canções* and elegies give the poet's true measure, the *redondilhas* must not be underestimated. In the production of these elegant trifles Camões was inimitable. He rejuvenated the ancient art of glossing by the apparent spontaneity and simplicity, the delicate irony and the piquant phraseology of his verses, and so raised courtly grace in poetry to its highest level. These poems show a Camões who could be happy and carefree.

In their efforts to discover who inspired most of Camões' poems, critics have made, on very slender grounds, many contradictory suggestions, *e.g.* Isabel Tavares, D. Catarina de Ataíde, D. Francisca de Aragao, the Infanta D. Maria and a young Chinese girl said to have been shipwrecked with him, but the real muse, if the poet had one, remains an enigma. Nor should it be forgotten in trying to resolve the doubt that he himself said in one of his sonnets, "em várias flamas variamente ardia" ("I burnt myself at many flames").

Camões' epic, *Os Lusíadas* ("The Portuguese"), published in Lisbon in 1572, extols the glorious deeds of the Portuguese and their victories over the enemies of Christianity: victories not only over man, but also over the forces of nature motivated by inimical gods. From the 17th century onward, critics have censured Camões for using pagan mythology in a poem exalting the deeds of Christians. Some have claimed that it has an allegorical significance, while Voltaire, in the 18th century, set the tone for neoclassical criticism. Camões was undoubtedly thinking of the *Aeneid* when he conceived the idea for his poem, but in *Os Lusíadas* Bacchus intervenes because he fears that immortality itself is in peril, while Venus, helping the Portuguese, seeks to prolong it by causing them to land on her island and marry her nymphs. The new Argonauts and their progeny will supersede the ancient gods who are only men whom Fama immortalized by blazing abroad their noble deeds (Canto IX, 91–92).

The courage and enterprise of Portuguese explorers had inspired the idea of a national epic during the 15th century but it was left to Camões in the 16th century to put it into execution. It is impossible to say for certain when he decided to do so or when he actually began his epic. He wrote the dedication to Sebastian, however, during the prince's minority which ended on Jan. 20, 1568, and, according to Diogo do Couto, was revising his poem during the winter of 1569–70 in Mozambique. The royal licence permitting printing and granting copyright is dated Sept. 24, 1571.

The poem describes the discovery of the sea route to India by Vasco da Gama. After being saved from Mombaça's treachery, the voyagers spend several days in Melinde on the east coast of Africa, and, at the king's request, Vasco da Gama relates the entire history of Portugal from its origins to the inception of their great voyage (Cantos III, IV and V). These cantos contain some of the most beautiful passages in the poem: the death of Inês de Castro, the battle of Aljubarrota, the vision of King Manuel I, the Velho do Restelo, the description of St. Elmo's fire and the waterspout, and the story of Adamastor, a supremely beautiful poetical conception.

When they re-embark the poet takes advantage of leisure hours on board to narrate the story of the Doze de Inglaterra (Canto VI, 43–69). In the meantime, Bacchus, ever ready to impede the progress of the Portuguese in the east, convokes a council of the sea gods and incites them to arrange the shipwreck of the Portuguese fleet. This is prevented by Venus (Canto VI, 85–91) and Vasco da Gama is able to reach Calicut, the end of his voyage. There his brother, Paulo da Gama, receives the king's representative, the *Catual*, on board and explains the significance of the characters depicted on the banners that adorn the captain's ship (Cantos VII and VIII). On their homeward voyage the mariners chance upon the island which Venus has created for them and the nymphs reward them for their labours. One of the nymphs sings of the future deeds of the Portuguese (Cantos IX and X) and the entertainment ends with a description of the universe (Ptolemaic system) given by Thetis and Vasco da Gama, after which the sailors embark once more and the nymphs accompany them on their homeward journey.

In *Os Lusíadas* Camões achieved an exquisite harmony between classical learning and practical experience, delicate perception and superb artistic skill, expressing through them the gravity of thought and the finest human emotions. It was his eulogy of the *vida perigosa* ("dangerous life") and a stern warning to the Christian princes, who, idling their time away in petty struggles, were forgetting Mohammed, the common enemy, who was advancing against Europe (Cantos VI, 95 and VII). In critical periods of their history the Portuguese have found in Camões an inspiring example of strength and endurance.

In his dramatic works Camões tried to combine national and classical tendencies. In *Enfatriões* he accentuated the comic aspect of the myth of Amphitryon; in *El-Rei Seleuco* he reduced the situation found in Plutarch to pure farce; in *Filodemo* he developed the *auto*, a kind of morality play, which Gil Vicente had earlier made popular. But for Camões, comedy was unimportant, a mere curiosity and a recreation to which he could give only transitory attention. Nevertheless, by imposing classical restraint on the Vicentian *auto;* increasing the importance of the plot; transferring the comic element from the characters to the action; and by refining the farce, Camões indicated a possible means of rejuvenating 16th-century comedy in Portugal, but later dramatists, unfortunately, were incapable of following the lead he had given. This, however, is the least important aspect of Camões' poetry. It was his epic and his lyrics, among which are some of the loveliest ever written, that made him one of the greatest poets of 16th-century Europe and have given him a lasting claim to fame.

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(A. J. da C. P.)

CAMOMILE (Camomile Flowers), a drug consisting of the dried flower heads of certain species of Compositae, once widely used as a home remedy in the form of a tea. Hungarian or German camomile (*matricaria*) is derived from wild plants of *Matricaria chamomilla,* an annual herb indigenous to Europe and western Asia and naturalized in parts of Australia and the Unite States. It has a warm aromatic odour and a bitter taste. It constituents include bitter principles and a strongly aromatic volatile oil that is sometimes used medicinally.

Roman, English or Russian camomile (*anthemis*) is derive from *Anthemis nobilis,* a perennial herb indigenous to southe and western Europe and cultivated for medicinal use in Saxony France, Belgium and England. It contains bitter principles an a volatile oil similar to that of *matricaria.* Spanish camomile i derived from wild plants of this species. It is richer in activ principles but more likely to produce nausea.

The camomiles are said to act as stimulants, allayers of nervou excitement and carminatives.

The name wild camomile is applied to cotula (mayweed), th dried plant of *Anthemis cotula,* which is native to Europe bu naturalized as a common weed in many parts of North America It is the most acrid of the camomiles; the juice of the fresh leave will blister the skin.

(V. E.)

CAMORRA, a secret society of the province of Naples i southern Italy. When it began is uncertain, but by 1830 it wa publicly known. It originated in Neapolitan jails, its first purpos being protection of prisoners. Former inmates then continue the society outside the jails, notably in the city of Naples. Th Camorra grew rapidly in influence and power; its operations included criminal activities of various kinds, such as smugglin blackmail and ordinary road robberies. The general disorder o Naples was so great and the police so badly organized, that merchants were glad to engage the Camorra to superintend the loading and unloading of merchandise. Because the society wa nonpolitical, the government did not interfere with it; indeed i members were taken into the police service, and occasionally the solved crimes that baffled the authorities.

During the decade of reaction which followed the Neapolita revolution of 1848, many *camorristi* became interested in politic and supported the national and liberal cause. They organize demonstrations against the despotic regime of King Ferdinand I After the elimination of the Bourbon dynasty and the incorporati of its realm into the United Kingdom of Italy, the political powe of the Camorra became truly formidable. It proceeded to abus this power, and widespread disorder ensued. In 1862 sever repressive measures were inaugurated against the society an continued for several decades. The Camorra struck back by mea of political intrigues and acts of brigandage. The authoriti countered in their turn with an intensive series of manhunts th started in 1882. Thereafter the Camorra steadily lost ground; i decline was climaxed by the defeat of all its candidates in th Neapolitan elections of 1901.

Although greatly weakened, the society was not yet extin however. In 1911, popular attention was drawn to the fact of i survival by a famous case, the Cuocolo murder, in which some persons were brought to trial. They were all accused of bein affiliated to the Camorra, among them the man reputed to be i chief, who was extradited from the United States. The cas which lasted over a year, was transferred from Naples to Viterb to insure an impartial verdict, and the severe sentences which we passed dealt a shattering blow to the organization. *See* als Mafia.

(S. W. Hn.)

CAMOUFLAGE, the military art of concealment and dece tion. It is the means of defeating enemy observation by concealin or disguising installations, activities or equipment. (The prote tive coloration, or camouflage, found among animals is dealt wit in Coloration, Biological: *Animal Colours.*) The principles camouflage have not changed since the Chinese military write Sun Tzu stated in his book *The Art of War* in 500 B.C.:

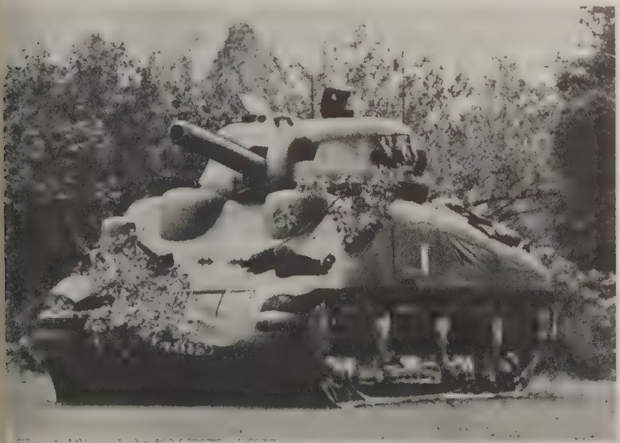
> All warfare is based on deception. Hence when able to attack, must seem unable; when using our forces, we must seem inactive; wh we are near, we must make the enemy believe that we are away; wh far away, we must make him believe we are near. Hold out baits entice the enemy. Feign disorder, and crush him.

In the conventional use of the term, camouflage is restrict to passive defense measures. The surface camouflager, for exa ple, does not try to prevent aerial surveillance by jamming the enemy's radar. He is more likely to invite aerial surveillance, especially by photography, so that he will have an opportunity to deceive the enemy. Thus the conflict is mental rather than physical, with one side seeking information through surveillance while the other side not only attempts to deny it but proffers misleading visual information. The camouflager requires a knowledge of the enemy's operating methods and military doctrine in order to predict how he will respond to specific deceptive visual information.

Both concealment and deception adversely affect the enemy's intelligence effort. The withholding of information compels him to increase his collection effort, especially surveillance, and thus to divert from combat a greater number of men and machines. The receipt of incorrect reports along with correct information may confuse the enemy and force him to devote more time to analyzing the data. Camouflage may thus contribute to indecision on the part of the enemy commander, cost him critical time and resources and may even lead him to make wrong decisions.

Camouflage as a means of deceiving the enemy is different from countermeasures. Camouflage does not give itself away by obviously impairing the ability of the sensing device to "see" its target, for that would merely forewarn the observer. False information must be given to the enemy without arousing his suspicions. Countermeasures, on the other hand, do impair the ability of the sensing device to "see" and are not concerned with whether the enemy is aware of this action as long as the ability to detect is destroyed. For example, the dropping of chaff from aircraft in flight and the launching of diversionary guided missiles are designed to confuse, divert and saturate air defense systems; they are normally considered countermeasures rather than camouflage.

History.—Camouflage, from the French word *camoufler* (to disguise), came into English usage during World War I when air warfare was introduced. Development of military aircraft exposed enemy dispositions to the air observer and the aerial camera. Each major army therefore organized a camouflage service of specially trained troops to practise the art of deception. Concealment effort was generally limited to positions within artillery range, for aircraft were used to spot targets for the artillery. By World War II the increased capabilities of aircraft for long-range bombing threatened warring countries in their entirety, not just the front lines. At the same time, camouflage concepts were broadened to include active deception of the enemy as well as passive concealment against observation and photography. World War II gave marked impetus to both camouflage and surveillance in their traditional competitive roles. Practically everything of military significance was camouflaged to some degree. Almost all tactical vehicles carried camouflage nets and were painted in dull colours. All military personnel received training in camouflage fundamentals during basic training. The soldier was taught the importance of choice of position, camouflage discipline and camouflage construction. He learned to conceal himself by blending into his background and to avoid silhouetting himself against the skyline. He was taught how to camouflage his helmet, to guard against shiny equipment, to camouflage the spoil from his entrenchment and to hide the glow from his cigarette at night. He became familiar with camouflage materials such as twine nets, chicken-wire netting, cloth garnishing and the use of natural foliage.



COURTESY OF THE IMPERIAL WAR MUSEUM

FLATED DECOY OF SHERMAN TANK USED BY THE BRITISH ARMY DURING ORLD WAR II

In Great Britain entire airfields and large manufacturing plants were camouflaged to protect them against aerial attack. At the close of the war the British air ministry reported that:

> A network of 500 dummy cities, airfields, shipyards and other targets so realistic they blazed at night under enemy attack caused thousands of tons of German bombs to drop harmlessly in open fields during the Battle of Britain. Mock airfields drew even more raids than the real ones—443 compared with 434 on actual installations. The fields appeared so genuine that Allied pilots had to exercise great care to avoid trying to land on them.

In evaluating German camouflage in World War II, the United States Strategic Bombing survey reported that:

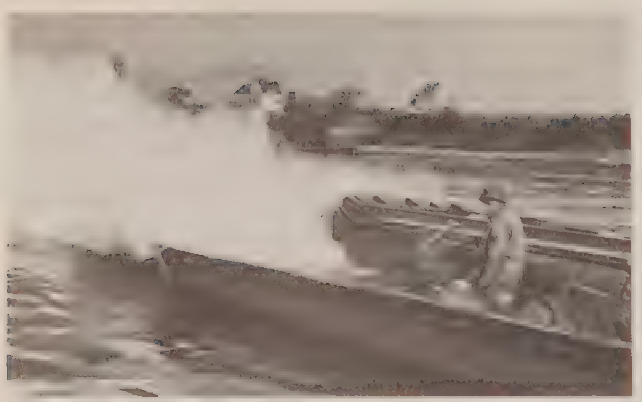
> Protective concealment was practiced with greater variety of materials probably with greater ingenuity, and certainly with greater expenditures of manpower, than had been used by any warring nation previously. One of these ambitious camouflage projects was undertaken in Hamburg where the inner basin of the Alster, measuring roughly 500 by 450 yards, surrounded by the main business district, was covered to make it appear like terrain.

Dummies, displays and decoys were widely used during World War II to accomplish varied objectives. The extent of dummy displays ranged from crude improvisation of coconut logs for guns in Burma and on Pacific islands to an elaborate simulation of an entire army in England. Prior to the Normandy invasion German reconnaissance aircraft many times reported "loaded fleets in British ports and large size mechanized units in the field." This display in reality consisted of pneumatic decoys made to resemble different types of weapons and pieces of equipment arranged to represent large convoys and concentrations of landing craft, tanks, trucks and artillery. Dummy fleets of landing craft appeared and disappeared overnight in invasion harbours. Dummy assault boats drew some of the defensive fire during the assault on the Normandy beaches.

British Field Marshal Bernard L. Montgomery surprised Erwin Rommel, the German commander, at El Alamein through the use of dummies combined with a feint. His intention to force a gap through the German defensive system in the north was masked by a long-term cover plan designed to make the Germans think that the prospective attack was to take place in the southern sector. By skilful use of dummy material, the armour and other equipment required for the northern attack was shifted to the north without any visible decrease of strength in the south. Simultaneously, active measures designed to suggest a southern attack took place. Dummy pipelines and supply dumps were built and a radio deception program was operated by a bogus divisional headquarters. The deception was maintained through the first three days of the battle, during which time the XIII corps gave the appearance of attempting to make a breakthrough in the south. This kept Rommel guessing and prevented him from repositioning his 21st panzer division.

The protective concealment provided by smoke was also effective during World War II. Land and sea movements, both large and small, were blanketed by smoke. Huge smoke screens covered fleets at anchor when air-raid alerts sounded. Preparations for river crossings were similarly hidden. The 60-mile smoke screen along the Rhine that covered the reorganization of the 21st army group and its subsequent crossing of the river in March 1945 was probably the greatest smoke cover ever produced.

The Korean war (1950–53) brought little change in camouflage techniques. It was mostly a post-graduate course to World War II training with emphasis upon seasonal and geographic factors. During the years that followed, concepts as to the importance of camouflage in future warfare varied widely among the military services and even within each service. By the 1960s it was generally recognized that greater emphasis should be placed on de-



BY COURTESY OF THE U.S. ARMY, OFFICE OF THE CHIEF OF INFORMATION

U.S. ARMY SMOKE GENERATOR PRODUCING PART OF THE SMOKE SCREEN THAT PROTECTED THE ALLIED CROSSING OF THE RHINE; GERMANY, MARCH 1945

ception operations in atomic warfare. Concealment and deception, it was felt, should become commonplace—everyday activities of the small units that were visualized as the basic combat units of the future. Through such tactics, it was argued, the enemy's stockpile of atomic weapons might be wasted on fictitious targets while his means of delivery would be more easily located.

As the result of a relatively greater development effort, a variety of new detection devices appeared. Some were supersonic aircraft and drones equipped with television, radar, infrared scanning devices, acoustic detection and high-speed photographic equipment with multiple filters. Ground battle area surveillance equipment included television, radar and aids to night vision. Other developments were earth satellites carrying radar, television and photographic equipment. Camouflage research and development meanwhile provided new techniques, materials and equipment for countering such surveillance devices. Methods and materials for effective concealment and deception throughout the electromagnetic spectrums from the ultraviolet through the visual infrared and radar region were developed. Improved pneumatic devices were produced to simulate items of military equipment such as trucks, armoured vehicles, artillery and guided missiles. These devices could be used in combat deception schemes where military forces were simulated. They provided effective visual, infrared and radar simulation. Other materials were developed to simulate bridges, convoys, bivouac areas, airstrips, marshaling yards, post activities and supply dumps. Some diversionary equipment could be used to represent a paratroop drop and gunfire.

Basic Principles.—The basic principles of camouflage remain constant in that they are governed by natural phenomena such as light, heat and colour. Recognition is the fundamental issue in the contest between surveillance and camouflage. The objective of camouflage concealment is to prevent recognition; the objective of camouflage deception is to induce false recognition. This implies that camouflage is not always designed to be a "cloak of invisibility"; sometimes camouflage is designed to permit detection, and although nature and circumstances do not always permit the denial of detection, recognition can be made difficult or even impossible. An example of permitted detection is the use of improperly garnished drape nets over decoy equipment. Recognition through appearance is the result of conclusions drawn by the observer from the position, shape or other characteristics of the objects or persons under surveillance. Recognition through behaviour or movement includes deductions made from the actual movements themselves, from the tracks of persons or vehicles, or by other violations of camouflage discipline.

Regardless of the type of observation, there are certain factors that help to identify an object. These are the telltale elements that determine how quickly the object will be seen or how long it will remain unobserved. The eight factors of recognition are position, shape, shadow, texture, colour, tone, movement and shine. These factors must be considered in camouflage to ensure that no one of them reveals the location of the concealed object.

Position, of course, is the relation of an object or person to its background, while shape is the outward or visible form of an object or person. Shape refers to outline or form and is distinguished from surface characteristics and colour. At a distance the form or outline of objects can be recognized before the observer can make out details in their appearance, such as colour or texture. For this reason, camouflage has much to do with concealing the shape of an object or person. But shape alone will sometimes not be enough for identification. A vertical photograph, for example, could show several different objects with rectangular shapes; they might be buildings, swimming pools, trucks or parking lots. To determine their true identity, other factors must be studied, particularly shadow.

Shadow may be more revealing than the object itself, especially in photographs taken from the air. Objects such as factory chimneys, utility poles, vehicles and tents have distinctive shadows. Conversely, shadows sometimes may assist in concealment, for an object in the shadow of another object is more likely to be overlooked.

Texture affects the tone and apparent coloration of things because of its absorption and scattering of light. Rough surfaces tend to appear dark and to remain constant in tone regardless of the direction of view and lighting, whereas relatively smooth surfaces change from dark to light with the change of direction of viewing or lighting. Altering the texture of an object often has the added advantage of disrupting its shape and the shape of its shadow, thus making it more difficult to detect and identify.

Colour is an aid to an observer when there is contrast between the colour of an object and its background. The greater the contrast in colour, the more visible the object appears. Colour differences or differences in hue, such as red and green-yellow, become increasingly difficult to distinguish (or tend to merge) as the viewing range is increased. This is because of atmospheric effects. Colours in nature, except for certain floral and tropical animal life, are not brilliant. The impression of vividness of nature's colours results from the large areas of like colour involved and the contrast of these areas with each other. The principal contrast is in their dark and light qualities. However, the dark and light colour contrast does not fade out quickly and is distinguishable at greater distances. Therefore, as a first general principle the camouflage must match the darker and lighter qualities of the background and be increasingly concerned with the colours involved as the viewing range is decreased or the size of the object or installation becomes larger. A second general rule is to avoid contrasts of hues and when treating mobile objects in foliated terrains, light-toned colours are to be avoided as they tend to attract attention.

Tone is the effect achieved by the mixing of light, shade and colour. In a black-and-white photograph, the shades of gray in which an object appears are known as tone. By adding texturing material a smooth or shiny surface can be made to produce a darker tone in a photograph because the textured surface now absorbs more light rays. Objects become identifiable because of contrasts between them and their background. Camouflage blending is the process of eliminating or reducing these contrasts. The principal contrast is that of tone; *i.e.*, the dark and light relationship existing between an object and its background. The two principal means available for reducing this contrast or difference in tone are the application of matching coloration and the use of texturing. As an example of coloration effects, a light-coloured aircraft on a light-coloured runway is most easily located by its shadow, while the same aircraft on a darker runway is easily picked out through its own contrast with its background. If all colour contrasts are reduced, a dark-coloured aircraft on a dark-coloured runway is relatively inconspicuous or practically disappears from view. Installations subject only to high aerial observation can best be concealed by toning down contrasts in shade and colour rather than by attempting complicated disruptive patterns. Poorly chosen disruptive patterns tend to make the object more conspicuous instead of concealing it.

Movement is the strongest factor in attracting attention. The eye is very quick to notice any movement in an otherwise still scene. The aerial camera can record the fact that something has moved when two photographs of the same area are taken at different times. If an object has moved, the changed position is apparent when the two photographs are compared.

Shine is a particularly revealing signal to an observer. Whenever light strikes smooth surfaces such as truck windshields, headlights, mess gear or even a person's face, light may be reflected directly into the observer's eye or the camera's lens with striking emphasis.

Photographic Film.—Different types of film have been developed for use in aerial photography including the following four types used for photography camouflage detection.

The most common film is the ordinary black and white variety. Although its sensitivity is different from that of the eye and does not reproduce colour, it provides a permanent record of tonal differences that may be subjected to prolonged study. Selected filters may be used to improve the photograph or to record only the light that is known to give the greatest tonal differences between natural backgrounds and the object being sought.

Colour film approaches the sensitivity of the human eye. Because of its chemical makeup and its principle of operation, however, this film will give the best results only in bright sunlight. The advantages of colour film are two-fold. First, it provides colour contrasts; second, because colour film is slightly different from the human eye in sensitivity, it often reveals camouflage by recording colour differences not discernible to the unaided eye.

Infrared film is sensitive to radiation of wave lengths not detectable by the human eye. Infrared photographs may be made of objects and terrain utilizing these wave lengths of radiation exclusively by filtering out the visible wave lengths of light. This film has many advantages in that it can be used to take photographs in darkness, provided there is a source of infrared radiation. Of particular advantage for camouflage detection is the fact that living green vegetation reflects the infrared waves very readily. Because of this characteristic, it provides pictures showing contrasting tones between living green vegetation and artificial plants and materials. However, infrared reflective paints have been developed that greatly limit this advantage.

Camouflage detection film is a colour film in which the sensitivity has been altered from recording blue, green and red light to recording green, red and infrared radiations. Since live green plant life has a particular and consistent relative reflection of these radiations, the film is made to reproduce an image of live plant life as red. All other combinations of reflection are recorded as some other colour. Thus camouflage is reproduced in some colour other than red in the photograph—usually green or blue-green. A photo interpreter trained in the use of this film is better able to detect camouflage positions because of the high colour contrast of the position and its background when the position is situated in an area of living vegetation. (C. W. He.)

CAMP, WALTER CHAUNCEY (1859–1925), U.S. athlete called the "father of American football," was born in New Britain, Conn., April 17, 1859. A former Yale halfback and captain, he was a member of the Intercollegiate Football rules committee for 48 years. He changed the game from Rugby to American football, creating the scrimmage line, 11-man team, signal calling, and the quarterback position. He originated the rule whereby a team had to give up the ball unless it was advanced a specified distance within a certain number of downs. (*See* also Football: *U.S. Football.*)

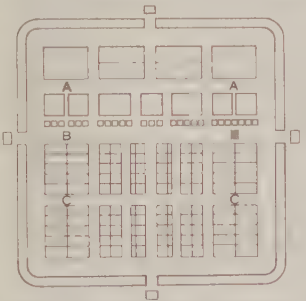
Camp studied medicine at Yale for two years, but gave it up to go to work in his uncle's watch factory and to coach the 1888 Yale football team. He and Casper Whitney picked the first All-American team in 1889. His publications included *Football: How to Coach a Team* (1886), *American Football* (1891) and *Walter Camp's Book of College Sports* (1893). Camp died in New York on March 14, 1925. (J. D. McC.)

CAMP, a military term denoting an area for temporary or semipermanent sheltering of troops in tents, huts, or other structures, sometimes called cantonment. It is usually distinguished from a bivouac, a temporary encampment where the troops have no shelter or, at most, "pup tents" carried in sections by the men themselves. Camps are also distinguished from billets or quarters. In earlier centuries army commanders billeted or quartered their troops, individually or in small groups, in the houses of a town or countryside, for food and shelter.

In modern U.S. army usage, temporary military posts are generally designated camps while permanent installations are designated forts.

The modern use of the word to designate a military post comes from the practice that prevailed among the ancient Romans of fortifying every encampment. With their genius for the practical, the Romans made a science of camp construction, a fact that accounted for much of their success in war. Under the republic, an army of two legions, numbering about 10,000 men in all, occupied a square of 50 ac. Even if the camp was only for one night and was in friendly territory, Roman discipline required the digging of ditches and erection of earth walls and palisades with well-guarded gates of entry on each of the four sides.

The three main avenues of the tent community (*see* fig.) had always the same names and locations. The same spot was assigned each night to the same unit so that the legionary always found himself oriented in surroundings so familiar that on the darkest night he could form into ranks to repel an enemy assault. Such strict sanitary regulations were observed, moreover, that the Romans escaped the epidemics that are the penalty of carelessness. Only on rare occasions was a Roman camp surprised and successfully attacked.



PLAN OF A ROMAN CAMP SHOWING TRANSPORT, BAGGAGE, SUPPLY AND HEADQUARTERS SERVICES ON EITHER SIDE OF AVENUE (A); TENTS OF TRIBUNES AND CENTURIONS, EACH OPPOSITE HIS OWN COMMAND, ALONG AVENUE (B); AND THE ROMAN LEGION SEPARATED FROM THE ALLIED LEGION BY AVENUE (C)

Military camps of later centuries bore little resemblance to those of ancient Rome. The development of firearms of ever increasing powers of penetration made obsolete the wooden barricades of the Roman era. As a rule, they were located at some distance from the combat area and were therefore not heavily fortified or kept in a state of constant readiness to repel attacks. In the 17th and 18th centuries soldiers not on campaign were quartered in private homes or in public buildings temporarily taken over for the purpose, though tent camps where soldiers could be closely guarded were sometimes necessary to cope with the problem of desertion. When linear tactics were replaced by mobile warfare during the French Revolutionary campaigns, the weight of tents was regarded as excessive. The armies of the Napoleonic wars usually bivouacked when not occupying billets. In the early months of the American Civil War, hastily mobilized troops lived in tent camps.

In the 20th century when millions of men (and women) were quickly mobilized the armed services built camps for temporary housing and training. These camps occupied thousands of acres of land and included hundreds of huts, two-story barracks, or tents, along with buildings for administrative offices, recreation, and medical care. Some also had extensive areas for drill and maneuver. Such camps had extensive water, sewage and electrical facilities, and were, in fact, self-contained communities. The sites for such camps were usually selected with an eye to healthful living conditions and a climate suitable for outdoor training the year around. (Ln. Ms.)

CAMPAGNA DI ROMA, the low country surrounding the city of Rome, bounded on the northwest by the hills surrounding the lake of Bracciano, on the northeast by the Sabini mountains, on the southeast by the Alban hills and on the southwest by the sea. *See* Italy: *Physical Geography;* Rome: *The Ancient City;* and, for origin of the name, Campania.

CAMPAGNOLA, DOMENICO (*c.* 1484–after 1563), Italian painter and print maker, was one of the first professional draftsmen. His chief activity centred around Padua, at which city he was probably born and where he remained to decorate many of the churches and palaces with frescoes. He is also renowned as an engraver and as a cutter and designer of woodcuts. He was a prolific draftsman, usually working in pen and ink, and was among the first to make his drawings ends in themselves rather than preparatory studies.

Early in his career, he is known to have assisted Titian with a series of frescoes in Padua. Titian remained a great stylistic influence on him. He was also a pupil, and possibly a relative, of Giulio Campagnola, but did not follow his stipple technique, preferring a looser touch and picturesque effect.

CAMPAGNOLA, GIULIO (*c.* 1482–after 1514), Italian painter and engraver, was born in Padua. His only recognized work consists of his engravings. Much of his significance derives from the special character of his engraving technique: a system of delicate flicks and dots with the graver, by means of which he achieved subtle nuances in his modeling. He anticipated by over two centuries the development of stipple engraving. His mature style was most influenced by Giorgione, after whom he engraved several prints.

CAMPANELLA, TOMMASO (originally GIOVAN DOMENICO CAMPANELLA) (1568–1639), Italian philosopher and poet, tried to reconcile the naturalistic philosophy of the Renaissance with the theological orthodoxy of the Counter-Reformation. He was born at Stilo, Calabria, on Sept. 5, 1568. In 1583 he entered the Dominican Order, taking the name Tommaso. While studying Aristotelian philosophy, he read widely, and was deeply impressed by the ideas of Bernardino Telesio (*q.v.; see* also PHILOSOPHY, HISTORY OF: *Patristic and Medieval Philosophy*).

In 1589, without permission, he went to Naples, where publication of his *Philosophia sensibus demonstrata* (1591) was followed by trial on suspicion of heresy, and a few months' imprisonment. Released on condition that he return to Calabria, he went instead to Padua, and there met Galileo, whose work he was to defend in his *Apologia pro Galilaeo* (1616). While there he was involved (1593) in an inquiry into allegations of sodomy but was acquitted. Then, charged with having engaged in a debate with a Jew on matters of faith, he was sent to Rome for trial, and in 1596 formally abjured the heresy of which he had been accused. A fourth trial in 1597 ended with a final command to him to return to Calabria.

Allegations against him during these trials suggest that at this time Campanella was influenced by Neoplatonic animism as well as by a Democritean scientific materialism. Philosophical pragmatism and interest in political reform are already manifest in his early writings (many of them lost), which include the *De monarchia Christianorum* and the *De regimine Ecclesiae* of 1593; and the *Discorsi ai prìncipi d'Italia* and the *Dialogo politico contra Luterani, Calvinisti ed altri eretici* of 1595. In these works he expounds the theory that fallen humanity can be regenerated through a religious reformation founded on the establishment of a universal ecclesiastical empire. After his eventual return to Stilo in 1598, however, the misery of the people there caused him to adopt a more limited, though no less utopian, plan of reform, to begin with the setting up in Calabria of a republican community governed in accordance with naturalistic principles. In pursuit of this plan, in the summer of 1599 he became the spiritual leader of a plot organized by Calabrese republicans to overthrow Spanish rule—it was discovered, and on Sept. 6, Campanella was arrested. On Nov. 8, he was taken in chains to Naples, where he was charged both with political sedition and with heresy. During his political trial, on Feb. 7, 1600, he was forced by torture to confess his responsibility for the Calabrese plot. Two months later, to escape the death penalty, he began to feign madness. Because he succeeded in maintaining this pretense even under the most severe torture, his insanity was legally recognized, and in 1602, at the end of his trial for heresy, he was sentenced to life imprisonment.

While in prison, Campanella reverted to acceptance of orthodox Catholic doctrine, and attempted to reconcile his own ideas and missionary zeal with the authority of the church. In 1602, however, he wrote his most interesting work, *La Città del Sole* (*The City of the Sun*), a practical design for a utopian commonwealth ruled by pure reason, which clearly reflects his outlook at the time of the Calabrese plot. (*See* also UTOPIA.) It was in prison, too, that his lyrical poems were written, of which only a selection (*Scelta* [1622]) survives. It includes, as well as some conventional love poems, a number of metaphysical *canzoni*, elegies, madrigals, and sonnets, written in a powerful, intensely personal style. In them, he tries to express with urgent immediacy the need for a moral regeneration according to his own philosophical ideas. The best are those in which he adopts a Latin metrical system, so exemplifying the successful use of classical tradition for the expression of a "new" moral message. His collection of poems is, perhaps, the most original in the Italian literature of the period.

De Gentilismo non retinendo (1609–10) expresses Campanella's changed philosophical and theological outlook; but from the metaphysical point of view his most important work is the *Metafisica* (18 books), which survives in a Latin version that was published in Paris in 1638. Campanella's theory of metaphysics is based on three principles: power, wisdom, and love, forming a trinitarian structure that is the essence of all beings, finite and infinite, of the human soul as well as of the Divine Trinity. In the 30 books of his *Theologia* (1613–14), he reconsiders Catholic doctrine in the light of this new concept; and, in *Quod reminiscentur*, he expounds its political consequences: that Christianity, as taught by the church, should be accepted by all nations since, given the metaphysical correspondence between human reason and the Divine Mind, it is only within the church that humanity can attain unity.

On May 23, 1626, Campanella was released by the Spanish authorities, and soon after, went to Rome to try to get the church to accept his new ideas. Since, however, he no longer looked to Spain to unify the world politically (as he had done in his *Monarchia di Spagna* of 1600), but to France, he met with strong opposition, particularly from the Spanish faction within the Roman Curia. In 1634, after discovery of an anti-Spanish plot in Naples he fled to France, where he was made welcome by Louis XIII and Cardinal Richelieu, and where many of his works written earlier were published. He died in Paris on May 21, 1639.

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CAMPANIA, a region of southern Italy comprising the provinces of Avellino, Benevento, Caserta, Naples and Salerno (*qq.v.*) with a total area of 13,595 sq.km. (5,249 sq.mi.) and a population (1966 est.) of 4,973,824. Campania extends from the Garigliano (the lower Liri river, ancient Liris) in the north to the Gulf of Policastro in the south, facing the Tyrrhenian sea; on the inland side it is bordered by Latium (Lazio), Abruzzi, Molise, Apulia and Basilicata. Its physiography is dominated by volcanic and seismic phenomena that characterize the area surrounding the Gulf of Naples (Campi Flegrei or Phlegraean fields; Vesuvius [*q.v.*]). Around these areas of volcanic activity extend the principal lowlands of Campania: the Volturno lowland; the plains called Terra di Lavoro from the middle Volturno (*q.v.;* ancient Volturnus) river to the eastern flanks of Mt. Vesuvius; while the only other lowland of any size, the plain of the lower Sele river (ancient Silarus), is separated from the others by the Lattari mountains between Pompeii and Salerno. To the east are the complex uplands of the region, part of the Apennine system, the Matese mountains (Mt. Miletto 2,050 m.; 6,726 ft.), the Picentini mountains (Mt. Cervialto 1,809 m.; 5,935 ft.), the Cilento (Mt. Cervati 1,899 m.; 6,230 ft.) and, beyond these, the Neapolitan Apennines (Appennino Napoletano). The only rivers of any size are the Volturno in the northern and the Sele in the southern part of the region. Among the intermontane basins that of Benevento is the most important. While communications between the coastal areas of Campania are relatively easy, the highly dissected character of the interior makes rail and road travel "across the grain," in the west-east direction, very difficult.

The most important farming areas of Campania are the lowlands of the Terra di Lavoro and of the circum-vesuvian plain. The land is fertile and utilization is extremely intensive, characterized by interculture, with plots of land producing cereals on the ground, fruit on trees along the edges of the plots, and grapes from vines trailing between trees. Farms are usually small, and human labour is used for most farming operations. The most important crops are fruit (apricots, apples, peaches, nuts, citrus and grapes), early vegetables and flowers, and such industrial crops as tobacco and hemp. Wines of Campania, especially those from Vesuvius (Lacrima Christi), from Ischia (Epomeo) and from the Sorrento pennsula, are famous throughout Italy. Fishing is important in the bay of Naples, Procida and Torre del Greco being the leading ports. Campania is the only region of southern Italy with a major concentration of industry, most of it centred on Naples. Metallurgy (steel and iron at Bagnoli and Torre Annunziata [*q.v.*]), chemicals (San Giovanni a Teduccio), machinery and tools (Pozzuoli [*q.v.*]), extiles, agricultural industries (canning, flour milling, tobacco) and shipbuilding (Castellammare di Stabia [*q.v.*]) are the most mportant branches. In Naples and its suburbs there is a flourishng artisan industry working coral, pearls, tortoise shell, leather and lace. The tourist trade in Naples, on the Sorrento peninsula nd on the islands of Capri and Ischia (*qq.v.*) is an important ource of income. Naples is the leading Italian port, second only o Genoa. The transportation system is also centred on Naples. Main lines connect the city with Rome (via Formia and via Cassino), with Benevento, Foggia and the Adriatic coast, with Potenza and Taranto, and with Reggio di Calabria and Sicily. A motorway (Autostrada del Sole) connects Naples with Rome and Milan, with extensions southward to Salerno and others planned astward to Foggia and Bari. (G. Kh.)

History.—Ancient Campania was smaller than the modern egion and roughly extended over the area now comprising the provinces of Naples, western Caserta and northern Salerno. It was bounded on the northwest by the territory of the Aurunci, on he northeast by Samnium, on the south by the Sorrento peninsula nd on the west by the Tyrrhenian sea. By the 1st century A.D. he northwestern boundary extended as far as Sinuessa (near Mondragone) and the Volturnus (Volturno) river, and the northern boundary came between Venafrum (modern Venafro) and Casinum (Cassino); the Volturnus valley and foothills of the Apennines as far as Abellinum (Avellino) formed the boundary on he northeast. The southern boundary remained unchanged.

Campani was the Roman name for inhabitants first of the town f Capua (*q.v.;* mod. Santa Maria Capua Vetere) and its district nd then for inhabitants of the Campanian plain. The name is pre-Roman and appears with Oscan terminations on coins of the early 4th or late 5th century B.C. struck for or by the Samnites (*q.v.*), the conquerors of the Etruscans in Campania at the end of he 5th century. Cumae (*q.v.*) was taken in 428 or 421, Nola (*q.v.*) about the same time, and the local dialect, henceforth known s Oscan (*q.v.*), spread over all Campania except for the Greek ities, although Etruscans remained for at least another century. Latin became general soon after the Social War (90–89 B.C.) except in Neapolis (Naples) where Greek was the official language during he Roman empire. The Samnites took over many Etruscan ustoms; the haughtiness and luxury of the men of Capua were roverbial at Rome. This town became the ally of Rome in 338 .C. By the end of the 4th century Campania was completely omanized, and was granted a limited form of Roman citizenship (*civitas sine suffragio*). Certain towns with their territories (Neapolis, Nola, Abella [Avella], Nuceria Alfaterna [Nocera Inferiore]) were nominally independent in alliance with Rome. These towns were faithful to Rome throughout the war against Hannibal (218–202 B.C.), but Capua and its satellite towns revolted. After its capture by the Romans in 211 the people of Capua were severely punished and their land confiscated. During the Roman empire, however, it flourished as a *colonia*. In the division of Italy into *regiones* by the emperor Augustus, Campania with Latium formed the first region. From *c.* A.D. 285 the name Campania was extended northward to include the whole of Latium. This district was governed by a *corrector* who received the title of *consularis c.* A.D. 333.

Puteoli (modern Pozzuoli), the chief ancient harbour, was most important in the 2nd–1st century B.C. The road system of Campania was extremely well developed, the most important road centre being Capua. The Appian way (*q.v.*) met the Via Latina at Casilinum, 3 mi. to the northwest.

After the fall of Rome the region was occupied successively by the Goths and Byzantines. The Normans conquered it in the 11th century and it was incorporated in the kingdom of Sicily in the 12th century. After the Sicilian Vespers (*q.v.*) it became part of the kingdom of Naples until it was united with Italy in 1861.

See also references under "Campania" in the Index.

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(T. A.; A. W. V. B.)

CAMPANILE, a bell tower, most commonly built beside or attached to a church; the word is oftenest used in connection with Italian architecture. The earliest campaniles, variously dated from the 7th to the 10th century, were plain round towers with a few small round-arched openings grouped near the top. Typical are those beside the churches of S. Apollinare in Classe and S. Apollinare Nuovo, Ravenna. Round campaniles appeared occasionally in later periods—the famous leaning tower of Pisa (begun in 1174), for instance, is a more elaborate version of this type, sheathed in a series of superimposed arcades.

Roman.—From the 10th century onward, most campaniles were based on a square ground plan, which seems to have been developed simultaneously in Rome and Lombardy. This type was generally decorated with projecting vertical strips, known as pilaster strips, and ranges of arcaded cornices which divided the tower into several stages, each stage having single-, double- or triple-arched openings on all four faces. The roof, particularly in early examples, was usually a pyramid of low pitch, invisible from the ground. Such, with minor variations, was the Roman type of campanile throughout the middle ages, as we may see it at S. Prassede (1080), Santi Quattro Incoronati (1123) and S. Maria in Trastevere (1139). The Roman campanile in general tended toward an effect of horizontality rather than verticality, which was often increased by treating all the horizontal stages with identical ranges of wall arcades, as in the campanile of S. Giorgio in Velabro (early 12th century), and by emphasizing the immediate surface through built-in fragments of Roman ornament.

Lombard.—Campaniles in Lombardy basically resembled the Roman type, but their elements were usually more complex and elaborate. The early tower of S. Satiro in Milan, for instance, at the end of the 9th century showed an advanced composition of horizontal stages, arcaded cornices which connected the corner pilaster strips, and arched openings, single below and double above. In the later, and much larger, northern campanile of S. Ambrogio in Milan (early 12th century) semicircular projections like engaged columns broke up the stages and gave additional vertical lines. The top story was developed into a kind of crown to the whole composition —effectively unifying the whole—and a pyramidal, or occasionally conical, spire was added. The result was an increasing emphasis on verticality. This may be seen in the famous campanile of Florence, designed by Giotto, Taddeo Gaddi and others in the early 14th century. It followed the Lombard tradition of horizontal stages but attained a sense of lightness by daring use of octagonal corner buttresses, a tremendous enlargement of the belfry stage to approximately twice the height of any other and a consistent vertical patterning in decorative marble sheathings and ranges of sculpture.

Venetian.—It was mainly around Venice that the possibilities of this development were fully realized and brought to mature expression. Venetian campaniles consisted of tall, square, slim shafts, frequently tapered or battered, which rose unbroken to open belfries at the top. The belfry had one or two stages of arcade and was often in stone, although the rest of the tower was brick. Above the belfry cornice rose the spire, sometimes square, as in the famous 320-foot campanile at St. Mark's in Venice (lower portion 10th and 12th centuries, belfry story 1510, the whole rebuilt in 1908 in exact imitation of the original), sometimes octagonal, as in the campanile of S. Zeno at Verona (12th century). (*See* VENICE.)

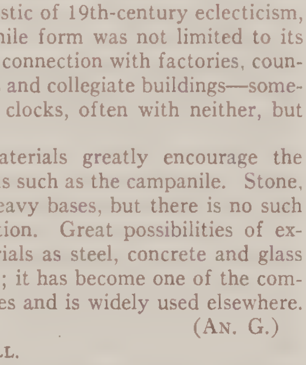
19th and 20th Centuries.—Campaniles of this mature type continued to be built in the region of Venice far into the Renaissance period; but elsewhere, as the Renaissance preference for other forms (particularly domes) developed, they became obsolete and remained so until the early 19th century. Then, an Italian Romanesque revival made "Lombardic-style" churches with their characteristic campaniles an alternative to neo-Gothic in northern Europe (English examples are Christ Church, Streatham, and SS. Mary and Nicholas, Wilton—both begun 1840). Later in the century, under the influence of John Ruskin, the Venetian form of campanile became popular; it may be said to have inspired the tower at Westminster Cathedral (by G. F. Bentley, 1897). It was characteristic of 19th-century eclecticism, however, that the revived campanile form was not limited to its original uses, but appeared also in connection with factories, country houses, blocks of flats, markets and collegiate buildings—sometimes with bells, sometimes with clocks, often with neither, but simply for picturesque effect.

Twentieth-century building materials greatly encourage the construction of free-standing forms such as the campanile. Stone, brick or wooden towers require heavy bases, but there is no such necessity in steel-frame construction. Great possibilities of expressing the nature of such materials as steel, concrete and glass are offered by the campanile form; it has become one of the commonest types of tower for churches and is widely used elsewhere. *See* also BASILICA. (AN. G.)

CAMPANOLOGY: *see* BELL.

CAMPANULA (BELLFLOWER), in botany, a genus of plants (family Campanulaceae) containing about 300 species, found in the temperate parts of the northern hemisphere, chiefly in the Mediterranean region. The name is taken from the Latin for a little bell. *Campanula rotundifolia* is the harebell (*q.v.*) or Scottish bluebell. *C. medium*, Canterbury bell, with large blue, purple and white flowers, is a handsome biennial, of which there are numerous varieties. *C. persicifolia*, the peach bell, is a perennial with more open flowers. The Eurasian *C. glomerata* has crowded flower heads.

In North America there are about 20 native species of bellflower, widely distributed throughout the continent. Among these are the tall bellflower (*C. americana*), found in moist woods from New Brunswick to South Dakota and southward to Florida and Oklahoma, which grows six feet high, with shallow, blue flowers, an inch across, borne in a dense spike often two feet long; the harebell, found from Labrador to Alaska and southward to New Jersey, Nebraska and California; and the California bellflower (*C. prenanthoides*), a delicately beautiful plant, native to wooded mountain slopes from Monterey to southern Oregon. In northeastern United States and adjacent Canada the creeping bellflower (*C. rapunculoides*), the Coventry bell or throatwort (*C. trachelium*) and the clustered bellflower (*C. glomerata*) have become widely naturalized.


J. HORACE MCFARLAND CO.

CLUSTERED BELLFLOWER (CAMPANULA GLOMERATA)

While the bellflowers are of no economic value, the beauty of their flowers is so great and the garden possibilities are so obvious that over 120 kinds are cultivated in Great Britain, and about 40 in the United States. One of them, the rampion (*C. rapunculus*), is a biennial and yields in Europe salad greens from its radical leaves, which are boiled; the scraped root is eaten raw.

The garden species may be divided into four divisions: (1) annuals or biennials, (2) perennials for the open border, (3) rock garden species and (4) pot plants. Some of the more desirable species in each group, together with their height and country of origin, are given below. All are blue-flowered unless noted to the contrary.

Annuals and Biennials: Sow seed about ¼ in. deep in April for the annuals and in June for the biennials. A selection could include: *C. drabifolia*, an annual 4–6 in. high from Greece and Asia Minor; *C. erinus*, a rough-hairy annual from southern Europe, 4–9 in. high, with white or pinkish flowers; *C. medium*, a biennial 2–4 ft. high from southern Europe; and *C. ramosissima*, 8–12 in. high, an annual from southern Europe.

Rock Garden Species: Their culture demands a loose, gritty soil, and the specialized conditions found in the moraine or scree. A selection might include: *C. barbata*, 4–18 in. high, with pale blue flowers, from the Alps; *C. garganica*, a Dalmatian sprawling herb, the flowers pale blue; *C. pulla*, a creeping herb 3–4 in. high, from eastern Europe; and *C. saxifraga*, a Caucasian crevice plant hugging the ground. All are perennials.

Perennials: This is the largest group and the easiest to grow. They require open sunlight and a rich loam. There are so many species that enumeration is impossible here. They range in height from *C. bellardi* (4–6 in.) to the chimney bellflower, *C. pyramidalis* (3–5 ft.).

Pot Plants: Some of the outdoor perennials can be so used. In addition, the following, which are rather tender, should always be grown in pots and sheltered over the winter: *C. colorata*, a Himalayan perennial; *C. isophylla*, a trailing Italian perennial fine for hanging baskets; *C. jacobaea*, a woody perennial from Cape Verde Islands; and *C. versicolor*, a Grecian perennial 4–6 ft. high. (N. TR.)

CAMPBELL, ALEXANDER (1788–1866), U.S. religious leader and one of the founders of the Disciples of Christ and Churches of Christ, was born in County Antrim, Ire., the son of Thomas Campbell (1763–1854), a Presbyterian minister who urged Christian unity. In 1807 Thomas Campbell emigrated ahead of his family to America, where he formed the Christian association of Washington, Pa., to promote "simple evangelical Christianity" as the way to church union. Following a breach with Presbyterianism he produced a *Declaration and Address* for the association in 1809. Alexander Campbell, after a year at the University of Glasgow, emigrated with the rest of the family in 1809. The son espoused his father's program for Christian unity and emerged as the leader of the movement for religious reform. He began preaching, without salary, in 1810 and married in 1811, settling in what is now Bethany, W.Va. Biblical study led him and his followers to adopt immersion in 1812, and in 1813 they joined the Baptists; tension on other issues led to dissociation in 1830. In 1832 Campbell's followers, known as Disciples, or Christians (nicknamed Campbellites), joined Kentucky "Christians" under Barton W. Stone (*q.v.*) to form the Disciples of Christ, or Christian Church.

Influenced by John Locke's epistemology, Campbell presented a rationalistic and deliberative Christianity based on the New Testament and opposed alike to speculative theology and emotional revivalism. He exercised his leadership through preaching, addresses and extensive debates with the Roman Catholic bishop John Purcell of Cincinnati, the secularist Robert Owen of Scotland and others.

Campbell's major writing and publishing began with a periodical, the *Christian Baptist*, in 1823, continued as the *Millennial Harbinger* after 1830. He wrote or edited over 60 volumes, including *The Living Oracles*, a version of the New Testament first issued in 1826, and a hymnal. Thomas Campbell gave his son much editorial assistance. Alexander Campbell was a member of the constitutional convention of Virginia in 1829. He founded Bethany college in 1840, and was its president till his death. In 1849 he became the first president of the first national convention and missionary society of the Disciples of Christ. Managerial ability and scientific methods of farming brought him wealth, and his home, with much original furniture and decoration, still stands, open to the public. *See* also CHRIST, CHURCHES OF; DISCIPLES OF CHRIST.

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CAMPBELL, SIR COLIN: *see* CLYDE, COLIN CAMPBELL, BARON.

CAMPBELL, DOUGLAS HOUGHTON (1859–1953), U.S. botanist whose chief work was in the study of mosses and ferns, was born at Detroit, Mich., Dec. 16, 1859. After study at the University of Michigan at Ann Arbor (Ph.D., 1886) and in Germany, he became in 1888 professor of botany at Indiana university, Bloomington. When Stanford university was assembling its first faculty in 1891, Campbell was selected to organize and head the department of botany. His researches before moving to Stanford centred around the morphology of ferns, and his first years at Stanford were spent on similar studies on the mosses and liverworts. Study in these two fields formed the basis for a treatise, *The Structure and Development of Mosses and Ferns,* that was the standard work in the field for 50 years. Other of Campbell's interests included plant evolution and geography. He died at Palo Alto, Calif., Feb. 24, 1953.

Principal publications include: *Elements of Structural and Systematic Botany* (1890); *The Structure and Development of Mosses and Ferns* (1895, 1905, 1918); *A University Textbook of Botany* (1902); *Plant Life and Evolution* (1911); *An Outline of Plant Geography* (1926); and *The Evolution of Land Plants (Embryophyta)* (1940).

See *Biographical Memoirs,* National Academy of Sciences (U.S.), vol. xxix (1956). (G. M. S.)

CAMPBELL, JOHN CAMPBELL, 1ST BARON (1779–1861), lord chief justice of England from 1850 to 1859 and lord chancellor from 1859 until his death, was, like many of the famed lawyers of his period, a Scot, born at Cupar in Fife on Sept. 15, 1779. He was the second son of a clergyman, George Campbell, and he too was originally destined for the clergy. He entered St. Andrews university at the age of 11 and concluded his work for an M.A. at the age of 15, beginning then on the four years of divinity training required by the general assembly. In 1798, however, he went to London as a tutor and was sufficiently enchanted with the opportunities for fame at the English capital to give up the church in favour of the bar. To finance his way, he became a reporter for the *Morning Chronicle,* and his newspaper training stood him in good stead at later periods of his life. He entered Lincoln's Inn in 1800 and in 1804 secured a desk in the chambers of William Tidd, the famed special pleader. Campbell's immediate predecessors in Tidd's office were the younger John Singleton Copley, Charles Pepys and Thomas Denman. The first of these was to become Baron Lyndhurst, thrice lord chancellor; the second, as the 1st earl of Cottenham, was also to be chancellor; and the third was to be lord chief justice.

Campbell was called to the bar in 1806, an impoverished barrister with no connections but with great ambition and self-confidence. For three years he languished on the home circuit, supporting himself by revising Watson's treatise on partnership, writing for the *Chronicle,* doing special pleading for Tidd and answering cases for Marryatt. He started on his road to success when he undertook to report cases at nisi prius for the legal publisher Henry Butterworth. His reports, especially of Lord Ellenborough's decisions, were first-rate and earned him fame as well as income. He changed from the home to the Oxford circuit, where the competition was less keen, and soon moved to the head of the bar. In 1821 he married the daughter of James Scarlett, later Lord Abinger, perhaps the pre-eminent advocate of the day. The marriage was a happy one, also providing Campbell with entree into the great Whig homes, and he turned his attention to politics as a means to place.

In 1826 Campbell ran unsuccessfully for the seat for Stafford, a borough of extraordinary corruption even in those corrupt times. He subsequently ran successfully for Stafford after the accession of William IV. In 1827 he became king's counsel. Peel put him at the head of the Real Property commission, after Edward Sugden had declined the post, in 1828. Characteristically, Campbell claimed credit for the bills drawn as a result of the commission's efforts, though Lord St. Leonards later said "that Campbell had no more to do with it than his footman." Campbell was also offered a puisne judgeship by Lyndhurst, which he peremptorily refused.

In parliament, Campbell was content to follow where his party led, even to the point of supporting the Reform bill of 1832, though he thought it "Jacobin." After being made solicitor general in 1832, he helped carry through several measures of reform of the real property law. In commons he was indefatigable and, though far from a brilliant speaker, most effective. As solicitor general he assumed all the functions of the chief law officer, and when Sir William Horne was forcibly retired, Campbell was promoted to attorney general. This resulted in his displacement from parliament for three months, since he failed to be elected at Dudley, but the Whigs provided him with a seat for Edinburgh. When the mastership of the rolls became vacant, Campbell applied for the post but was passed over in favour of Pepys, the solicitor general.

When the Whigs were turned out in 1834, Campbell's father-in-law, James Scarlett, was appointed chief baron of the exchequer, as Lord Abinger, removing Campbell's greatest competition at the bar. He was again returned for Edinburgh in 1835. Pepys was made chancellor and Bikersteth was sent to the rolls, again over Campbell's claim to priority. Campbell threatened resignation, but his feelings were assuaged by the elevation of Lady Campbell to the peerage. The Whigs asserted that he was too valuable in the house of commons to permit his removal to the bench. He was largely responsible for the Municipal Corporations act of 1835 and the Prisoners' Counsel act of 1834, among others.

Campbell's practice of law flourished, and he successfully defended Melbourne, who was then prime minister, in the infamous suit by George Norton for criminal conversation with Norton's wife. Campbell's skilful and effective defense saved the government. He remained attorney general until 1841, when pressure on Plunket caused him to resign the post of lord chancellor of Ireland in favour of Campbell. He was elevated to the peerage as Baron Campbell of St. Andrews. But shortly thereafter the Whigs were turned out.

Campbell found himself disqualified from practice and moved to the comparative quiet of the house of lords, where he served as a judicial officer. Under these circumstances, Campbell found that time was heavy on his hands, and he turned to the preparation of his famous volumes on the lives of the chancellors and the chief justices. They were a great literary success, though they are marred by plagiarism, unscrupulous misrepresentation and venom, the last especially directed to those whom he had known best. The last volume on Brougham and Lyndhurst, published after Campbell's death, did greater damage to Campbell's reputation than to those of his subjects, but neither of them, ever came out from under the cloud that Campbell created. As Sir Charles Wetherell remarked, these volumes "added a new sting to death."

In 1846, on the return of the Whigs, Campbell was made chancellor of the duchy of Lancaster and was given a place in the cabinet. When Denman became ill, the government again resorted to pressure to bring about his removal so that Campbell could be appointed (1850) lord chief justice. His judgments were of the highest order, but he browbeat counsel and wooed juries to bring about the results he wanted. He was most anxious to bring about decisions, especially at nisi prius, that would be agreeable to the populace. Courage was not one of his strong points.

When the Whig party regained power in 1859, there was difficulty on the question of the chancellorship, for the Whigs could not spare Bethell (Lord Westbury) from his duties in the commons. Campbell was appointed chancellor on condition that he would resign when Bethell was available. He served with some distinction as chancellor for two years before his death at the age of 81 on June 22, 1861. He left behind the record of a great judge, but a small man. (P. B. K.)

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CAMPBELL, SIR MALCOLM (1885–1948), British racing motorist who set world speed records on land and water, was born at Chislehurst, Kent, on March 11, 1885. In 1906 he became a member of Lloyd's, but, after serving as a dispatch rider and as a pilot in the Royal Flying Corps during World War I, he became interested in motor racing. In 1924 he achieved his first world's land-speed record at 146.16 mph, and increased it to 150.86 mph in 1925. In 1927, with the first "Bluebird," a Napier-Campbell, he reached 174.88 mph, a record which he raised to 206.97 mph in 1928. In 1931 he was knighted after achieving 246.09 mph. This record was followed by four others, 253.97 mph in 1932, 272.46 in 1933, 276.82 and 301.13 in 1935.

Sir Malcolm, in his first "Bluebird" hydroplane, captured the world water-speed record at 129.5 mph in 1937, raised it to 130.93 mph in 1938, and to 141.75 in 1939. He held that record when he died in Reigate, Surrey, on Dec. 31, 1948.

His son, Donald Malcolm Campbell (1921–67), who was born on March 23, 1921, used a jet-powered "Bluebird" to set a world water-speed record of 260.35 mph in 1959. In 1964 he raised it to 276.33 mph and the same year set a land-speed record for wheel-driven cars of 403.1 mph. He was killed while trying to break his water-speed record on Coniston Water, Eng., Jan. 4, 1967.

See also Motorboat; Automobile Racing.

(D. M. Cl.; X.)

CAMPBELL, MRS. PATRICK (née Beatrice Stella Tanner) (1865–1940), English actress, famous for her portrayal of characters at once passionate and intelligent, was born at London on Feb. 9, 1865. She made her name in 1893, when her performance as Paula Tanqueray in Arthur Pinero's *The Second Mrs. Tanqueray* put her very high in her profession. In 1895 she played Juliet to the Romeo of Sir Johnston Forbes-Robertson (*q.v.*), and afterward appeared with him in many plays. In 1907 she was a memorable Hedda Gabler and in 1914 created the part of Eliza Doolittle in *Pygmalion* by George Bernard Shaw, with whom she maintained a warm friendship.

Gifted by nature with talent, beauty and wit, she was always a fascinating character, but her temperament rebelled at discipline and this—as Shaw's letters to her clearly show—made her difficult to work with. This told against her as she grew older, and was the chief reason why she was seldom seen on the London stage after World War I. She was twice married—in 1884 to Patrick Campbell (d. 1900) and in 1914 to George Cornwallis-West. She died in Pau, France, on April 9, 1940. (W. A. Dn.)

CAMPBELL, (IGNATIUS) ROY (DUNNACHIE) (1901–1957), South African poet, whose vigorous extrovert verse contrasted with the uneasy self-searching of the more socially conscious poets of the 1930s. Campbell led a roaming life, and his latter years were spent mainly in Europe. His poem *The Flaming Terrapin* (1924) exalts the instinctive vital force that brings forth intelligent human effort out of apathy and disillusionment. *The Wayzgoose* (1928) is a satire on South African intellectuals and *The Georgiad* (1931) attacks the literary figures of the Bloomsbury group. His lyrical works include *Adamastor* (1930), *Flowering Reeds* (1933) and *Talking Bronco* (1946). Campbell translated Spanish, Portuguese and French writers, and wrote two autobiographical books, *Broken Record* (1934) and *Light on a Dark Horse* (1952). He was also noted as a bullfighter and steer thrower. He fought for Gen. Francisco Franco in the Spanish civil war and during World War II he served in Africa. He died in a car accident near Setúbal, Port., on April 22, 1957.

CAMPBELL, THOMAS (1777–1844), Scottish poet, chiefly remembered for his sentimental and martial lyrics, was born in Glasgow on July 27, 1777. In 1799 he published *The Pleasures of Hope, With Other Poems*, in heroic couplets, in the 18th-century tradition of the broad survey of human affairs. It was highly derivative, with a special debt to Alexander Pope and Mark Akenside, but its theme of freedom earned Campbell immediate popularity. In the following year he went to Germany, visited Friedrich Klopstock in Hamburg, and eventually returned to Altona on the Danish bank of the Elbe, after witnessing some military action near Ratisbon. There he planned some of the martial lyrics on which his reputation rests: "Ye Mariners of England," "The Soldier's Dream" and "Hohenlinden." Returning to England in 1801, on the outbreak of war with Denmark, he wrote "The Battle of the Baltic," inspired, it is said, by the sight of the Danish batteries at Glückstadt.

In these lyrics Campbell experimented with metrical forms. He wrote also a number of ballads and poems on legendary subjects, notably "Lord Ullin's Daughter" (1804), but he was not in the romantic tradition, belonging rather to the sentimental school of the 18th century. His aim, not often achieved, was a polished perfection of utterance, and preoccupation with this resulted in weaknesses in other respects. His other main works were *Gertrude of Wyoming* (1809), *Theodric* (1824) and *The Pilgrim of Glencoe and Other Poems* (1842); he also edited *Specimens of the British Poets* (1819). Campbell knew most of the prominent men of his time, and in 1805 was awarded a pension. In 1825 he was one of the instigators of the scheme for founding London university. He died at Boulogne, France, on June 15, 1844.

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CAMPBELL, WILLIAM WALLACE (1862–1938), U.S. astronomer, exerted great influence on observational astronomy particularly through his determinations of the radial velocities of stars. He was born on a farm in Ohio on April 11, 1862, and died in San Francisco, Calif., on June 14, 1938. He studied civil engineering and astronomy at the University of Michigan, Ann Arbor, graduating in 1886. In 1890, after a two-year period as instructor in astronomy at Michigan, he joined the staff of the Lick observatory on Mt. Hamilton, Calif., and became its director in 1901. Campbell was president of the University of California, Berkeley, from 1923 to 1930, and president of the National Academy of Sciences from 1931 to 1935.

Using a powerful three-prism spectrograph attached to the 36-inch telescope at Lick observatory, Campbell pioneered in obtaining accurate radial velocities for thousands of stars. To extend the measurements to stars visible only from the southern hemisphere, he sent a 36-inch reflecting telescope, equipped with a stellar spectrograph, to Santiago, Chile. Combining the data, he determined the sun's motion in our galaxy as well as the average random velocities of stars of various spectral types. He led sever solar eclipse expeditions from the Lick observatory, and brought back a wealth of material on the corona and the flash spectrum.

See also Spectroscopy, Astronomical: *Historical Development*.

(P. W. M.)

CAMPBELL, WILLIAM WILFRED (1858–1918), Canadian poet, was a contemporary of Archibald Lampman and Duncan Campbell Scott. Born in Berlin (now Kitchener), Ont., on June 1 1858 (sometimes given as 1861), he was educated in Toronto and in Cambridge, Mass., for the Anglican ministry, and served parishes in West Claremont, N.H., St. Stephen, N.B., and Southampton, Ont. *Lake Lyrics* (1889), celebrating the scenery of the Lake Huron-Georgian Bay country near his boyhood home of Wiarton, established his reputation. He left the church in 1891, and entered the civil service at Ottawa. Like Lampman and Scott, he wrote about nature, but his principal books, *The Dread Voyage* (1893), *Beyond the Hills of Dream* (1899), *Poems* (1905) and *Sagas of Vaster Britain* (1914), reveal that he took an independent course—characterized by transcendentalism, distrust of "neopagan naturalism," missionary zeal for the culture of the British "race," warmth and acidity in addressing his public and an interest in primitive mythology uncommon among poets before 1918. His robust, melodramatic imitations of Shakespearean plays were published in *Mordred and Hildebrand* (1895) and *Poetical Tragedies* (1908). He also wrote two novels, *Ian of the Orcades* (1906) and *A Beautiful Rebel* (1909); and descriptive works, *Canada* (1907), *The Canadian Lake Region* (1910) and *The Scotsman in Canada* (1912). He was well received abroad in 1897, 1901 and 1906.

See *The Poetical Works of Wilfred Campbell*, ed. with a memoir by W. J. Sykes (1923); Carl F. Klinck, *Wilfred Campbell, a Study in Late Provincial Victorianism* (1942). (C. F. Kk.)

CAMPBELL-BANNERMAN, SIR HENRY (1836–1908), British statesman who led the Liberal party successfully through a period of bitter internal dissension, and was prime minister from 1905 to 1908, was born at Glasgow on Sept. 7, 1836, the second son of Sir James Campbell, afterward lord provost of the city. Henry Campbell added Bannerman, the surname of his mother's family, to that of his father in 1871 when he inherited a property from his maternal uncle. He was educated at Glasgow high school, Glasgow university and Trinity college, Cambridge. For ten years from 1858 he worked (although not too onerously) for J. and W. Campbell, a family firm of Glasgow merchants, marrying in 1860 Charlotte Bruce, a daughter of the general commanding the garrison at Edinburgh. He was unsuccessful radical candidate at a by-election in the Stirling Burgh in March 1868, but at the general election, later in the same year, he reversed this result and was first elected for the constituency which returned him to parliament for the remainder of his life.

Early Career.—After three years in the house of commons Campbell-Bannerman was appointed financial secretary to the war office and served in that department under Edward (afterward Lord) Cardwell until the fall of Gladstone's first government (1874). When Gladstone returned to office in 1880 Campbell-Bannerman was appointed to the same post, but was transferred to the parliamentary and financial secretaryship of the admiralty in 1882, when, the first lord being a peer, Campbell-Bannerman became admiralty spokesman in the house of commons. There were strong suggestions in 1883 that he might be offered the speakership, but these fell through and he was appointed chief secretary for Ireland (1884) but without a seat in the cabinet. He served under the viceroy, Lord Spencer, with great loyalty and considerable skill during a year when the Irish scene was even more than usually troubled.

In Gladstone's third government, Campbell-Bannerman, an easy convert to the policy of Home Rule for Ireland, achieved cabinet rank as secretary of state for war (1886). This administration was too short-lived for him to make much mark in his department, but when the last Gladstone government took office in 1892 and Campbell-Bannerman returned to the war office he was able to begin a tenure of some distinction. He introduced the eight-hour day into Woolwich arsenal and in 1895 (having retained his office when Lord Rosebery replaced Gladstone as prime minister in 1894) he secured without ill-feeling the resignation of the duke of Cambridge as commander in chief. The duke had held this appointment for 39 years and had become a major and seemingly irremovable obstacle to army reform, but Campbell-Bannerman succeeded where successive secretaries of state had failed, and the queen, who was not predisposed in her cousin's favour, recognized Campbell-Bannerman's achievement by awarding him a knighthood.

On the day of his success Campbell-Bannerman was by ill chance responsible for the fall of the government. A snap vote in a thin house of commons on a Conservative motion to reduce the war minister's salary, found the government supporters in a minority of seven. Had the government possessed a vigorous hold on life this decision could easily have been reversed; but Rosebery and his colleagues, already in a sad state of disarray, seized the opportunity to resign. The incident did little to detract from the general respect which Campbell-Bannerman had earned as a minister.

Liberal Party Leader.—Resignation did equally little to correct the Liberal party's disunity. From 1895 to 1902 it presented a spectacle of confusion and weakness. In 1896 Rosebery resigned from the leadership. The earl of Kimberley was appointed his successor in the house of lords, and Sir William Harcourt carried on in the commons. Two years later, however, Harcourt himself decided upon an unexpected resignation on the ground that the party was "rent by sectional disputes and personal interests," and John Morley made it clear that he was retiring with his chief. The succession to which Campbell-Bannerman was the senior claimant was a singularly unappetizing one. His most likely rival was H. H. Asquith, certainly a more formidable parliamentarian but one whose close association with Rosebery made him rather doubtfully acceptable to the majority of the Liberal party and whose professional commitments made him loathe to rush at political promotion. In the event, Asquith proving less eager and Campbell-Bannerman less reluctant than had been anticipated, the latter was elected without opposition on Feb. 6, 1899.

Although the new leader applied himself strenuously to trying to hold his party together, the internal disputes, so far from showing signs of abatement, were exacerbated by the outbreak of the South African War in 1899. In one famous vote on the war in July 1900 the Liberal party split three ways: 40 of its members, including Asquith, Sir Edward Grey and R. B. Haldane, voted with the Unionist government; 35 abstained with Campbell-Bannerman; and 31, including John Morley, James Bryce, David Lloyd George and Henry Labouchere, voted for an amendment condemning the government. As his position in this vote indicated, Campbell-Bannerman was trying to steer a middle course and avoid both the outright opposition to the war of the "pro-Boers" and the support for its prosecution of the Liberal imperialists. In its later stages, however, he delivered himself of one of the most memorable of the antiwar statements: "When was a war not a war?"—he asked at a banquet of the National Reform union on June 14, 1901—"When it was carried on by methods of barbarism in South Africa." The result of this statement—and of a counterstatement by Asquith ten days later—produced the sharpest crisis of Campbell-Bannerman's leadership. For a time a Liberal imperialist secession seemed likely. This danger was avoided, however, and his leadership was unanimously confirmed on July 9 at a party meeting attended by both Asquith and Grey.

This was not only the most acute but the last of the major Liberal quarrels of this period. A year later the war ended and greatly eased the tension within the party. At the beginning of 1903 Joseph Chamberlain launched the first effective challenge to free trade for half a century and provided his opponents with the greatest unifying force they had ever enjoyed. Carried forward by this wave they were even able to compose their differences on Home Rule. Campbell-Bannerman secured a fair degree of unity on the point by reaffirming the party's belief in this policy, but making it clear that there was to be no repetition of the 1886 and 1892 practice by which it was made the central and immediate purpose of a Liberal government. By-elections in 1904–05 went heavily against Arthur Balfour's administration, and Campbell-Bannerman built up close relations with King Edward VII, whose first minister he seemed highly likely soon to become.

Prime Minister.—Balfour resigned on Dec. 4, 1905, without defeat either at the polls or in the house of commons, and Campbell-Bannerman immediately accepted office from the king. There were considerable difficulties about cabinetmaking and with them some revival of the old South African War division. Asquith, Grey and Haldane had come to an understanding in Sept. 1905—the "Relugas Compact"—the terms of which were that none of them would accept office unless all three were satisfied. This was intended to mean that the new prime minister should take a peerage, leaving the leadership of the commons to Asquith, and that Haldane should become lord chancellor. But Asquith was unwilling to split the party on a personal issue and when he accepted office unconditionally, Campbell-Bannerman was able to defeat both these propositions and secure the adhesion of all three men, although Grey stood out for three days before accepting the foreign office. Asquith became chancellor of the exchequer and Haldane secretary of state for war. The other members of what was generally agreed to be a distinguished administration included Morley, secretary of state for India; Lloyd George, president of the board of trade; James Bryce, chief secretary for Ireland; Lord Ripon, lord privy seal; Lord Crewe, lord president of the council; Herbert Gladstone, home secretary; and John Burns, president of the local government board.

The dissolution of parliament followed quickly and the general election (Jan. 1906) resulted in an immense Liberal victory. The differences which had arisen in forming the cabinet were dissolved in the great success of this campaign and the government began under happy auspices. Campbell-Bannerman, fortified by his great majority, was able to establish an early ascendancy over the house of commons which was epitomized by his successful rebuke to such an accomplished parliamentarian as Balfour: "I say, enough of this foolery!"—when the latter had indulged in a notable display of dialectics. The prime minister's command did not extend to the house of lords, however, and much of the legislative work of the government was nullified by the Conservative majority in the upper chamber. In the first session an education bill and a plural voting bill both perished in this way. Campbell-Bannerman's reply was to bring forward a plan for limiting the veto of the house of lords, so that "within the limits of a single parliament the final decision of the commons must prevail." He pushed this through the cabinet against some opposition and then carried it as a house of commons resolution by a large majority. It formed the basis of the Parliament act of 1911. The most important Campbell-Bannerman measure with which the lords did not dare to interfere was the Trades Disputes act (1906), which removed the restrictions upon trades unions imposed by the Taff Vale decision of 1902 (*see* English History: *The Twentieth Century*) and gave the unions a very favourable legal status. But his greatest personal triumph was outside the legislative field in the grant of responsible government to the Transvaal and Orange River colonies (*see* South Africa, Republic of: *History*). It was a controversial and courageous step, based on his belief that the relationship between the imperial government and the Boers could only be maintained on a basis of mutual confidence.

Campbell-Bannerman's wife died in Aug. 1906 and in 1907 his own health began to fail. As a result he was less active in parliament than most prime ministers, and much of the day-to-day work fell on Asquith. It was fortunate for the government that, in office, relations between the prime minister and the chancellor of the exchequer were far smoother than they had been in opposition. Campbell-Bannerman made his last appearance in the house of commons on Feb. 12, 1908, and, becoming seriously ill, he resigned as prime minister on April 5 of that year. He died at No. 10 Downing street, on April 22, 1908.

Character.—Campbell-Bannerman was not a great prime minister but he earned the deep affection of his own party and the respect of the whole nation during his relatively brief tenure of office. Most of the major achievements of the pre-World War I Liberal government were carried through under Asquith, who was a more notable figure, but, in view of the latter's identification with the extreme right wing of the party during the South African War, the government probably got off to a better start under Campbell-Bannerman than it would have done had Asquith occupied the highest office from the beginning. Campbell-Bannerman was above all a unifying force. His modest, loyal and simple (although by no means uncultivated) outlook on life is well summed up in one of his last speeches to his constituents: "Altogether I have no fault to find with anybody. And it is because I have no fault to find with anybody that I am where I am . . . It has not been by my seeking that I am where I am . . . An old friend was accustomed to say: The man who walks a straight road never loses his way. Well, I flatter myself that I have walked on a pretty straight road, probably because it was easier, and accordingly I have not gone astray. I trust that that will be continued to the last which cannot be long deferred now."

See J. A. Spender, *The Life of . . . Sir H. Campbell-Bannerman* (1923). (R. J.)

CAMPBELTOWN, a royal and small burgh and seaport in Argyll, Scot. Pop. (1961) 6,525. It is situated on Campbeltown loch, toward the southeastern extremity of the peninsula of Kintyre, 11 mi. N.E. of the Mull and 83 mi. S.W. of Glasgow by water, but 134 mi. by road. There is a daily air service from Machrihanish airport (4 mi. W.N.W.) to Glasgow.

Campbeltown, originally known as Dalruadhain, was the seat of the Dalriadan kings. After they had moved to Lorn, St. Ciaran (Kieran), one of the Twelve Apostles of Ireland, landed there in the 6th century whence it was renamed Kilkerran, afterward Kinlochkerran. Later, James V transferred the territory from the MacDonalds to the Campbells of Argyll, who gave it their family name. No memorial of its antiquity has survived, but a finely sculptured granite Celtic cross (*c.* 1500) stands in the market place, and there are ruins of an old chapel. It became a royal burgh in 1700. The staple industries are coal mining (a new pit was sunk in 1946), whisky distilling, fishing, dairy products and net making. On the Atlantic shore (5½ mi. W.) are the well-known golf links of Machrihanish; 10 mi. S. is Southend, the most southerly village in Kintyre. Davaar Island with its lighthouse lies at the entrance to Campbeltown loch.

CAMPECHE, a southeastern state of Mexico, named for the ancient Maya province of Kimpech or Canpech on the peninsula of Yucatán. Area 21,666 sq.mi. Pop. (1960) 168,219, mostly mestizos and Indians. Campeche comprises much of the westward portion of the peninsula; it is bounded north and east by the state of Yucatán, from which it seceded in 1867, and northwest by the Gulf of Mexico. The state lies on a low, level limestone plain, broken at the north by low hills. The northern half is arid and semiarid, chiefly composed of a district called Chenes (Maya, "wells") and marked by deep grottoes and caverns which are the principal supply of water. Where water is available, agriculture and stock raising are found. East and south of the state capital Campeche, excessive rainfall produces forested tracts that become tropical rain forest; high temperatures make much of it unhealthful and uninhabitable.

Rivers running through the southern half of the state drain into a large tidewater lake at Laguna de Términos, at the gulf entrance to which is the chief depot of the area, Ciudad de Carmen.

In 1951 the rail line that connected Campeche to Mérida, Yucatán, was linked to the trunk lines on the Mexican mainland, but coastwise and river shipping are still extensive. Airlines link the area with Veracruz, Mérida and Mexico City.

There was considerable commercial fishing and a promising oil potential in the second half of the 20th century, but the state's main products came from its forests—hardwoods, chicle, *palo de Campeche*. Chemical dyes almost killed the old dyewood trade. Fustic, hides and guitars are other products. (J. A. Cw.)

CAMPECHE (Campeche de Baranda), a port of Mexico and capital of the state of Campeche on the Yucatán peninsula. Pop. (1960) 43,874. About 90 mi. S.W. of Mérida, Campeche is connected with Mexico City by rail links completed in 1951 and with Mérida by extension of the same route. Campeche is a relatively poor port. Vessels drawing more than 9 ft. cannot clear its bar and must stand off nearly 10 mi. to discharge cargoes into lighters. Port works accommodating vessels up to 2,500 tons were constructed at nearby Lerma. Both places are unprotected and therefore are troubled by tropical "northers," strong winds which prevail from October through April.

The town, an attractive place with its historic walls erected for protection against 17th-century pirates and filibusters, fine public buildings, shady squares and colourful houses, lies on the western extremity of a fertile plain in a natural-amphitheatre formed by small hills encircling the bay. The Spanish town was founded in 1540 on the site of an earlier Maya village (Kimpech) whose remains are visible. In the 18th century Campeche was opened as one of three ports on the gulf and thrived on its monopoly of Yucatán trade, mainly exports of dyewood and salt. At various times in the early 19th century, Campeche was the capital of Yucatán. When the province seceded, it became the capital of the new state (1867). Opening of competitive ports at Sisal, then Progreso (1874), plus displacement of vegetable by chemical dyes reduced its economic importance, though it continued to do a brisk trade in dyewood, cotton, rice, sugar cane, tobacco, cigars and guitars. The old citadel, colonial churches, a theatre and market are chief sights. (Hd. C.; R. B. McCk.)

CAMPEGGIO, LORENZO (1474–1539), Italian cardinal, humanist, and lawyer, entered the service of the church in 1510 and at once became one of the most valued representatives of the papacy. Between 1511 and 1539 five popes employed him almost continuously as nuncio or legate; his political and religious embassies gave him a particular knowledge of Germany, where he was nuncio to the Emperor Maximilian in 1511 and 1513 and legate at the Diets of Regensburg (1524) and Augsburg (1530). In Rome his knowledge of curial procedure made him a realistic advocate of reform, though always loyal to the papacy. He first visited England on an unsuccessful mission for Leo X (1518–19), was given the See of Salisbury in 1524, and in 1528 went to England to enquire into the king's marriage with Catherine of Aragon as co-legate with Cardinal Wolsey; the case was withdrawn to Rome before a decision had been given.

After serving on preparatory commissions for the Council of Trent, Campeggio died in Rome on June 19, 1539. (M. Dk.)

CAMP FIRE GIRLS, the first nonsectarian, interracial organization especially for girls, was founded in South Casco, Me., in 1910 by a group of prominent educators including Luther Halsey Gulick and his wife, Charlotte. It was designed and continues as a highly flexible program, placing emphasis on the individual and encouraging each girl to achieve her full potential.

A nonprofit, specifically U.S., organization, Camp Fire Girls had more than 430 chartered Camp Fire Councils with groups in all 50 states in the late 1960s and a membership of 630,000 (77% girls and 23% adult volunteers, both men and women). The high adult ratio reflects the fact that small groups (10 to 14 girls) work with at least one adult. Programs are constantly updated for each age group: Blue Birds, 6–8; Camp Fire Girls, 9–11; Junior Hi, 12–13; Horizon Club, 14 through high school. A girl may join at any time and begin appropriate activities without making up preceding ranks. She selects her own area of specialization, or several subjects for diversification, sets her own goals, and proceeds at her own pace.

The insignia is crossed logs and flame. Symbols and honours are derived from the naturalistic, poetic lore of the American Indian. Wo-He-Lo—the watchword—means Work, Health, Love. The highest achievement award is the Wohelo Medallion.

Community service has always been emphasized. Camp Fire was the first national youth agency to receive a local council grant from the National Institute of Mental Health for the purpose of assisting girls with school problems, and the first to receive a Children's Bureau grant for an action-research program in three selected inner-city areas. The CF program has been adapted and implemented for retarded and handicapped children's institutions. Conservation and beautification projects are kept current in all councils.

The Gulicks founded the first girls' camp in 1888, and by the late 1960's, under local council jurisdiction, Camp Fire sponsored 150 resident and day camps, the camping experience being seen as increasingly valuable in the light of urban crowding and the identity crisis of youth.

The governing policy body, the National Council (150 regionally elected volunteers plus the national Board of Directors), meets annually. The organization's national headquarters is at 65 Worth Street, New York City.

Publications are *The Camp Fire Girl* magazine and program books for each age level.

CAMPHOR is a white, waxy substance, rather volatile and possessing a penetrating, somewhat musty, aromatic odour. For centuries camphor had been known and valued in the far east for its medicinal properties and odour. It was introduced into Europe and became known to alchemists, who did not, however, make a clear distinction between true camphor and borneo camphor (borneol). The first chemical investigations of camphor were carried out by A. Lavoisier, R. Boyle and J. B. Dumas. Lavoisier, in particular, demonstrated by chemical analysis that it was a compound of carbon, hydrogen and oxygen. The correct molecular formula, $C_{10}H_{16}O$, was established by 1833.

Historically, the term camphor was used to designate any of a considerable number of different compounds having the physical characteristics of camphor and possessed of aromatic odours. Examples are: borneol, $C_{10}H_{17}OH$; mint camphor (menthol), $C_{10}H_{19}OH$, and buchu camphor (diosphenol), $C_{10}H_{16}O_2$. (*See* also Terpenes.)

The production of camphor from the camphor laurel (*Cinnamomum camphora*) has been carried out on the island of Formosa and in neighbouring regions of China and Japan for centuries, and still represents an important industry there, although about half of the camphor used commercially is made synthetically from α-pinene, the principal component of turpentine.

Natural camphor is readily isolated by blowing steam through the chopped-up wood of the camphor laurel and condensing the vapours. Camphor crystallizes from the oily portion of the crude distillate. It is purified by pressing and sublimation. The oil left after the camphor has been removed is known as camphor oil. It still contains a considerable amount of dissolved camphor which is frequently isolated by fractional distillation. Camphor oil finds uses in the scenting of soaps and as a flotation agent in mining operations. Because of the commercial importance of camphor and camphor oil, reforestation programs to replenish the supply of camphor laurel trees were undertaken in Formosa and Japan during the 1950s.

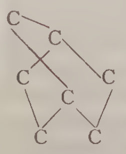
Camphor finds some use as a plasticizer or softening agent in cellulose nitrate plastics. It is also used as a plasticizer in some plastic film and in nitrocellulose explosives. Much of the production of camphor goes into cosmetic and medicinal products, where its use depends upon its odour and mild antiseptic and anesthetic properties.

CHEMISTRY OF CAMPHOR

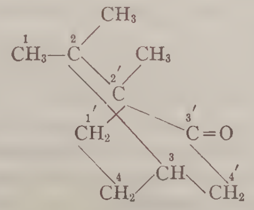
The camphor molecule is unsymmetrical and the substance occurs in two optically active forms known as *d*-camphor and *l*-camphor (*see* Stereochemistry). Of the two forms, *d*-camphor, which in solution rotates the plane of polarization of light in the clockwise direction, is the more abundant natural form. When pure it has a melting point of 178° C., and a specific optical rotation, $[\alpha]_D^{20}$, of 44.2° (20% solution in absolute alcohol). The left-rotating form, *l*-camphor, was not found in nature until 1848 when it was isolated from the oil of *Matricaria parthenium*.

Although the correct molecular formula for camphor was known early in the history of organic chemistry, the structure of the molecule was not determined until the beginning of the 20th century. Some idea of the structure problem can be gained from the fact that in the period 1870–95 more than 30 proposals for the arrangement of the atoms in the camphor molecule received consideration. The source of the problem was the unusual arrangement of seven carbon atoms in two rings (I) in the camphor molecule. Such bicyclic systems were unknown at the time, and, indeed, once it had been established that such a system was present in the camphor molecule, progress in the elucidation of other bicyclic structures became rapid.

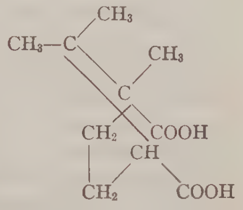
The correct structural formula for camphor (II) was proposed by J. Bredt in 1893, and although his hypothesis was not promptly accepted, it was fully validated by unambiguous synthesis within ten years. It had long been known that camphor on oxidation was converted into camphoric acid (III) from which camphor could be reformed by well-understood means, and it was in fact the proof of the structure of camphoric acid by rational synthesis that validated Bredt's formula for camphor.



I

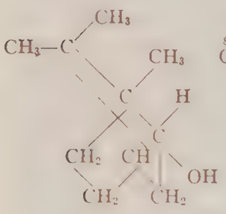


II

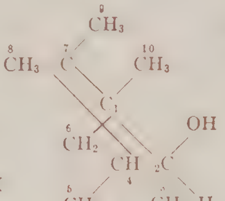


III

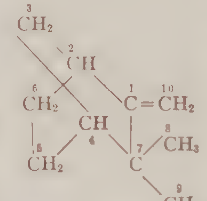
Camphor (II) is a ketone in the class of oxygenated bicyclic monoterpenes, and it conforms to the isoprene rule since its carbon skeleton can be divided into two isoprene units as indicated by the numbering in II. Reduction of camphor with sodium in alcohol gives borneol (IV), while catalytic hydrogenation using platinum black as catalyst produces mainly isoborneol (V). These two alcohols derived from camphor differ in the disposition of the OH group with respect to the $CH_3—C—CH_3$ unit. In borneol the OH group is directed away from the $CH_3—C—CH_3$ unit, while in isoborneol the OH group is directed toward it.



IV



V



VI

Both borneol and isoborneol when treated with dehydrating agents such as sulfuric acid yield camphene (VI). Isoborneol undergoes the change somewhat more readily. The formation of camphene from the borneols involves a rearrangement of the carbon skeleton (Wagner-Meerwein rearrangement), and it was just such rearrangements that plagued the efforts of early investigators to determine the carbon skeleton of camphor, for molecular rearrangement was but poorly understood at the time. In fact, the elucidation of the structures of camphor and the rearranged products contributed greatly to the present understanding of the processes by which one carbon skeleton is converted into another. The identifying numbers of the carbon atoms in the formula for isoborneol (V) are carried over into that for camphene (VI) to demonstrate the complexity of the change in skeletal structure accompanying the rearrangement.

To supplement natural sources of camphor several processes have been developed for its production from α-pinene, a very abundant terpene. Treatment of pinene with hydrogen chloride gas produces a mixture of bornyl and isobornyl chlorides with the former predominating. These chlorides correspond in structure to borneol (IV) and isoborneol (V) with Cl replacing OH, and their formation involves a molecular rearrangement of the carbon skeleton of pinene. Bornyl chloride has been known as "artificial camphor." Removal of hydrogen chloride from bornyl chloride by the action of alkali converts it into camphene (VI). Camphene is oxidized to camphor in one process. Another method for the production of camphor involves the addition of formic acid to camphene to form isobornyl formate (the formic acid ester of isoborneol) and subsequent saponification of the formate to produce isoborneol. Isoborneol is then oxidized to camphor. Catalytic processes for the formation of camphene from pinene have been developed in recent years. The synthetic camphor from these sources (*dl* or racemic camphor) is usually of low optical activity and consists mainly of a mixture of equal amounts of the dextro- and levo-rotatory forms.

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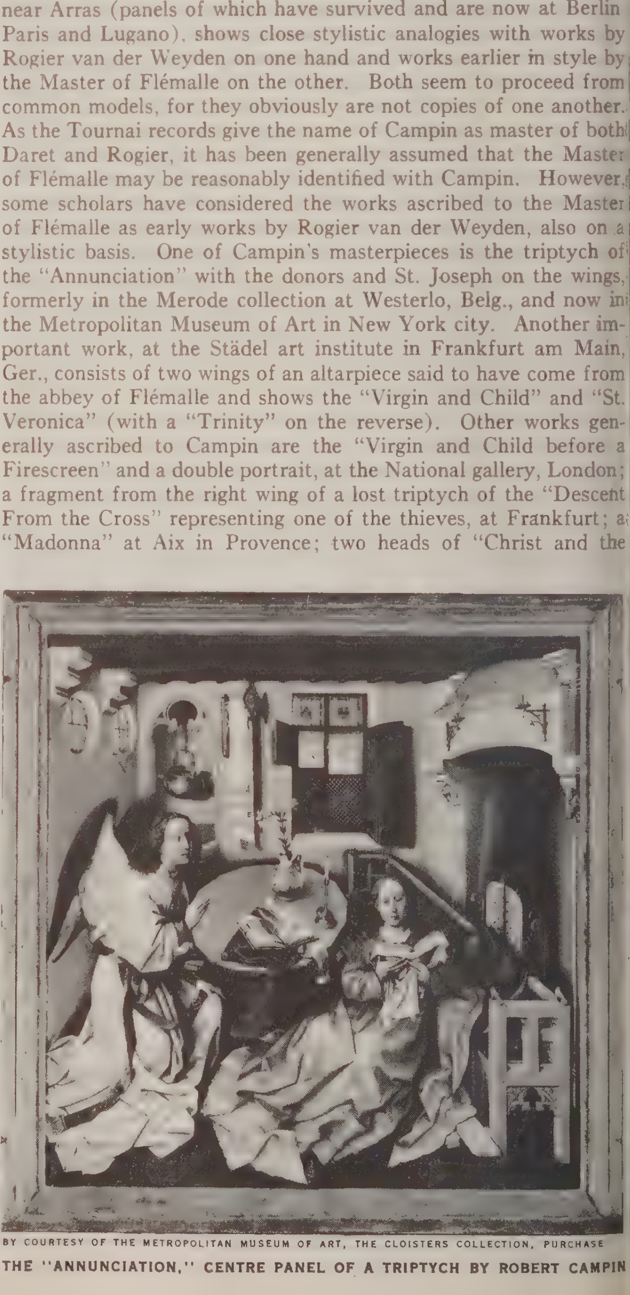
CAMPI, GIULIO (1502–1572), Italian painter and architect, who led in the formation of the Cremonese school, was born at Cremona. His work, and that of his followers, was elegant and eclectic. Campi was a prolific painter, working in both oil and fresco. At its best his work was often distinguished by the richness of its colour. He first studied under his father, Galeazzo Campi (1475–1563), and Bernardo Gatti (*c.* 1495–1575), and later formed his style under the influences of Giulio Romano (whom he reportedly once assisted on a painting in Mantua) and Pordenone. Among the earliest of his school were his brothers, Vincenzo (1536–1591) and Antonio (1536–*c.* 1591); the latter was also a sculptor and historian of Cremona.

Bernardino Campi (1522–*c.* 1592), a pupil of Giulio Campi, did extensive work as a painter of portraits and sacred subjects, and was active in many Italian cities outside of Cremona. Son of the goldsmith Pietro Campi, he early followed his father's profession, later turning to the study of painting under Giulio Campi and Ippolito Costa. Giulio Romano and Correggio had great influence upon his style.

Bernardino died at Reggio, Italy.

CAMPIN, ROBERT (*c.* 1378–1444), a painter of the school of Tournai (Belgium), is named in the archives of that city between 1406 and 1444 as being entrusted with decorative work by the town council. Two pupils are mentioned as entering his studio in 1427—Rogelet de la Pasture (generally identified with Rogier van der Weyden [*q.v.*]) and Jacques Daret. Campin died on April 26, 1444. An identification of Campin with the Master of Flémalle (the painter of the panels wrongly supposed to come from an abbey at Flémalle near Liège and now at Frankfurt) has been made on a stylistic basis. The only documented work by Jacques Daret, an altarpiece executed for the abbey of St. Vaast near Arras (panels of which have survived and are now at Berlin, Paris and Lugano), shows close stylistic analogies with works by Rogier van der Weyden on one hand and works earlier in style by the Master of Flémalle on the other. Both seem to proceed from common models, for they obviously are not copies of one another. As the Tournai records give the name of Campin as master of both Daret and Rogier, it has been generally assumed that the Master of Flémalle may be reasonably identified with Campin. However, some scholars have considered the works ascribed to the Master of Flémalle as early works by Rogier van der Weyden, also on a stylistic basis. One of Campin's masterpieces is the triptych of the "Annunciation" with the donors and St. Joseph on the wings, formerly in the Merode collection at Westerlo, Belg., and now in the Metropolitan Museum of Art in New York city. Another important work, at the Städel art institute in Frankfurt am Main, Ger., consists of two wings of an altarpiece said to have come from the abbey of Flémalle and shows the "Virgin and Child" and "St. Veronica" (with a "Trinity" on the reverse). Other works generally ascribed to Campin are the "Virgin and Child before a Firescreen" and a double portrait, at the National gallery, London; a fragment from the right wing of a lost triptych of the "Descent From the Cross" representing one of the thieves, at Frankfurt; a "Madonna" at Aix in Provence; two heads of "Christ and the


BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, THE CLOISTERS COLLECTION, PURCHASE

THE "ANNUNCIATION," CENTRE PANEL OF A TRIPTYCH BY ROBERT CAMPIN

Virgin" in the Johnson collection at Philadelphia, Pa.; a "Marriage f the Virgin" in Madrid; a "Nativity" at Dijon; an "Entombment" in the collection of Count Seilern in London; a "Trinity" nd a "Madonna and Child at the Chimney" in Leningrad. To Campin's last period belong the wings of an altarpiece in Madrid dated 1438 and painted for Heinrich von Werl, a notable professor t Cologne.

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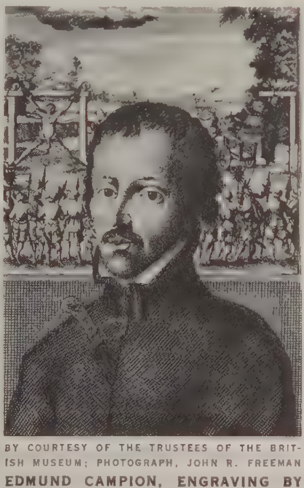
(J. FE.)

CAMPINAS, a city in São Paulo state, Braz., 65 mi. N.W. f the city of São Paulo by rail and 114 mi. from the port of antos, with which it is connected by the Paulista and Santos-undiaí railways. Pop. (1950) city 99,156, municipality 152,47; (1960) city 179,797. Campinas is the commercial centre of one of the state's oldest coffee-producing districts and the outlet or a rich and extensive agricultural hinterland. The Mogiana railway starts from this point and extends north to Minas Gerais state, while the Paulista lines extend northwest into settled and very ertile regions; the Sorocabana railway also reaches the city. Locally, coffee has given way to diversified farming. The industries of Campinas include foundries, textile mills, and packing and processing plants; agricultural equipment is also manufactured. The state agronomical institute with large experimental plantations and other institutions devoted to raising agricultural production are located there. The city has a faculty of pharmacy and denistry affiliated with the University of São Paulo, and higher intitutions for liberal arts, economics and law. (R. M. M.)

CAMPION, EDMUND (1540–1581), English Jesuit executed as a traitor by the government of Elizabeth I, was born in London on Jan. 25, 1540, and educated probably at Christ's Hospital or at St. Paul's and at St. ohn's College, newly founded at Oxford by Sir Thomas White, a patron of Campion. His Catholic endencies became known and his scholarship benefactors demanded an assurance that he was a sincere Protestant. Rather than give this, he left Oxford and, after a stay in Dublin, eventually went, to escape the attentions of he English government, to Douai in northern France to join the English college founded there (1568) by William Allen. He was eceived into the Roman Church and in 1573 went to Rome to join he Society of Jesus. He was sent to Prague and conducted uccessful missions among the Hussites. In 1580, under the eadership of Robert Persons, he was sent on a dangerous mission to England, where Catholic practices were strictly proscribed. After precarious ministering in Berkshire, Oxfordshire, Northamptonshire, and Lancashire, Campion caused a sensation by having 400 copies of his *Decem Rationes* against the Anglican Church distributed in St. Mary's, Oxford, before the degree-giving ceremony on June 27, 1581. Shortly afterward, on July 14, while preaching at Lyford, Berkshire, he was arrested by a spy named George Eliot and taken to London. He was several times examined, gave word of his loyalty to Elizabeth, mpressed his hearers by his strength of argument and his gaiety, and was then racked in an effort to make him recant and deny his adherence to Roman Catholicism. On Oct. 31 he was accused at Westminster of having conspired with others at Rome and Reims to dethrone the queen. On Nov. 20, after being found guilty, he claimed: "If our religion do make us traitors we are worthy to be condemned; but otherwise we are and have been as good subjects as ever the Queen had." Campion was sentenced to death as a traitor and executed on Dec. 1, 1581. Of all the English Jesuits who suffered for their allegiance to Roman Catholicism Campion is the best known. His life and his aspirations were pure, his zeal true, and his loyalty unquestionable. He was beatified in 1886. Campion Hall at Oxford is named after him.



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM; PHOTOGRAPH, JOHN R. FREEMAN

EDMUND CAMPION, ENGRAVING BY J. M. LERCH

See E. Waugh, *Edmund Campion,* new ed. (1961). (P. CN.)

CAMPION, THOMAS (1567–1620), English physician, poet, composer, and musical and literary theorist who is one of the outstanding songwriters of the English lutenist school. His poetry reflects his quality as a musician in its subtle mastery of rhythmical and melodic structure.

He was born in London on Feb. 12, 1567, the son of John Campion, and Lucy, *née* Searle. On John Campion's death in 1576, Lucy married Augustine Steward, one of the queen's sergeants at arms. When Lucy died in 1580, Steward married Anne Sisley, and in 1581 Campion was sent to Peterhouse, Cambridge. There is no record of matriculation or degree for Campion, though he stayed till 1584. In 1586 he was admitted to Gray's Inn, where he took a full part in social activities, contributing to the *Gesta Graiorum,* a masque performed in 1594. We do not know how long he remained, but he was probably still there in 1595. He was never called to the bar. He may have seen service with the gentlemen adventurers from London who went to help Henry IV of France in 1591. It is not known where he was for more than ten years before 1606, when lines prefixed to Barnabe Barnes's *Foure Bookes of Offices* are by "Tho: Campion, Doctor in Physicke." There are no records of Campion's studying medicine at Oxford or Cambridge. Though there is no doubt that Campion went abroad, continental university records of the time are sparse, and he appears nowhere in them. France is the only foreign country mentioned in his writings, and he may have read medicine there; but Leiden was famous for medicine, and 17th-century Dutch translations of Campion's poems suggest that he may have been known in Holland. He practised medicine, apparently with honour, for the rest of his life. Through one patient and patron, Sir Thomas Monson, he was connected with the notorious Overbury poisoning case of 1613 (*see* OVERBURY, SIR THOMAS), but he, with his patron, can be acquitted of knowing complicity. He died in London, on March 1, 1620.

Works.—Campion's first publication was five sets of verses appearing anonymously in Newman's surreptitious 1591 edition of Sidney's *Astrophel and Stella.* In 1595 came *Poemata* (Latin epigrams). In 1601 *A Booke of Ayres* appeared; the music of the first part was by Campion, that of the second by Philip Rosseter, but almost certainly the words of both parts were by Campion. *Obseruations in the Art of English Poesie* came out in 1602 (and was answered by Daniel's *Defence of Ryme*). Campion wrote a masque in 1607, and three more in 1613. *Two Bookes of Ayres* probably appeared in this year. *The Third and Fourth Booke of Ayres* came out in 1617, and probably at about the same time he wrote the undated *A New Way of Making Fowre-Parts in Counter-point.* His last publication was an enlarged *Poemata* (1619). He also wrote several sets of occasional verses. He is often mentioned by contemporaries as an elegant Latinist, and as "musicks and poesies stout Champion."

The work of most lasting interest is undoubtedly the lyrical poetry and the song-settings, but Campion is not negligible as a literary and musical theorist. His attack on rhyme in the *Obseruations* (which he largely denied in practice) has tended to obscure the value of his insistence that timing is the fundamental element in verse structure, that the sensitive ear is the judge of verse, and that in English verse the larger units of line and stanza provide the temporal stability within which feet and syllables may be endlessly varied. His theories of music are slight, but one statement, "the third makes the cadence of the key," explains why his work was used and reissued late in the 17th century, when Thomas Morley's more learned work was neglected: it shows that Campion thought naturally in the modern key system with major and minor modes rather than in the old modal system.

Theory facilitated some good practice. Campion's music (always for "ayres," not madrigals) is delicate, singable, and expressive. His quantitative theories of verse produced as one example the exquisite poem of which the first verse is

> Rose-cheekt *Lawra*, come
> Sing thou smoothly with thy beawties
> Silent musick, either other
> Sweetely gracing.

used to exemplify one form of unrhymed verse in the *Obseruations*. In it lack of rhyme does not obscure structure, for the poet's fine ear for syllables enables him to help the reader, with assonance, alliteration, and other devices, to hear the intended quantities. In his verse for music (usually rhymed) he also uses these devices so that the structure can still be heard when the words are separated from the music.

Campion's are the usual Elizabethan subjects: "Divine and Morall Songs" and "Light Conceits of Lovers." His originality lies in his treatment. Visual imagery is rare, and always generalized: "thy red and white" is all that he mentions of a mistress' colouring. Static pictures are reserved for ideas of a removed heaven: "Ever-blooming are the ioys of Heau'ns high paradice." Earthly delights are expressed in terms of sound or movement and change. Addressing a lady, he says

> Awake, thou spring of speaking grace, mute rest becomes not thee;
> The fayrest women, while they sleepe, and Pictures, equall bee;

and he seems to feel this about the whole natural world. Winds blow through his gardens, the seasons are at the point of change, sun and shadows fly after each other. Above all, experience comes alive to him through hearing. "Heau'n is Musick," and the highest earthly beauties are musical.

His insistent, yet delicate, appeal to ear rather than eye gives freshness to hackneyed subjects, and seems to suggest an immediate personal experience of even the commonest feelings.

Bibliography.—The *Works* were first edited by A. H. Bullen (1889, completed by *Songs and Masques, with Observations in the Art of English Poesy*, 1903). The standard edition is by P. Vivian (1909). For the scores of the songs, see *The English School of Lutenist Song Writers*, ed. by E. H. Fellowes, 32 vol. (1920–32). *See* also T. MacDonagh, *T. Campion and the Art of English Poetry* (1913); M. M. Kastendieck, *England's Musical Poet, T. Campion* (1938); B. Pattison, *Music and Poetry of the English Renaissance* (1948); C. M. Ing, *Elizabethan Lyrics* (1951). (C. M. I.)

CAMP MEETING was the name given to three- or four-day outdoor revival meetings held along the American frontier during the 19th century by the various evangelical denominations either singly or jointly. The origin is obscure, but historians have generally credited James McGready, a Presbyterian, with inaugurating the first typical camp meetings in 1799–1801 in Logan county, Ky., along the Gasper, Muddy and Red rivers. Other ministers who associated with McGready (William and John McGee, William McKendree and Barton W. Stone) spread his methods throughout the southwest. As the name implies, those who attended such meetings came prepared to camp out, gathering at the prearranged time and place from as far as 30 to 40 mi. away. Families pitched their tents around a forest clearing where log benches and a rude preaching platform constituted an outdoor church in almost constant session for four days. As many as 10,000 to 20,000 were reported at some meetings. People came partly out of curiosity, partly out of a desire for social contact and festivity, but primarily out of their yearning for religious worship. Camp meetings, through their preaching, their prayer meetings, anxious bench, hymn singing, weddings and baptisms, filled a definite ecclesiastical and spiritual need in the unchurched settlements of the west which itinerant home missionaries were not numerous enough to supply. Often scenes of wild enthusiasm and hysteria in the early years, camp meetings acquired a bad reputation among conservative churchmen. The Presbyterian Church refused to countenance participation in them after 1805. Nevertheless they were vigorously carried westward with the frontier by the Methodists, Baptists, Shakers, Disciples, and Cumberland Presbyterians, the latter two denominations being direct outgrowths of the camp meetings. The Methodist Church profited most by their popularity and gradually institutionalized them int its system of evangelism. By 1811 the Methodist bishop Franci Asbury reported in his journal that over 400 camp meetings wer being held annually along the frontier from Georgia to Michigan Although the theology of camp meeting preachers varied from modified Calvinism to pure Arminianism, the insistent emphasi upon a sudden conversion experience reduced doctrinal preachin to a minimum, broke down the old creedal standards and undermined the concept of a learned pastoral ministry. But the individualistic and activistic elements in Protestantism stressed i these meetings comported well with the character of frontier lif and eventually pervaded the religious outlook of rural America Camp meetings lingered archaically as summer Bible conference into the 20th century, but their significance passed after 189 with the frontier society that created them. Despite their occasional fanaticism and frenzy they helped in a crude way to brin the stabilizing and humanitarian force of religion to the raw wilderness settlements. *See* also Revivalism.

Bibliography.—Charles A. Johnson, *The Frontier Camp Meetin* (1955); Catharine C. Cleveland, *The Great Revival in the West, 1797 1805* (1916); Francis Asbury, *Journals*, 3 vol. (1852); Peter Cartwright, *Autobiography* (1857); Barton W. Stone, *The Biography o Eld. Barton Warren Stone, Written by Himself* (1847). (W. G. McL.)

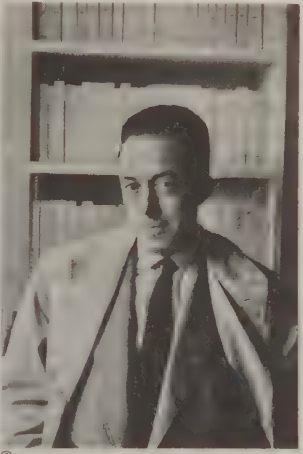
CAMPOAMOR Y CAMPOOSORIO, RAMÓN DE (1817–1901), Spanish poet and politician, chiefly remembered fo some short epigrammatic poems, was born at Navia (Asturias) o Sept. 24, 1817. As a member of a generation which missed th early idealism of Liberal excitement he rather reflects the calculate plot and counterplot characterizing mid-century parliaments an observes a moderate conservatism. He excels in epigrammati verses of worldly wisdom, which have the simplicity and force o proverbs and earned him in his day an undeserved reputation a master poet and philosopher. His permanent value lies in hi lively, economic expression of contemporary social attitudes an preoccupations with their bittersweet ironies of detail and thei mass sentiment disguised as individual thought. Certain of hi collected verses—*Doloras* (1846), *Pequeños poemas* (1871, etc.) *Humoradas* (1886)—were regarded by himself and others as symbolizing innovations in form and ideology. In fact they are neithe original nor greatly different from each other, but present, in varying proportions, his basic ingredients of satire and sensibility. On large canvases (*El drama universal*, 1869, or the drama *Dies irae* 1873) his inadequacy becomes more apparent. His early lyrics correctly forecast his facile talent. He died in Madrid on Feb. 12 1901. (I. L. Mc C.)

CAMPOBASSO, chief town and capital city of Molise region southern Italy, and an episcopal see, lies in a fertile plain. Pop (1961) 33,798 (mun.). The old town stood on a hill, surrounded by a wall with six towers and five gates and joined to the Castello de Monforte. In 1732 the people abandoned their feudal town and built a new town in the plain. The old town contains the castle (1459), lately restored, and the Romanesque churches of S. Leonardo, S. Bartolomeo, and S. Giorgio (13th century).

The new town has the neoclassical cathedral and a museum with relics of the Samnites, Frentani, and Campani. Agricultural products include the well-known pears which ripen in winter and the popular *scamorze* cheeses. The making of cutlery, long a speciality, has dwindled, but paving tiles and soap are made. The town is on the Benevento-Termoli railway (junction for Isernia). (M. T. A. N.)

CAMPRA, ANDRÉ (1660–1744), the most important French opera composer between Lully and Rameau, was born of Italian descent at Aix-en-Provence, Dec. 4, 1660. He is supposed to have been *maître de musique* at Toulon cathedral at the age of 19 and certainly held similar posts at Arles in 1681 and Toulouse in 1683. In 1694 he went to Paris as director of music at Nôtre Dame, where he was the first to introduce instrumental music into the services. Already well-known for his motets, he turned to secular music and produced his first dramatic work, *L'Europe galante*, in 1697 under an assumed name. In 1700 he gave up his church appointment and for 40 years enjoyed a wide reputation or his stage works. The opera-ballet in his hands became a harming vehicle for chain upon chain of danced and sung *diverissements* uncomplicated by any great dramatic unity. His regious music does not compare with that by Clérambault or Lalande but is nevertheless of power and beauty. Campra died at Versailles, June 29, 1744. (B. P.)

CAMUS, ALBERT (1913–1960), French essayist, novelist, nd playwright, whose influential and penetrating analyses of the redicament of the modern human conscience won him the Nobel Prize for literature in 1957, was born at Mondovi, near Constanine, Alg., on Nov. 7, 1913. His ather was killed in World War I nd he was brought up by his mother in difficult circumstances. He studied philosophy at the University of Algiers, but illness prevented his proceeding to post-raduate studies. He held various ositions such as meteorologist, tockbroker's agent, temporary ivil servant, and journalist while directing an amateur theatrical ompany. He remained keenly nterested in the technical aspects of the stage.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ALBERT CAMUS

His first books, *L'Envers et 'endroit* (1937) and *Noces* 1938), collections of essays, reveal, in a richly sensuous prose, his intense feeling for North Afica. His first journey outside it was in 1938, when he visited Spain, Czechoslovakia, and Italy. He went to France in 1939 and oined the Resistance movement in 1942. His first novel, *L'Étranger* (1942; Eng. trans., *The Outsider* [U.S. title, *The Stranger*], 1946), illustrates his favourite themes—the irrational nature of the world, its absurdity, and suicide—which were reaoned out in his essay *Le Mythe de Sisyphe* (1942; Eng. trans., *The Myth of Sisyphus*, 1955). After the liberation of Paris, his eading articles in the former underground newspaper *Combat* atracted considerable attention. They seemed to bridge the gap beween journalism and literature.

Several plays followed: *Le Malentendu* (1944; Eng. trans., *Cross Purpose*, 1948); *Caligula* (1944; Eng. trans., 1948); *L'État de Siège* (1948). In *Les Justes* (1950) Camus opposed the idealist nd humanitarian to the realist and implacable revolutionary. Later he devoted himself to ambitious dramatic adaptations: *e.g.*, William Faulkner's *Requiem for a Nun* (1956), and Dostoevski's *The Possessed* (1959; Eng. trans., 1960).

In 1947 he published *La Peste* (Eng. trans., *The Plague*, 1948). An allegory of the Resistance, this novel describes in a sober classial style a plague epidemic in North Africa. It raises the probems of responsibility and commitment for the believer and the unbeliever. In 1951 *L'Homme révolté* (Eng. trans., *The Rebel*, 953), a discussion of the ideology of revolution, had a mixed reception. Camus attempted to analyze the implications of ends and means. He examined the "individual terrorism" of the Rusian nihilists and contemporary "state terrorism" ("irrational" with the Fascists, "rational" with the Communists). Camus' conception of revolt had been attacked by the surrealist leader André Breton. It was now severely criticized by the leading French existentialist, Jean Paul Sartre. In 1956, with *La Chute* (Eng. rans., *The Fall*, 1957), a complex, ironical, and semiautobiographical monologue, Camus seemed to return to his earlier pessimism. n 1957 appeared a volume of short stories, *L'Exil et le royaume* Eng. trans., *Exile and the Kingdom*, 1958). *Réflexions sur la peine capitale* (1957), written jointly with Arthur Koestler, was an ppeal for the abolition of the death penalty.

Albert Camus died at the age of 46 in an automobile accident near Sens (Yonne), France, on Jan. 4, 1960.

Camus insisted that he was a moralist and not a philosopher. He was a characteristic representative of the 20th-century European rationalist tradition in which literature, ethics, and philosophy have tended to overlap. Confronted with the impossibility of religious belief, he tried to define the basic tenets of an atheistic humanism.

Like many French writers of the 1940s he was obsessed with what seemed to him the theoretical failures of Hegelianism and Marxism as well as the political errors and crimes of Communism. Many commentators, and especially those with an empiricist slant, have disputed his method of reasoning. Camus' talent as an artist, however, has rarely been seriously questioned. He was an acknowledged master of French prose.

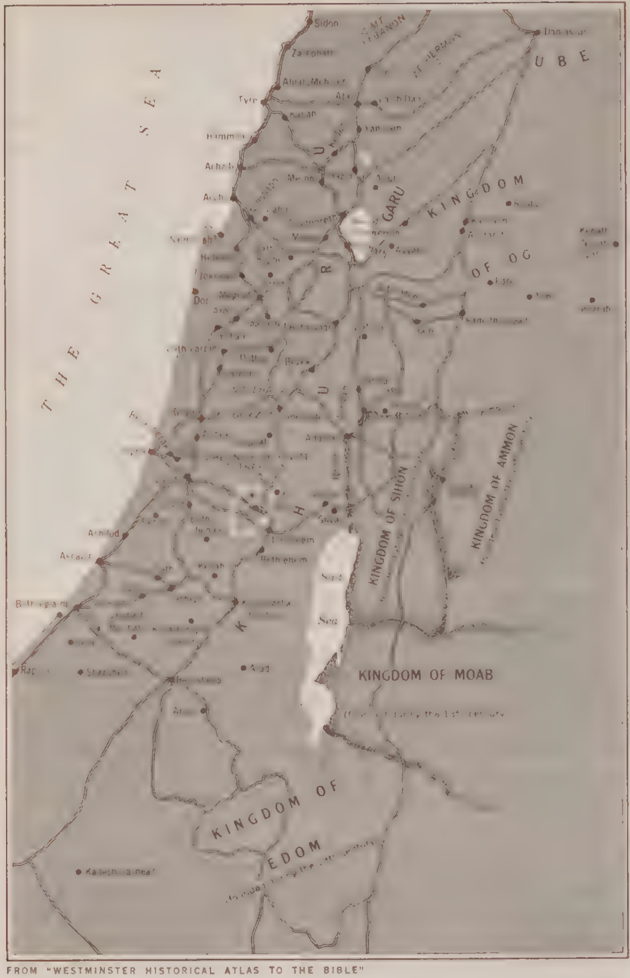
BIBLIOGRAPHY.—Publication of Camus' *Carnets* (notebooks) began in 1962; an English translation (*Carnets, 1935–1942*, by P. Thody) appeared in 1963. The works have been translated into more than 30 languages. A good selection in English is to be found in *The Collected Fiction of Albert Camus* and *Resistance, Rebellion and Death* (both 1961). For biography and criticism *see* R. de Luppé, *Albert Camus* (1951); P. Thody, *Albert Camus: a Study of His Work* (1957), *Albert Camus, 1913–1960* (1961); T. Hanna, *The Thought and Art of Albert Camus* (1958); J. C. Brisville, *Camus* (1959); G. Brée, *Camus* (1959), *Albert Camus* (1964), (ed.), *Camus: A Collection of Critical Essays* (1962); J. Cruickshank, *Albert Camus and the Literature of Revolt* (1959); N. A. Scott, *Albert Camus* (1962); C. Gadourek, *Les Innocents et les coupables: Essai d'exégèse de l'oeuvre d'Albert Camus* (1963); M. Lebesque, *Albert Camus par lui-même* (1963); A. King, *Camus* (1964). (O. To.)

CANAAN, probably meaning "Land of the Purple," is the ancient name for Palestine, found both in the Old Testament and in earlier Egyptian and cuneiform writings. Originally, it would seem, it denoted only the coastal strip from Acre (Akko) northward, being derived from the fact that the principal commodity of that area was a rich purple dye extracted from the murex shellfish in the adjoining waters. In this stricter sense—sometimes retained by biblical writers (Num. xii, 29: Josh. v, 1; Isa. xxiii, 11; Zeph. ii, 5)—it was translated into Greek as Phoenicia, from *phoinix*, "purple."

From early times, however, the name was also used in a wider and looser manner. Thus in the Amarna letters of the 14th century B.C. Canaan designates the entire Egyptian province of Egypt and lower Syria; in Gen. x, 19 it is said to extend from Hamath in the north to Gaza in the south, and in Josh. xi, 3 it includes territory east as well as west of the Jordan. On the other hand, "Canaanite" is employed at times in the Hebrew Scriptures to denote only one element of a complex population (Gen. xiii, 7; xv, 21; Ex. iii, 18); sometimes, too, it is simply a synonym for "merchant" (Isa. xxiii, 8; Zech. xiv, 21; Prov. xxxi, 24; Job xl, 30).

History.—Modern knowledge of Canaanite history and culture is derived both from archaeological excavations and from literary sources. The former, conducted mainly during the 20th century, have brought to light the remains of many important Canaanite cities—*e.g.*, Ai, Beth-shan, Byblos, Gezer, Hazor, Jericho, Lachish, Megiddo, Qatna, Shechem and Ugarit (*q.v.*)—as well as several of the temples and "high places" of the country. Among the literary sources special importance attaches to the Amarna letters (*see* TELL EL AMARNA)—a series of dispatches sent, in the 14th century B.C., by governors of Palestinian and Syrian cities to their Egyptian overlords—and to the celebrated Ras Shamra texts (discovered after 1929), which include, besides administrative records of the city of Ugarit, a series of mythological poems and cultic documents of the same period. These writings are in turn supplemented by references to the Canaanites in Egyptian literature (*e.g.*, the narrative of a certain Wen-Amon's journey to Phoenicia, *c.* 1100 B.C.), in Mesopotamian texts and in the Old Testament, as well as by sundry information furnished (in garbled form) by later Greek and Roman authors.

The civilization of Canaan can be traced to Paleolithic times. Skeletons of Neanderthal type (*Paleanthropus palestinensis*), estimated to date about 30,000 B.C., were discovered in caves near Mt. Carmel and the Sea of Galilee (Sea of Chinnereth); while at Wad' en-Natufeh, northwest of Jerusalem, and in the vicinity of Athlit, evidences of a Mesolithic culture (*c.* 8300–5000 B.C.) have been unearthed. The people involved seem to have been of Caucasian race and to have possessed some knowledge of farming.



FROM "WESTMINSTER HISTORICAL ATLAS TO THE BIBLE"

LAND OF CANAAN BEFORE ISRAELITE CONQUEST

Settlement in fixed towns and villages first appears in the subsequent Neolithic Age (*c.* 7000–4000 B.C.). There was then, of course, no acquaintance with the use of pottery, but crude mud figures of animals have been unearthed in the lowest levels of Jericho. The following Chalcolithic Age (*c.* 4000–3000 B.C.), characterized by the use of pottery and copper, is represented by excavations at Megiddo and Beth-shan, and especially at Teleilat el-Ghassul, north of the Dead sea. Typical of this period are houses of uncut stones, with walls made of mud brick and ornamented with geometrical designs. There is also evidence of the burial of infants in jars.

The introduction of metal in the Early Bronze Age (*c.* 3000–2100 B.C.) brought about a cultural revolution, marked by a decline in painted pottery, offset by the development of sculpture and metallurgy. Egyptian influence now presents itself, as attested especially at Ai in the central highlands and at Byblos on the coast of Syria. Greater protection against marauders is also characteristic of this period; at Ai, the settlement is girded by a triple wall, and at Megiddo by a massive bulwark. It was in this age that the Semites first entered the land.

With the Middle Bronze Age (*c.* 2100–1500 B.C.) the era of recorded history is entered. The dominant element of the population was now the Semitic Amorites (*q.v.*), who penetrated from the northeast and whose culture is represented especially by the discoveries at Mari (Tell el Hariri), on the upper Euphrates. These, however, were not the only invaders. The Egyptian Sesostris III descended upon the land *c.* 1850 B.C., capturing a city named S-k-m-m, identified by some scholars as Shechem; and a century later, Canaan was overrun by the Hyksos (*q.v.*), or "foreign princes," a mixed horde of Asiatics and others who appear to have swept down from the north and who succeeded also in dominating Egypt. Their settlements are distinguished by great rectangular enclosures surrounded by earthen ramparts—evidently designed to fence in the horses, which these invaders introduced into the country. The Hyksos appear to have established a more or less feudal form of society. Moreover, in the wake of the Aryan advance into the southern Caucasus, a people called the Hurrians (*q.v.;* the Horites of the Old Testament) now migrated southward into Syria and Palestine. Indeed, by the close of this period they had become so prominent an element of the population that the land now came to be designated by the Egyptians "the land of the Hurrians" (Huru).

The Late Bronze Age (*c.* 1500–1200 B.C.) is one of Egyptian domination. In the 15th century B.C., Thutmose III invaded Canaan and captured, among others, the cities of Joppa, Lydda, Gezer, Taanach and Megiddo, pushing northward as far as Aleppo. In the north, however, he came into contact with the powerful Hittites (*q.v.*) of Asia Minor and found his further progress impeded. In the following century, the Hittites took the initiative and marched southward as far as Byblos. Canaan now became something of a shuttlecock between the two empires, and its woes were further increased by constant incursions of marauders called Hapirue or Apiru. These people, a multi-ethnic group who for some reason possessed no full civil rights anywhere, are identified by many scholars with the original Hebrews, of whom the later Israelites were only one branch or confederation. The Amarna letters contain several references to their marauding expeditions.

During the reign of Ikhnaton (1379–62 B.C.), a king more preoccupied with religious reforms than with the preservation of his empire, Egypt increasingly lost its grip on Canaan. An attempt to regain this power was made later by Seti I, who conducted campaigns there, and, more intensively, by his imperialistic son Ramses II (1304–1237 B.C.). The Hittites, however, now offered formidable opposition. Ramses engaged them at Kadesh-on-the-Orontes (1288 B.C.), but the victory which the Egyptian records claim for him appears to have been somewhat academic. Within a few years, a treaty was concluded between the two powers, the Dog river (north of Byblos and south of Ras Shamra), being determined as the boundary between them. Thenceforth, however, Egypt's dominance over Canaan waned, and at the end of the Bronze Age the Hittites collapsed under the assault of enemies from the north.

It was during the transition from the Late Bronze to the Early Iron Age—roughly, about 1250 B.C.—that the Israelites, a confederation of the Hebrews, entered Canaan, settling at first in the hill country and in the south. The land was now clear of Egyptian sovereignty, but the stronger cities were still in the hands of the native Canaanites (Judg. 1, 19, 21, 27–36). Archaeological investigation has shown that the scriptural account of the invasion represents a foreshortened version of events that had been taking place during the preceding two centuries and that Jericho, for instance, must have fallen to earlier Hapirue invaders, not to the Israelites under Joshua. Israel's invasion, says the Book of Judges, was opposed not only by the Canaanites but also by Moabites, Midianites and Ammonites from the east.

In the following century, Canaan suffered further invasion at the hands of the Philistines (*q.v.*), who appear to have come from Crete, in alliance with other "sea peoples" (*q.v.*). Although they were headed off from Egypt by the vigorous measures taken against them by Ramses III, some of them managed nonetheless to gain a foothold on the southern coast of Canaan, where they eventually established a coalition of five city-states (Gaza, Ascalon, Ashdod, Ekron and Gerar), each ruled by a "tyrant" or headman. (It is from this people that the name Palestine is derived, though that name was later extended by the Romans to cover the entire country.) The Philistines were technologically in advance of the Israelites, having already learned the use of iron (*cf.* Josh. xvii, 16; Judg. i, 19). For a time they endeavoured to maintain their superiority by denying to their rivals the services of blacksmiths (I Sam. xiii, 19 ff.). Eventually, however, when the increasing extension of their power gave real cause for alarm, the Israelites rallied against them until, under the leadership of David, the main ower of the Philistines was effectively broken. At the same time, e native Canaanites too were vanquished, and Jerusalem was rested from them. Thenceforth Canaan became, to all intents nd purposes, the Land of Israel. To be sure, an attempt was ade at Sidon, around 1000 B.C., to revive the ancient civilization nd, since the Canaanites were extensive maritime traders, they tablished colonies in Cyprus, Sicily, Sardinia and other parts of e Mediterranean area, even voyaging so far as Spain. Most of hese colonies, however, collapsed within 200 years, and although me of those that survived proudly affected the ancient name even own to late Roman times, Canaan in the old sense of the term had y then long ceased to exist.

Culture and Religion.—Canaan stood at the crossroads of sevral cultures, and throughout its recorded history it manifests in s art and literature a mixture of many elements. Figurines of s principal goddess appear now in Egyptian, now in Mycenaean nd now in Cypriotic styles, and other deities are often portrayed ongside Egyptian symbols. Its pottery likewise shows the inuence now of Egypt, now of Crete. Among the Ras Shamra texts a Canaanite translation of a Hurrian myth, while elsewhere on anaanite soil fragments of the Mesopotamian Gilgamesh epic have ome to light.

Most of what is known about Canaanite religion is derived from series of tablets, in alphabetical cuneiform script, discovered fter 1929 at Ras Shamra, site of ancient Ugarit, on the north oast of Syria. The tablets themselves were inscribed in the 14th entury B.C., but their contents, being traditional, are doubtless far lder. The principal god was El, but the effective disposition of ainfall and fertility was delegated to Baal, or Hadad. Other imortant gods were Resheph, lord of plague and the nether world, nd Kothar, the divine craftsman. Goddesses included Asherah, onsort of El, Astarte and the virgin Anat.

The principal myth relates the combat of Baal, as genius of ain, against Yamm, lord of the sea and rivers, and Mot, the power f death and sterility. It is basically an allegory of the seasons. nother myth describes how a mortal youth named Aqhat came y chance into possession of a bow belonging to the goddess Anat. efusing to surrender it, he was put to death. His death was venged, however, by his sister, who slew the goddess' hired assasn. Aqhat was apparently resuscitated. This story has been xplained as a Canaanite version of the classical myth of Orion. third myth relates the adventures and misadventures of a king amed K-r-t in search of a bride and offspring. The Canaanite yths throw light on several passages of Old Testament poetry, reviously obscure. They make mention, for instance, of the ragon Leviathan. Similarly, figures of griffins flanking representaons of Canaanite sacred chests at last clarify the identity of the herubim who similarly protected the Israelitic Ark of the Coveant (*see* ANGEL).

Language and Script.—The language of the Canaanites may e described most conveniently as an archaic form of Hebrew, tanding in much the same relationship to that of the Old Testaent as does the language of Chaucer to modern English.

The Canaanites are the first people, so far as is known, to have sed an alphabet. A form of script recognized by most scholars s the parent of the Phoenician, and thence of the Greek and Latin lphabets, has been found in Late Bronze Age levels at Lachish, eth-shemesh and elsewhere, while at Ras Shamra a curious cuneiorm alphabet was in use. Furthermore, a peculiar form of writing, robably syllabic but as yet undeciphered, occurs on inscriptions f the Late Bronze Age from Byblos (*see* ALPHABET). Side by de with these innovations, however, the traditional syllabic cuneiorm of Mesopotamia was regularly employed. *See* also PALESNE: *Prehistory and History;* PHOENICIA.

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(T. H. G.)

CANACHUS, a Greek sculptor of the city of Sicyon in the latter part of the 6th century B.C. He made two great statues of Apollo with a stag and a bow, one in bronze for the temple at Miletus and one in cedarwood for Thebes. The former is represented on coins of Miletus.

CANADA is the largest self-governing country in the Commonwealth of Nations, although, with a population of 20,014,880 in 1966, it is by no means the most densely populated. With a total area, including land and fresh water, of 3,851,809 sq.mi., it is the largest country in the western hemisphere, being 6.5% larger than the United States (3,615,208 sq.mi.) and 17.2% larger than Brazil (3,286,470 sq.mi.). The only national territory in the world larger than Canada is the U.S.S.R. (8,649,489 sq.mi.).

TABLE I.—*Area of Canada*
(in square miles)

Provinces and territories	Land	Water	Total
Newfoundland	143,045	13,140	156,185
Prince Edward Island	2,184	—	2,184
Nova Scotia	20,402	1,023	21,425
New Brunswick	27,835	519	28,354
Quebec	523,860	71,000	594,860
Ontario	344,092	68,490	412,582
Manitoba	211,775	39,255	251,030
Saskatchewan	220,182	31,518	251,700
Alberta	248,800	6,485	255,285
British Columbia	359,279	6,976	366,255
Yukon	205,346	1,730	207,076
Northwest Territories	1,253,438	51,465	1,304,903
Franklin	541,753	7,500	549,253
Keewatin	218,460	9,700	228,160
Mackenzie	493,225	34,265	527,490
Total	3,560,238	291,571	3,851,809

Canada comprises the northern half of the continent of North America and its adjacent islands, except Alaska, a state of the United States. Its boundary on the south is parallel of latitude 49°, between the Pacific ocean and Lake of the Woods, then a chain of small lakes and rivers eastward to the mouth of Pigeon river on the northwest side of Lake Superior, and the Great Lakes with their connecting rivers to Cornwall, on the St. Lawrence. From there eastward to the state of Maine the boundary is a line corresponding to latitude 45°; then an irregular line partly determined by watersheds and rivers divides Canada from Maine, terminating on the Bay of Fundy. The western boundary is the Pacific on the south, an irregular line following mountain crests a few miles inland from the coast along the panhandle of Alaska to Mt. St. Elias, and the meridian of 141° to the Arctic ocean. On the east are the Atlantic ocean, Davis strait, Baffin bay and the waters separating Ellesmere Island from Greenland; on the north lies the Arctic ocean. The most northerly point of land in Canada is Cape Columbia at 83° 06′ N., the most southerly is Middle Island in Lake Erie at 41° 41′ N. From east to west, Canada extends from Cape Spear (52° 37′ W.) to the Alaska boundary (141° W.). Canada is divided into ten self-governing provinces and two territories which are administered by the federal government. The names and areas of these divisions are given in Table I. For historic sites *see* separate articles on the provinces and territories. (*See* also NATIONAL PARKS AND NATURE RESERVES.)

Following are the main sections and divisions of the article:

I. Physical Geography
    1. Geological Structure
    2. Surface Relief and Land Form
    3. Lakes and Rivers
    4. The Coast Line and Coastal Waters
    5. Climate
    6. Vegetation
    7. Soils
    8. Animal Life
II. Geographical Regions
  A. Physiographic Regions
    1. The Cordilleran Region
    2. The Appalachian Region
    3. The Innuitian Region
    4. The St. Lawrence-Great Lakes Lowland
    5. The Interior Plains
    6. The Hudson Bay Lowland

        - 7. The Arctic Lowlands and Plateaus
        - 8. The Canadian Shield
    - B. The Basis of Geographical Classification
        - 1. Atlantic Region
        - 2. St. Lawrence-Great Lakes Lowland
        - 3. Prairie Region
        - 4. Southern Cordilleran Region
        - 5. Northern Cordilleran Region
        - 6. Eastern Boreal Region
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        - 8. Arctic Region
        - 9. Geographical Pattern
- III. Native Peoples
    - 1. General
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- IV. History
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        - 1. The Company of One Hundred Associates
        - 2. Iroquois Wars
        - 3. Royal Province
        - 4. War With England
        - 5. Years of Peace
        - 6. British Conquest
    - B. Canada as Quebec
    - C. British North America
        - 1. Protest and Rebellion
        - 2. Union of Upper and Lower Canada
    - D. Confederation
        - 1. The Northwest
        - 2. The Atlantic Colonies
        - 3. The Quebec Conference and the Canadian State
    - E. The Dominion of Canada
        - 1. First Riel Rebellion
        - 2. Territorial Expansion
        - 3. Transcontinental Railroad
        - 4. The "National Policy"
        - 5. Second Riel Rebellion
        - 6. French-Canadian Nationalism
        - 7. Imperial Preference
        - 8. Support of the Empire
        - 9. Anti-American Feeling
        - 10. World War I
        - 11. Postwar Unrest
        - 12. External Affairs
        - 13. Economic Changes
        - 14. World War II and After
        - 15. National Sovereignty and Unity
- V. Population: Trends and Distribution
    - 1. Geographic Distribution
    - 2. Rural-Urban Distribution
    - 3. Natural Increase, Immigration, and Emigration
    - 4. Ethnic Composition
- VI. Administration and Social Conditions
    - A. Government
        - 1. Executive Power
        - 2. Legislative Power
        - 3. Judicial Power
        - 4. Taxation
    - B. Political Parties
    - C. Living Conditions
        - 1. Working Conditions
        - 2. Housing
    - D. Health and Welfare
        - 1. Health Services
        - 2. Welfare Services
    - E. Education
    - F. Defense
- VII. The Economy
    - A. Production
        - 1. Agriculture
        - 2. Forestry
        - 3. Mining and Minerals
        - 4. Fisheries
        - 5. Fur Production
        - 6. Electric Power
        - 7. Manufacturing
    - B. Trade and Finance
        - 1. Foreign Trade
        - 2. Banking, Currency, and Capital Markets
        - 3. National Finance
    - C. Transport and Communication

I. PHYSICAL GEOGRAPHY

1. Geological Structure.—Canada contains some of the oldest rocks in the world. They are found near the surface in an area of 1,600,000 sq.mi. surrounding the depression of Hudson bay, known as the Canadian shield. Belonging to the Precambrian, thes rocks include granites, gneisses, schists, quartzites and many othe crystalline rocks. These rocks contain many valuable mineral or yielding gold, silver, platinum, copper, nickel, cobalt, iron, lead an zinc, making Canada one of the greatest mining countries in th world.

Rock structures indicate that there were once great chains c mountains in the shield, but by the end of Precambrian time the had all been worn down to a relatively low level, which was lat invaded by the sea. Somewhat later the northeastern portion wa tilted up so that, in northern Labrador and Baffin Island, it ris to more than 5,000 ft. above sea level.

The weathered debris from this ancient land was deposit around it to form the stratified sandstones, limestones and shal comprising the Paleozoic system. In the central part of the co tinent where they rest on the unyielding rock mass of the shie they have been deformed relatively little, but along the sout eastern edge they have been pushed and folded to form the A palachian mountains. To the west and southwest, later Mesozo sediments were laid down upon large areas of the Paleozoic. Bo the Paleozoic and Mesozoic rocks contain coal, petroleum a natural gas, gypsum, salt, potash and other useful minerals addi greatly to Canada's natural wealth.

Toward the end of Mesozoic time there was crustal unrest alo the western margin of the continent. Under tremendous pressur thick rock formations were folded, faulted and upraised to for the Cordilleran region, 500 mi. wide from the Albertan foothil to the open Pacific, and containing the lofty peaks of the Rock mountains, the Columbia mountains, the Coast mountains and t mountains of Vancouver Island.

In the Mesozoic also, and perhaps somewhat earlier, there wa crustal unrest along the northeastern edge of the Canadian shiel giving rise to the Innuitian ranges of the northern arctic island

In parts of western Canada, particularly in southern Albert some younger, Tertiary rocks, derived from the erosion of the ear Rocky mountains, were laid down. They also have been erod but some remnants of Tertiary gravel remain in the upper leve of the Cypress hills and in the Rocky mountain foothills. Thu the hard old mass of crystalline rocks, the Canadian shield, whic gives shape and permanence to so much of North America, ma in places be buried by as much as 10,000 ft. of younger strat (*See* also PRECAMBRIAN TIME.)

Canada was almost completely glaciated during the Pleistocen thus the surface deposits are composed of either unsorted roc debris, or till, or water sorted gravels, sands, silts and clays. Th coarser materials are often found associated with the courses the ancient melt-water rivers, while the finer materials settled o on the floors of glacial lakes. Many of the best agricultural areas i both eastern and western Canada are to be found on the form floors of Lake Agassiz and other ancient lakes. (*See* PLEISTOCEN EPOCH.)

2. Surface Relief and Land Form.—Canada may be likene to an irregular basin, the lowest part of which is occupied by Hu son bay. Almost all around this central depression lie the hard o rocks of the Canadian shield, which locally may have a rough an rocky surface, but low and even, distant horizons. South and we of the Canadian shield lie vast plains underlain by horizontal bedded rocks. The lowlands along the St. Lawrence and low Great Lakes, and the lowlands of southern Manitoba, have larg areas of little relief, and for the most part are less than 1,000 f above sea level. The Great Plains of Saskatchewan and Albert are from 2,000 to 3,500 ft. above sea level. Vast areas have litt or no relief, except that provided by the valleys of the Saskatch wan river system. Other areas such as the Cypress hills and Woo mountains have a considerably rougher surface.

The greatest relief is to be found in the western rim of the C nadian basin where the young Cordilleran mountain systems hav many peaks between 10,000 and 20,000 ft. above sea level. Th eastern rim of Canada is also mountainous, although not so el vated as the west, for the ranges are older and more worn dow Nevertheless, some of the peaks in southeastern Quebec reach t about 4,000 ft., while the Torngats of Labrador are from 4,500 t

500 ft. high. The northeastern part of the rim is even higher, ith peaks in the United States range of Ellesmere Island ranging to 9,600 ft.

3. Lakes and Rivers.—The surface of Canada is well marked ith lakes and rivers. Besides the Great Lakes, of which Canada's iare is nearly 34,000 sq.mi., there are ten others varying from 600 sq.mi. to over 12,000 sq.mi. in area, the three largest being reat Bear (12,275 sq.mi.), Great Slave (10,980 sq.mi.), and innipeg (9,465 sq.mi.). There are more than 110 lakes with eas between 100 and 1,500 sq.mi. The total extent of surface ater could not be realized until recent years when aerial photogphy revealed tens of thousands of lakes of all shapes and sizes. ccurate mapping of 11,388 sq.mi. on the Canadian shield disosed no fewer than 10,500 small lakes.

The lakes often contain many islands; thousands can be counted Georgian bay, Lake of the Woods and Island lake. Small lakes e often rimmed with marsh and are slowly filling with peat to ecome bogs, or muskegs as they are known throughout northern anada. It is, in fact, difficult in some cases to distinguish beveen lake and marsh. It is probable that water surfaces account r about 10% of Canada's total area.

The lake basins, great and small, are largely the result of glaciaon. In some places the ice gouged out small rock basins while others it overdeepened existing valleys, at the same time, perps, leaving dams of glacial moraine across them. Such appears be the nature of the long mountain-valley lakes of British Combia. The shallow lakes and sloughs of the prairie provinces sult from the uneven surface of the glacial drift.

In most of Canada rainfall exceeds evaporation and plenty of ater is available to fill lakes at all times, but in the southern part the prairies and in the southern interior of British Columbia e summers are dry and small lakes may temporarily be transrmed into alkali flats.

The surface drainage, with the exception of very small areas of terior drainage, may be divided into drainage areas as shown in able II.

The largest, and longest, river in the arctic drainage area is e Mackenzie. Measuring 2,635 mi. from the Arctic ocean to its ost distant source in the Rocky mountains, this river drains an ea of approximately 700,000 sq.mi. Its chief tributaries are the eace and the Athabasca. The Mackenzie waterway is navigable r 1,644 mi. for tugs, barges and river boats which serve the fur ading posts and mining camps in its area.

The largest rivers draining to the Pacific ocean are the Yukon, e Fraser and the Columbia. The Yukon has a length of 1,979 i., of which the Canadian section is 714 mi. Long of service as transportation route, the river has a large power potential. The aser is 850 mi. in length. It contains the most important spawng grounds of the Pacific salmon. Its deep valleys also have proded the corridors for the building of the Canadian Pacific and anadian National railways to Vancouver, as well as routes for ovincial highways. The Columbia (total length, 1,214 mi.) has course of 459 mi. in Canada. The Kootenay, Arrow and Okanan lakes in its basin were important for navigation for many years. e Columbia drainage is also an important source of power.

The important river systems draining into Hudson bay include e Dubawnt, Churchill, Nelson, Albany, Moose, Eastmain and ottaway. All of these, and many smaller ones, were well aveled by the *voyageurs* of fur trading days. The Churchill ovides power for the Flin Flon mines. The length of the Nelson ver, to the most distant source of the Saskatchewan in the Rocky ountains, is 1,600 mi. It drains an area of 344,550 sq.mi. in the terior of Canada and the United States. In its mountain headters, and in its passage over the Canadian shield, it has important power sites. It is also used for irrigation in Alberta and Saskatchewan.

The largest river in the Atlantic drainage is the St. Lawrence. It drains an area of 306,900 sq.mi. and has a total length of 1,900 mi. The St. Lawrence and the Great Lakes provide a waterway into the heart of the continent which, since the opening of the St. Lawrence seaway, allows the entrance of large ocean vessels. The St. Lawrence and its tributaries provide several million horsepower of electrical energy for Canadian industries.

TABLE II.—*Drainage Areas*

Drainage basin	Area drained (square miles)	Percent of total area
tlantic drainage	580,097	15.29
udson bay drainage	1,421,350	37.47
rctic drainage	1,380,895	36.40
acific drainage	400,730	10.57
ulf of Mexico drainage.	10,121	2.7

4. The Coast Line and Coastal Waters.—Canada has probably the most extensive and irregular coast line of any country in the world. On three oceans and Hudson bay, it totals about 60,000 mi., estimated as follows:

Mainland.—Atlantic, 6,110 mi.; Pacific, 1,580; Hudson strait, 1,245; Hudson bay, 3,155; Arctic, 5,770; total, 17,860 mi.

Islands.—Atlantic, 8,680 mi.; Pacific, 3,980; Hudson strait, 60; Hudson bay, 2,305; Arctic, 26,785; total, 41,810 mi.

The great length and irregularity of the coast indicates that the continental mass has been drowned by a rising sea level. Around the margin of much of the continent there are large areas of shallow sea covering a continental shelf.

Off the eastern coast, the continental shelf extends about 250 mi. to the southeast of Newfoundland to form the Grand Banks, long noted as a major fishing area. A similar shelf off the southeast shore of Nova Scotia is crowned by the low, sandy crescent of Sable Island, on which many vessels have been wrecked. Fishing banks are found also in the Gulf of St. Lawrence and on the Labrador coast. There are also extensive continental shelves adjacent to the arctic islands. These have become noted for their oil reserves.

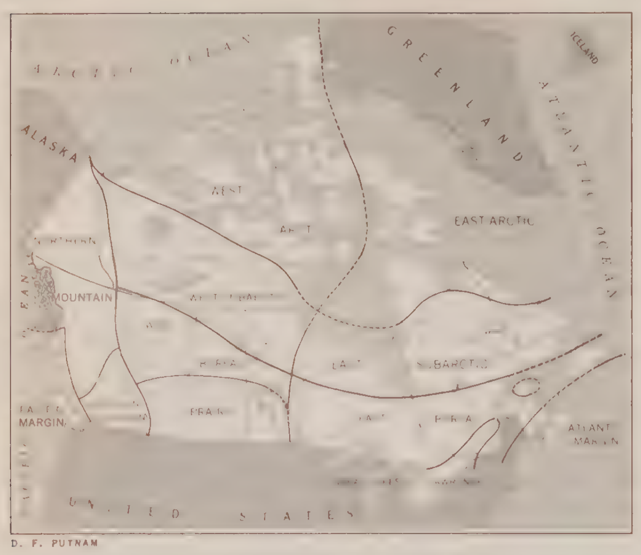
Cold arctic water tends to move south along the east coast, meeting the Gulf stream drift near the edge of the Grand Banks. This region thus becomes favourable for the growth of plankton upon which various fishes feed, while at the same time it is rendered subject to extensive surface fog. Drifting ice is also a hazard to navigation in spring and early summer.

Hudson bay is always cold, thus having an unfavourable influence on the climate of eastern Canada. Currents in the bay move in a counterclockwise direction, thus drifting the ice through the south side of Hudson strait into the Atlantic by the end of July. The Hudson bay ports are open to navigation from early August to mid-October.

The season of navigation decreases northward, varying with the winds and weather of the particular year, but the ice of the northwestern islands of the Queen Elizabeth group rarely breaks up, even in summer. With the exception of the southern coasts of Nova Scotia, New Brunswick and Newfoundland, the whole of the eastern coast is icebound in midwinter.

The Pacific coast does not have a broad continental shelf, but it has many bays and islands formed by the flooding of the margins of the western mountain systems. The waterway from Puget sound northward through the island-sheltered Inside Passage forms the steamship route to Alaska, as well as being the famous Pacific salmon fishing ground. The western coast of Canada is never icebound because of the drift of warm water from the Pacific ocean.

5. Climate.—The climate of Canada is under the influence of three great air masses. Cold and usually dry air moves southward from the arctic regions by way of the Mackenzie valley and Hudson bay. In winter this very cold air reaches the Great Lakes and may penetrate far south into the United States as a "cold wave." In summer such outbreaks are not so frequent and tend to move eastward through Hudson strait. Warm, moist air from the Gulf of Mexico and the Atlantic moves north to cover much of southeastern Canada in the summer. In winter this warm air may appear as a "thaw" in southern Ontario and the maritime provinces. The third great air mass is the mild, moist air from the North Pacific which impinges almost continually on the coasts of British Columbia and Alaska, bringing heavy winter precipitation. Crossing the mountains, it brings cloudy weather and scattered precipitation to the interior plains. Sometimes a fourth air mass, originating over the deserts of southwestern United States, may invade southern Canada in midsummer causing extended hot, dry periods.



D. F. PUTNAM

FIG. I.—CLIMATIC REGIONS OF CANADA

On the basis of temperature and moisture conditions, and the length of the growing season, Canada may be divided into climatic regions as shown in fig. 1.

Arctic climates are found north of the tree line, which is generally fairly close to the line of 50° F. average temperature for July. Low temperatures are compensated somewhat by long days. In the northern arctic the sun does not set for many weeks. On the other hand, the long, dark winters are bitterly cold. Permafrost, or permanently frozen subsoil, is almost universal. Much of the arctic gets only 5 to 10 in. of precipitation per year, most moisture being received in the eastern section. (*See* ARCTIC, THE: *Climate.*)

Subarctic climates lie south of the tree line but have less than five months in which the average temperature is more than 43° F. Winter cold is severe and in much of the area the subsoil remains permanently frozen. The western subarctic may get 10 to 12 in. of precipitation annually while the eastern area gets somewhat more, especially in the form of snow.

Boreal climates have average July temperatures above 60°, and growing temperatures for more than five months. The western section, with a summer rainfall maximum, gets from 12 to 14 in. per year while in the east, with much heavier snowfall, the yearly total may be two or three times as much. This is the area of Canada's pulpwood forests.

In the Atlantic climate, midwinter monthly temperatures average from 15° to 25° F. with about three months above 60° in the summer. Total precipitation ranges from 40 to 55 in. per year, the maximum being in the colder half of the year. From eight to ten feet of snow may fall per winter in some parts of New Brunswick and Newfoundland. The Atlantic coast is noted for summer fogs.

The Great Lakes-St. Lawrence region has much the same winter conditions as the Atlantic, but spring comes earlier and the summer is longer and warmer. The July temperature is 70° at Montreal and Toronto and somewhat higher in the interlake peninsula of southern Ontario. Precipitation is almost uniform from month to month, with the annual average ranging from 30 to 40 in. in different parts of the area. There is, however, some chance of summer drought. The prairie climate has a moderate supply of moisture, normally ranging from 12 to 16 in. per year, most of it falling as summer rain. Midsummer temperatures average about 65° F., while the midwinter average at Winnipeg, Prince Albert and Edmonton is around 0° F.

On the Pacific margin the winters are mild and wet, with temperatures seldom below freezing. Average summer temperatures seldom rise much above 60° F. Summer has less rain than winter with a tendency toward drought in the southern parts. Much of the area gets more than 80 in. of precipitation per year.

The western mountains have an extremely complicated set climatic conditions, depending upon elevation and exposure to rai bearing winds. High mountains, of course, have snow all the ye round. On the other hand, summers are warm and dry in the va leys between the southern ranges. July temperatures may avera 70° F. but the total rainfall may be only 10 in. per annum in t southern part of the Okanagan valley.

Much of Canada is too cold to be a desirable human habita while only the southern portion of the country has sufficient su mer warmth and length of growing season to support a successi agriculture.

6. Vegetation.—The pattern of vegetation is in very close a cord with the wide variation in climatic conditions. In gener there are three great plant associations: forest, grassland a tundra. Botanists, foresters and plant geographers, howeve usually recognize 13 subdivisions, or vegetative regions.

Acadian.—Prince Edward Island, Nova Scotia and most of Ne Brunswick are characterized by forests of red, white and bla spruce, balsam fir, white pine, hemlock, sugar maple, beech a yellow birch as well as many lesser species.

St. Lawrence-Great Lakes.—Covering a large part of southea Canada, this area formerly had magnificent stands of white pi which gave rise to the early Canadian timber trade. There we also excellent stands of sugar maple, beech, yellow birch, hemlo red pine, white cedar, elm, ash and, in some areas, red and wh oak. Much of the lowland has been cleared for agriculture second growth forest is found throughout the southern fringe the Canadian shield.

Deciduous.—A small area in southwestern Ontario has decidu hardwood forests resembling those of the adjoining United Stat Sugar maple, beech, basswood, red and white oak and butter hickory are characteristic. More rarely, also, such southern spec as black walnut, tulip tree, Kentucky coffee tree, mulberry, sy more and sassafras are found.

Boreal.—North of these areas, extending from Newfoundland Alaska, is a forest region in which coniferous needle-leaved tr are dominant. Among them are white and black spruce, bals fir and jack pine. There are large, poorly drained areas filled wi a growth of sphagnum moss and other water-loving plants for ing bogs, or muskegs.

Mixed Woods.—On the southern border of the Boreal regi stretching from Manitoba to British Columbia, the forest co tains a large admixture of deciduous broad-leaved trees, main various species of aspen and birch. This belt is usually known the mixed woods.

Parkland or Aspen Grove.—Between the mixed woods and open prairie is a belt in which the grassland is interspersed wi "bluffs," or small groves, of aspen and other deciduous trees.

The Prairies.—Stretching from the Red river (Red River the North) in Manitoba to the foothills of the Rocky mounta in Alberta is the northern portion of the interior grassland of Nor America, known to Canadians as "the Prairies." Botanists som times subdivide the Prairies into the tall grass, mixed grass a short grass belts, the distribution patterns being closely correlat with the amount and reliability of rainfall.

Rocky Mountain or Subalpine Forest.—On the slopes of t Rocky mountains, from 3,500 to 6,000 ft., there is a conifero forest with such species as Engelmann's spruce, alpine fir a lodgepole pine. Higher subalpine elevations have scrub fores and alpine tundra.

Columbia Forest.—Influenced by a belt of higher rainfall the Columbia mountains is a belt of forest containing Engelmann spruce, western red cedar, western hemlock and Douglas fir.

Montane Forest.—Found in the dry southern interior of Briti Columbia, the montane forest is characterized by ponderosa pi and is often interspersed with open grasslands.

Pacific Coast Forest.—The heaviest forest growth in Cana is found on the west-facing slopes of the mainland, Vancouv Island and other Pacific islands. There, such coniferous speci as western hemlock, western red cedar and Douglas fir grow tremendous size.

Subarctic Forest.—Constituting the northern border of t

Boreal region and effecting a transition to the tundra is a belt of inferior coniferous forest, eventually giving way to small stunted growths which have caused this belt to be known as "the and of little sticks."

Tundra.—More than one-third of Canada is composed of treeless plains, covered with lichens, moss, sedges and other low-growing plants. Permafrost underlies most of the area, thawing to a depth of one to three feet each summer.

Natural vegetation is an indicator of climate. The mild winters, warm summers and adequate moisture of the region near Lake Erie encourage the growth of many deciduous hardwood trees. The deep, cold waters of Lake Superior, on the other hand, give a boreal character to its shores. On the plains of the interior, the dominating factor is moisture supply. In southern Saskatchewan and Alberta, where rainfall is 10 to 12 in. per year and summer evaporation is high, the natural vegetation consists of short grasses, sage and cactus. Northward, through the mixed grass and tall grass prairies, rainfall increases somewhat and evaporation decreases. In the parkland and the border of the forest, precipitation is 15 to 16 in. but is relatively more effective because of lessened evaporation. Much of the northern forest belt has no greater rainfall but its evaporation is still lower. In the mountains zonation of vegetation is influenced by altitude. Valley bottoms often have deciduous trees, lower mountain slopes have good commercial stands of conifers, the cool upper slopes have a rather stunted growth and finally the tree line is defined by the high winds and intense cold of the peaks.

7. Soils.—Like the vegetation, the soils of Canada may be considered in three great regional groups: tundra soils, pedocals or grassland soils, and the podsols and podsolic soils of the forested area.

Tundra soils have not been investigated fully. They are underain by permafrost and the shallow surface layer which thaws in summer is chiefly composed of organic matter and usually is poorly drained.

The eastern podsols in the more humid environment of the Atlantic provinces are often intensively leached and somewhat infertile. Somewhat less leached brown podsolic soils are found in the Appalachian uplands of Quebec and on the southern fringe of the Canadian shield in Quebec and Ontario. Gray-brown podsolic soils n the lowlands of the lower Great Lakes and St. Lawrence developed on glacial and lacustrine materials, under a cover of mixed, deciduous forest. These are the most fertile soils in eastern Canada and helped to promote a vigorous and successful agriculture. The northern podsol region comprises the southern half of the Canadian shield. Most of its parent materials are acidic and the debris from the boreal coniferous forest also tends to have an acid reaction. This region contains large areas of rocky soils and much poorly drained land. Some agricultural settlement has aken place on the smooth terrain of the clay belt in western Quebec and northeastern Ontario. In the mixed woods region the soils are podsolic but not so highly leached as the true podsols; they are known as gray-wooded soils.

Three well-marked soil zones are recognized in the grasslands of western Canada. Brown soils are found under the short grass vegetation of the dry area in southwestern Saskatchewan and southeastern Alberta. East, north and northwest of this dry belt is a crescent of dark brown soils, more or less agreeing with the area of mixed grass vegetation. The dark brown soil zone is the most noted wheat producing area in Canada. Still outward, another concentric zone, the black soil area, has a tall grass cover because of greater effectiveness of the moisture supply. Deep, and rich n organic matter, these are among the most fertile soils in Canada. Wheat is grown there but mixed farming, with oats, barley and ivestock, is increasingly important.

The soils of the Cordilleras, as in any mountain area, are complex, owing to the variety of slope, climate and vegetation. Some areas of grassland soils in the southern interior valleys of British Columbia have been turned into highly successful fruit farms under irrigation and there is some mixed farming on the gray-wooded soils further north.

While only a relatively small area of Canada has been subject to detailed soil surveys, enough reconnaissance work has been done to show that most of the good agricultural soils are already in use. (D. F. Pu.)

8. Animal Life.—The larger animals of Canada are the musk ox and the caribou of the barren lands, both having their habitat in the far north; the caribou of the woods, found in all the provinces except Prince Edward Island; the moose, with an equally wide range in the wooded country; the Virginia deer, in one or other of its varietal forms, common to all the southern parts; the black-tailed or mule deer and allied forms, on the western edge of the plains and in British Columbia; the pronghorn on the plains; and small herds of the once plentiful bison in northern Alberta. The wapiti, or American elk, at one time abounded from Quebec to the Pacific, ranging as far north as the Peace river, but is now found only in small numbers from Manitoba westward.

In the mountains of the west are the grizzly bear and the black bear. The black bear is also common to most other parts of Canada; the polar bear along the arctic coasts. The large or timber wolf is found in the wooded districts of all the provinces, and on the plains there is the coyote. In British Columbia roams the puma or cougar, and generally distributed in wooded areas are the common fox and its variety, the silver fox, also the lynx, beaver, otter, marten, fisher, mink, skunk and other fur-bearing animals. The wolverine is largely confined to the southern edges of the tundra, which is also inhabited by the arctic fox. Mountain, plain and arctic hares and rabbits are plentiful or scarce in localities according to seasons or other circumstances. In the mountains of British Columbia are the bighorn or Rocky mountain sheep and the Rocky mountain goat, while sheep of two or three other species also are found, from nearly pure white in the north to black in certain areas in the southern Canadian Rockies.

The birds of Canada are mostly migratory, and are those common to the northern and central states of the United States. Wild fowl are numerous, particularly in the west, their breeding grounds extending from Manitoba and the western prairies north to Hudson bay and the arctic lowlands. The several kinds of geese, including the Canada goose, the snow goose or wavey, the brant and others, all breed in the northern regions, but are found in great numbers throughout several provinces, passing north in the spring and south in the autumn. Loons are common. The few whooping cranes that survive nest in southern Mackenzie and northern Saskatchewan. There are several species of grouse, including the ruffed grouse, ptarmigan and sharptailed grouse of the plains. In certain parts of Ontario the wild turkey formerly occurred, and in the 1950s game conservationists successfully transplanted them from the southern Atlantic coast of the United States; the quail, or bobwhite, still inhabits the southern part of the province.

The golden eagle, bald eagle, osprey and a large variety of hawks are common in Canada, as are the snowy owl, the horned owl and other owls. The raven is found only in the less populated districts, but the crow is common everywhere. Songbirds are plentiful, especially in the wooded regions, and include the American robin, oriole, thrushes, the catbird and various sparrows; while the introduced English sparrow has multiplied excessively and become a nuisance in the towns. Spreading rapidly are the European starling in the east and the Japanese starling in British Columbia. The smallest of the birds, the ruby-throated hummingbird, is found everywhere, even up to timber line in the mountains. Sea birds include a variety of gulls, terns, guillemots, cormorants and ducks, and in the Gulf of St. Lawrence the gannet is abundant. Nearly all the sea birds of Great Britain are found in Canadian waters or are represented by closely allied species.

The Migratory Birds Convention act of 1923 involved an agreement between the United States and Canada for the protection of bird life. (E. M. W.; J. R. Dy.; J. L. R.)

II. GEOGRAPHICAL REGIONS

Canada, with an area of almost 4,000,000 sq.mi., covers such an extremely large area that it cannot be properly comprehended unless it is divided into significant geographical regions. Political divisions, such as provinces and territories, are, of course, significant politically. The boundaries, however, tend to be rather arbitrary and artificial. In fact, some are simply parallels of latitude and longitudinal meridians cutting indiscriminately across both natural and human areas. Nevertheless, for many geographical purposes, it is necessary to refer to the political pattern because of the organizing authority of the provincial government and the economic and social centrality of the largest cities.

A. Physiographic Regions

Another pattern of fundamental significance in Canadian geography, as it is elsewhere, is the pattern of associations of land forms—the physiographic regions shown in fig. 3. Eight major divisions of greatly varying size have been mapped.

1. The Cordilleran Region.—The Cordillera of western Canada comprises most of the Yukon and British Columbia, together with narrow, adjoining sections of the Northwest Territories and Alberta. It may be divided into five major structural zones, trending northwesterly and roughly parallel to the Pacific coastline.

(a) The eastern system includes the Rocky, Mackenzie and Arctic mountains. Typified by the Rockies, these mountains rise in long chains with general elevations of 7,000 to 9,000 ft. (2,130–2,740 m.), with few through passes, and with many peaks ranging from 10,000 to 12,000 ft. (3,050–3,660 m.).

(b) Interior plateaus and mountain ranges form a rather complex upland surface from 3,000 to 6,000 ft. (915–1,830 m.) in British Columbia and the Yukon.

(c) The Coast mountains, a complex mountain area, form the coast of mainland British Columbia and provide the boundary between the province and Alaska. Some peaks in this area are higher than any in the Rocky mountains.

(d) The coastal trough which borders the Coast mountain area is a deep downfold drowned by the waters of the Pacific ocean.

(e) The Insular mountains comprise an upfolded region to the west of the coastal trough. Vancouver and Queen Charlotte islands represent the axis of greatest uplift, which is continued northward in the Alaskan Islands and the St. Elias mountains.

2. The Appalachian Region, occupying southeastern Quebec, the Maritime Provinces, and the Island of Newfoundland, consists of old worn-down mountain ranges and intervening basins. It is bordered by a wide continental shelf, shallowly submerged by the margin of the Atlantic ocean.

3. The Innuitian Region is a third mountain region, found in the far north, comprising a large part of Ellesmere Island and some neighbouring islands.

4. The St. Lawrence–Great Lakes Lowland, the smallest of the regions, is underlain by horizontally bedded limestones and other sedimentary rocks while the surface deposits and relief result from glaciation and inundation by postglacial lakes and seas.

5. The Interior Plains, lying between the Cordilleran region and the Canadian shield, occupy a very large area from the international boundary to the Arctic ocean. The underlying rocks are chiefly horizontally bedded limestones, sandstones, and, especially, great thicknesses of shale. The surface is a complex mosaic of glacial and postglacial landforms. Differences in general elevation, relief, and landform associations have influenced physiographers to further note four subregions: (a) First Prairie level, (b) Second Prairie level, (c) High plains, and (d) Mackenzie lowland.

6. The Hudson Bay Lowland, largely occupied by Hudson bay itself, is a great depression in the Canadian shield, floored by younger sedimentary rocks, similar in many respects to those of the St. Lawrence–Great Lakes lowland.

7. The Arctic Lowland and Plateaus comprise large areas in the Arctic archipelago together with smaller areas of the adjacent mainland. Structurally, this region is comprised of three basins of sedimentary rocks separated by portions of the Innuitian region and the Canadian shield.

8. The Canadian Shield, largest of all Canadian physiographic regions, underlain by rocks of Precambrian age, encompasses approximately half of the whole surface. Extending from Great Bear lake in the northwest to the Strait of Belle Isle on the east and to the Great Lakes lowland on the south, to Baffin Island and even to Devon and Ellesmere islands to the north, it entirely surrounds the Hudson bay depression. It reaches beyond Canadian territory to include a small area in New York state, as well as areas west and south of Lake Superior. In reality, its presence is much more widespread than its mapped area would indicate: the basement beneath Hudson bay, the St. Lawrence–Great Lakes lowland, and the Interior plains, not only of Canada but of a large part of the United States as well, is composed of rocks of similar age and lithology. Undoubtedly, the Canadian shield is the solid nucleus which, throughout the ages, has given form and permanence to the land mass of North America.

The evolution of the Canadian shield extended through four-fifths of recorded geological time; the ages of some of the rocks in such far-flung areas as Great Bear lake, the Labrador coas and the uplands near Lake Superior have been determined a about 2,500,000,000 years. In other areas the rocks may be only half as old. Age is not the only variable in this vast area. On the basis of structure and rock type, Canadian geologists have divided the shield into at least eight provinces, of which three Superior, Churchill and Grenville, contain highly mineralized areas. Most of Canada's great deposits of gold, iron ore, nickel copper and uranium occur in these areas. In vast areas, as yet, few economic mineral occurrences have been found.

Despite evidence of the existence of complex Precambrian mountain systems, the general surface of the shield is low, and while locally it appears very uneven, the skyline is remarkably uniform There are, however, certain elevated areas. In the southwest, near Lake Superior, upland surfaces at some points reach 2,000 ft. (610 m.). In the southeast, the edge of the shield overlooks the St Lawrence lowland as a long escarpment upon which isolated rock masses rise to more than 3,000 ft. (915 m.), while along the Labrador coast, the Mealy mountains in the south rise to more than 4,000 ft. (1,120 m.), and the Torngats in the north to about 5,000 ft. (1,525 m.). Large plateau areas in Labrador and Ungava are more than 2,000 ft. high.

B. The Basis of Geographical Classification

Useful as the foregoing may be, and absolutely necessary to an understanding of Canadian geography as it is, nevertheless, it does not provide a complete basis for a system of geographical regions which must recognize all of the significant factors. Many geographers argue that such a system is an impossibility, yet all would agree that significant differences and similarities exist within mos areas, and most certainly within a half-continent such as Canada The selection of the criteria for regional definition, therefore, mus be consonant with the purpose in hand: to divide Canada into a number of recognizable regions basic to an understanding o national development. The important considerations are location, physical conditions, settlement and land use patterns, and population distribution. Only the core areas will have a reasonable degree of homogeneity, but they will be surrounded by closely related fringe areas. There will also be remote areas, seemingly unrelated to any core.

Looking first at the people of Canada, the population is concentrated in four major but unequal areas near the southern border the St. Lawrence–Great Lakes lowlands, the coasts of the Atlantic ocean and its inlets, the Prairie plains, and the southwestern part of British Columbia. These are the core areas, if not the exact boundaries, of four major regions of human settlement and economic activity. Elsewhere, the sparse population makes it necessary to examine physical criteria. It is easy to understand the difference between plains and mountains, hence the western Cordilleran systems may be considered as a unit. The southern part has a well-developed network of transportation systems connecting a scattered group of populated places. The northern part has few centres of population, while large areas have no transportation facilities. North of the Prairie region and the eastern populated regions, and for a considerable distance separating west from east lies the Boreal forest, a region of sparse settlement. Most of the forest use and much of the mining activity take place in Ontario and Quebec; hence, the Boreal region may be subdivided into eastern and western sections. North of the Boreal forest lies an enormous area where forests do not grow and where inhabitants are exceedingly scarce: the Arctic region, more or less climatically determined. There are many versions of this boundary, but probably it should be considered as a line approximating the northern limits of continuous forest and the southern limits of continuous permafrost or frozen subsoil.

Most of the regional boundaries mentioned are approximations; in fact, some of them are rather broad transition zones. They serve, however, to divide Canada into eight significant regions which may be made the basis of rational geographical description: Atlantic region, St. Lawrence–Great Lakes lowland, Prairie region, Southern Cordilleran region, Northern Cordilleran region, eastern Boreal region, western Boreal region and Arctic region.

1. Atlantic Region.—The provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland are together known as the Atlantic provinces. The Atlantic region, for present purposes, however, does not include Labrador while, on the other hand, it does include the Gaspésian area of Quebec.

Physiographic relationship is strong throughout; the region is all part of the northern extension of the Appalachian hilly region of eastern North America. The folded rock structures of its worn-down mountain ranges trend northeastward, paralleling the Atlantic coast. The summit elevations of the Shickshock mountains of the Gaspé peninsula exceed 4,000 ft. (1,220 m.) while the Long Range mountains of Newfoundland and the central highland of New Brunswick have elevations of more than 2,600 ft. (792 m.) above sea level. Southeastern Quebec, New Brunswick, Cape Breton Island and Newfoundland all contain extensive, rolling, plateaulike surfaces above 1,000 ft. Important, also, are the crustal depressions such as the Bay of Fundy and the maritime geosyncline which contains the Gulf of St. Lawrence and the adjoining lowlands of Prince Edward Island, northern Nova Scotia and eastern New Brunswick.

Prince Edward Island is nearly all farmland, and good farms are found in the Annapolis valley and the St. John valley, but by far the greater part of the region is still forest covered and forest products are important in the regional economy. Coal mines are in operation in Cape Breton, northern Nova Scotia and central New Brunswick; base metals are found in northeastern New Brunswick, while most of the world's asbestos is obtained in southeastern Quebec. The outstanding feature of the region, however, is its long and sinuous coast line. No part of the area is more than 100 mi. from salt water. This influence is strongly reflected in the distribution of the human population. The largest cities, Halifax, N.S., Saint John, N.B., and St. John's, Newfoundland, are noted seaports. Most of the other cities and towns also are, or have been, ports or fishing centres, and fishing is still important; but large areas of the interior uplands are practically uninhabited.

2. St. Lawrence–Great Lakes Lowland.—The St. Lawrence waterway provided the early European settlers with the best route to the interior and it is not surprising that the adjoining lowlands should have become the wealthiest and most populous part of the country—its economic and political core region. Underlain by nearly horizontal and relatively undisturbed limestones, shales and sandstones of Paleozoic age, its surface is composed of Pleistocene glacial till and the sands, silts and clays deposited during the high-level phases of the Great Lakes and the marine invasion of the St. Lawrence plain. Jutting through the floor of this plain, eight ancient volcanic plugs form the Monteregian hills and provide a welcome contrast in relief. Although quite stony in some areas and poorly drained in others, the St. Lawrence–Great Lakes lowland affords the largest stretch of arable land in eastern Canada. A closely settled area of about 70,000 sq.mi. (181,300 sq.km.), it provides about one-third of Canada's agricultural wealth. Mixed crop and livestock farming is general with emphasis on dairying near the large cities, but there are also areas producing fruits, vegetables, tobacco, sugar beets and other special crops.

The region has more than 60% of Canada's population, containing the cities of Montreal (2,436,817); Toronto (2,158,496); Ottawa (494,535), the capital of Canada; and 50 other cities. More than 75% of the population is urban, employed in manufacturing, trade and service industries. Because of the strategic location of the area and the development of communications, this economic activity may be expected to increase under the long-term influence of the St. Lawrence seaway.

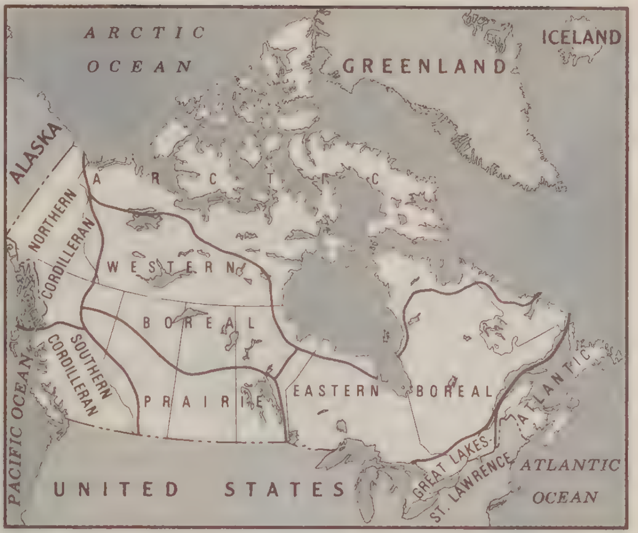


FIG. 2.—GEOGRAPHICAL REGIONS OF CANADA

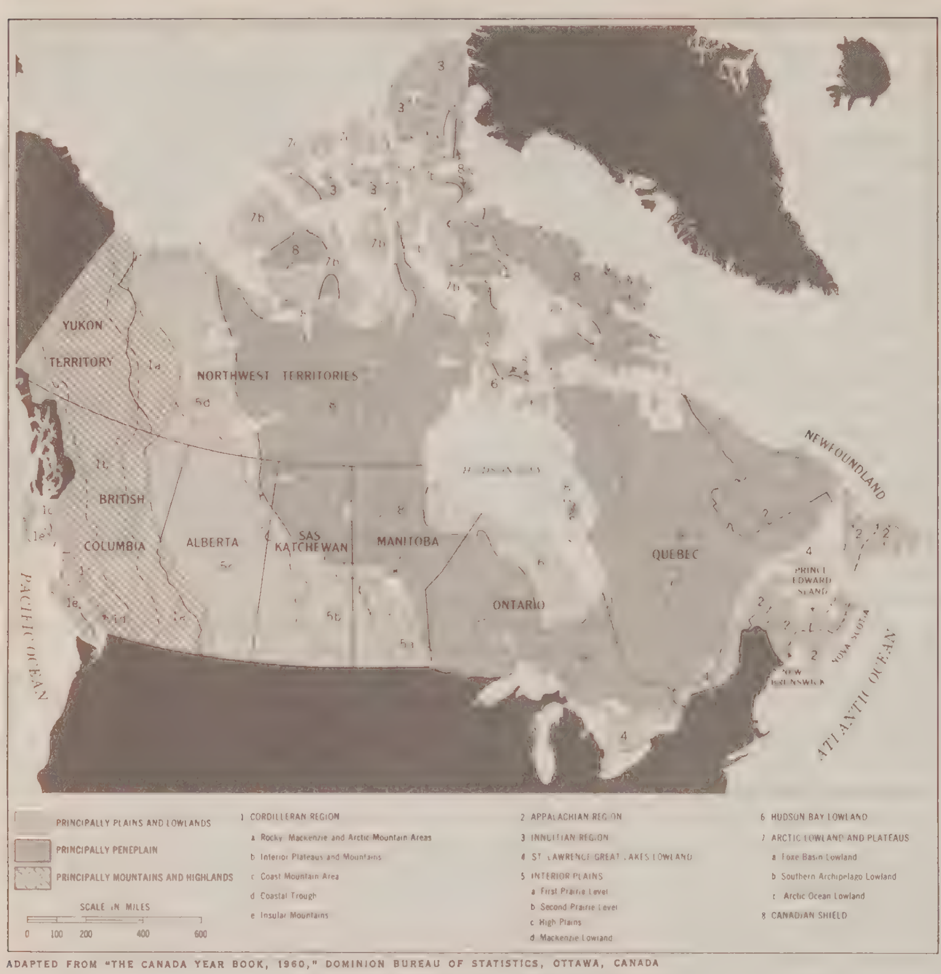
Along with the core area of this major geographic region must be included certain fringe areas such as the southern borders of the Canadian shield in both Ontario and Quebec, and the Appalachian plateaus and ridges of southern Quebec. Though differing in structure and in density of human settlement they must be considered as transition zones rather than as separate regions. In particular, they provide space for both summer and winter recreational activities of the people from the industrial cities.

Finally, although this region is the core of the Canadian ecumene, or permanently inhabited part, it is a double core. Neither Toronto nor Montreal can rightfully claim to be the primate city of Canada, though both are regionally dominant. Considering this and the language and cultural differences of the dominant groups in Ontario and Quebec, a case can be made for recognizing two subregions in this most important region of Canada.

3. Prairie Region.—In the southern parts of Manitoba, Saskatchewan and Alberta, the prairie plains constitute a northern extension of the Great Plains of the United States. More than 800 mi. (1,290 km.) wide along the international boundary, the plains are mostly underlain by relatively undisturbed Cretaceous and Early Tertiary shales and sandstones. Many of these formations contain valuable coal seams. Deeper still lie the Devonian limestones and sandstones with petroleum and natural gas reserves. The surface materials here, as in eastern Canada, are of glacial and lacustrine origin. In general, the plains rise toward the west in three great steps, the Manitoba lowland being less than 1,000 ft. (305 m.) above sea level, the Saskatchewan plain about 2,000 ft. (610 m.) and the Alberta plain more than 3,000 ft. (915 m.). While there are vast flat areas such as the Red river and Regina plains, there are also elements of considerable relief such as the Manitoba cuesta, the Missouri Coteau, Wood mountain and the Cypress hills. On the west the plains are ended abruptly by the Rocky mountain foothills.

Developed beneath the prairie grasses, the dark soils have been the basis of Canada's most extensive agricultural development. Settled, for the most part, in the 20th century, this is the spring wheat region, where annually 25,000,000 ac. (10,117,500 ha.) are sown and 300,000,000 to 700,000,000 bu. of wheat are harvested. Wheat farming dominates the central area but around it are areas of mixed farming with other grains and livestock.

After 1947, the year of the Leduc discovery, the prairies became a land of oil as well as grain. Pipelines carried it west to the Pacific and east to Ontario. Agricultural populations declined but prairie cities began to grow rapidly; Winnipeg, Edmonton, Calgary, Regina and Saskatoon, at the census of 1966, had a combined population


YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
PRINCE EDWARD ISLAND
NOVA SCOTIA
NEW BRUNSWICK
PACIFIC OCEAN
ATLANTIC OCEAN
PRINCIPALLY PLAINS AND LOWLANDS
PRINCIPALLY PENEPLAIN
PRINCIPALLY MOUNTAINS AND HIGHLANDS
SCALE IN MILES
0 100 200 400 600
1 CORDILLERAN REGION
a Rocky, Mackenzie and Arctic Mountain Areas
b Interior Plateaus and Mountains
c Coast Mountain Area
d Coastal Trough
e Insular Mountains
2 APPALACHIAN REGION
3 INNUITIAN REGION
4 ST. LAWRENCE GREAT LAKES LOWLAND
5 INTERIOR PLAINS
a First Prairie Level
b Second Prairie Level
c High Plains
d Mackenzie Lowland
6 HUDSON BAY LOWLAND
7 ARCTIC LOWLAND AND PLATEAUS
a Foxe Basin Lowland
b Southern Archipelago Lowland
c Arctic Ocean Lowland
8 CANADIAN SHIELD

ADAPTED FROM "THE CANADA YEAR BOOK, 1960," DOMINION BUREAU OF STATISTICS, OTTAWA, CANADA

FIG. 3.—PHYSIOGRAPHIC REGIONS OF CANADA

of more than 1,487,000 inhabitants and were becoming strong regional commerce and manufacturing centres.

4. Southern Cordilleran Region.—For the geomorphologist and the geologist, western Canada, from the eastern edge of the Rocky mountain foothills to the Pacific, is one of the major physical regions of the country. For the climatologist, and even more importantly for the human geographer, the southern part of the Cordilleran area is a geographic region containing one of the major clusters of the Canadian population.

For 500 mi. from east to west this is a land of mountains; high relief is characteristic and makes all landscapes look alike. But there are many differences. On the east, the Rocky mountains form a high barrier range with many peaks over 10,000 ft. Mt. Robson, the highest, stands 12,972 ft. (3,954 m.). The Rocky mountain trench is a striking, linear depression that separates the Rockies from the Columbia mountains, a series of ranges with peaks of 6,000 to 10,000 ft. (1,830–3,050 m.), which occupies the southeastern corner of British Columbia. Between these ranges are deep troughs containing the Kootenay and Arrow lakes which are part of the Columbia river drainage. Further west is the interior plateau, drained partly by the Okanagan to the Columbia and partly by the Thompson and Fraser rivers. North from the lower Fraser valley, the Coast mountains form a high granite wall, reaching 13,260 ft. (4,042 m.) in Mt. Waddington. The coastal trench west of the Coast range is drowned with many fiords similar to those of Norway. Finally the outer mountain range, also largely submerged, forms Vancouver Island and the Queen Charlotte Islands.

The great relief contrasts are paralleled by climate contrasts. The lower western mountain slopes get much rain and are heavily forested. The snow line in th south is from 7,500 to 9,000 ft (2,285–2,740 m.), lower on the seaward slopes, declining gradually to the north. The interior o British Columbia is relatively dry and in the Okanagan area, where some stations report less than te inches of rain per year, sparse grass, sage and cactus are the vegetation. Forests, though no so luxuriant as the coastal, ar found on the interior mountai slopes.

The focus of the geographica region is certainly the souther end of the coastal trench and th lower Fraser valley. Here ar the two largest cities, Victoria (173,455), the capital of British Columbia, and Vancouver (892,286), the metropolis of the Canadian west coast. Here also i about one-third of the agriculture of British Columbia. The cities of the interior are much smaller Trail, on the Columbia river, is noted centre of smelting of lea and zinc. Vernon, Kelowna an Penticton, on Okanagan lake, ar centres of irrigated fruit-growin areas. Prince George (24,471) an important lumbering centre, i the largest city in the northern part of this region.

The southern Cordilleran, o Pacific coast, region is an excellent example of a nodal region with 75% of its total populatio in one small part of the area and the much more sparsely settled remainder firmly tied to it. The total population of the region is about 1,800,000.

5. Northern Cordilleran Region.—Stretching northward from the 55th parallel, between the Alaska boundary and the Mackenzie lowland, lies the northern portion of the Cordilleran region, 350,000 sq.mi. (906,500 sq.km.) of mountains and high plateaus. In northern British Columbia the pattern resembles that to the south, with the high range of the Rocky mountains on the east and the granite peaks of the Coast range on the west, culminating in the St. Elias mountains on the Alaskan border with Mt Logan reaching an elevation of 19,850 ft. (6,054 m.); between lies the rugged upland of the Stikine plateau and the Cassiar mountains. The Rocky mountains die away in the Liard basin short o the Yukon boundary; north of it, the chief geomorphic units are the broad and deeply dissected Yukon plateau and the Mackenzie mountains. Tributaries of the Yukon river drain much of this area Some valleys are well forested, especially to the south, but most o the area is too high to have much tree growth.

The complex geology, in some areas, favours mining. The gold rush to the Klondike gravels was one of the most spectacular eve staged, but most later strikes were based on shafts driven into rock lodes, among them the rich lead and silver deposits in the Mayo district. Copper is mined from open pits near Whitehorse; but Yukon mining suffers from lack of transportation.

Notable among the geographic features of this region is the Alaska highway. The population of the region is about 15,000.

6. Eastern Boreal Region.—A forested area of 900,000 sq.mi (2,330,000 sq.km.) in eastern Canada is the eastern Boreal region Mostly it is underlain by rough, rocky terrain of the southern part of the Canadian shield with elevations of 1,500 ft. (457 m.) above sea level north of Lake Superior and in Algonquin park and of more han 3,000 ft. (915 m.) in Quebec and Labrador. It comprises also he lowlands underlain by Paleozoic rocks bordering Hudson and ames bays. Its cover is made up of the various associations of he Taiga, or Boreal forest region.

Scattered through the mass of Laurentian rocks characterizing nost of the shield are areas of Keewatin, Timiskaming and Huro-ian rocks, greenstone, schists and metamorphosed sedimentaries, vith various ore deposits. The mining camp, therefore, is one of he most characteristic human phenomena of this region. Among hem are Sudbury, where, since 1900, over half of the world's nickel as been obtained; Porcupine and Kirkland Lake, noted gold camps f northeastern Ontario; the Red Lake gold field of northwestern Ontario; and the gold and base metal mines of western Quebec nd the Chibougamau area.

Iron ore is found at Michipicoten and Steep Rock lake near ake Superior, at Marmora in southeastern Ontario, and in the reat Labrador trough shared by Quebec and Labrador. Noted ranium deposits are at Elliott Lake, north of Lake Huron, and ancroft, north of Lake Ontario.

Forest activity, however, is older and more widespread than nining. Earliest was the pursuit of fur bearing animals which ved in the forest, but the fur traders' post is no longer of great nportance. Later, in the area accessible to the tributaries of he St. Lawrence, great quantities of pine timber were cut, and ast quantities of saw logs. Most widespread in the second half f the 20th century was the cutting of pulpwood, while a whole eries of towns and cities along the entire southern margin of the hield were engaged in making pulp and paper.

There have been many attempts, also, to induce agriculture to nvade the southern margin of the shield. Fairly successful colo-ies are found in a number of pocket areas such as the Lake St. ohn basin, Abitibi, Cochrane, Timiskaming and the Nipissing low-nds. Farming, however, is clearly not favoured by either the errain or the climate of most of the eastern Boreal region.

The rivers, lakes, hills and forests of this region combine in nany attractive landscapes. Many areas such as Quetico Park, ake of the Woods, Timagami, Algonquin park, Muskoka and the hole sweep of the Laurentians are well-known vacation resorts. hey are not so spectacular as the western mountains, but they lie nuch nearer the homes of those who seek recreational activity.

7. Western Boreal Region.—Extending through the northern arts of Manitoba, Saskatchewan and Alberta, and the Mackenzie owland of the Northwest Territories, the western Boreal region as an area of almost 800,000 sq.mi. (2,072,000 sq.km.). About alf of the area is underlain by the Precambrian rocks of the anadian shield, and half by sedimentaries similar to those of the rairie region. Along this geological boundary are found a num-er of very large lakes: Great Bear, Great Slave, Athabasca, Rein-eer and Winnipeg.

Neither forest activity nor mining activity has shown as great evelopment here as farther east. There have been some notable nining camps such as Flin Flon, Uranium City, Port Radium, ellowknife, Lynn Lake and Moak Lake, and there are petroleum esources in the Peace, Athabasca and Mackenzie river areas. Norman Wells (pop. [1961] 297) on the Mackenzie supplies the orthwest. While the Mackenzie is one of the notable river routes f the world, most of the region is inaccessible except by air, naking transportation too expensive for most needs. The western oreal region is one of economic difficulty and, consequently, low opulation density. The total population is about 100,000 or about ne-tenth that of its eastern counterpart. Agriculture has invaded ne southern margin of the forest in central Saskatchewan and the eace river area but it faces great climatic hazards.

8. Arctic Region.—Although the arctic is supposed to be ounded by the Arctic circle, arctic conditions indicated by the ee line are encountered at least 500 mi. (805 km.) to the south long the shores of Hudson bay. Thus defined, including both nainland and islands, the area is more than 900,000 sq.mi. (2,330,-00 sq.km.). Most of the mainland is part of the Canadian shield, s are Baffin, Devon and some other islands. On Ellesmere Island ne high folded mountains of the Innuitian region have peaks up 10,000 ft. (3,050 m.), and large areas of snow field and icecap. In the north, too, are areas of Arctic coastal plain on disturbed Paleozoic rocks, where the structures indicate possibilities of petroleum. There is also a wide continental shelf.

Most of Canada's 13,000 Eskimos live in the southern part of this area. There are also a few thousand settlers of Caucasian origin located in scattered stations. Frobisher Bay, on Baffin Island, is an administrative centre and air base; promising iron ore deposits are found on the shore of Ungava bay and even more promising ones in the northern part of Baffin Island; it is probable that other mineral resources in many parts of the arctic region await development.

9. Geographical Pattern.—The pattern of population groups and geographical regions in Canada may be summarized rather briefly. In the south, because of ease of access, surface conditions and favourable climate, there are four reasonably well-populated regions, the Atlantic provinces, the St. Lawrence-Great Lakes lowland, the Prairie region and the southern Cordilleran region. Making up one-fifth the area, they contain 90% of the people, the agriculture, the industry and the wealth. While all four regions are separated, it can be seen that there is an especially wide gap between east and west.

Immediately north of the populated regions, and in fact serving to separate east from west, lie the eastern and western Boreal regions and the northern Cordilleran region. From the standpoint of human geography they are fringe regions, with pioneer economies depending upon forestry and mining to a large extent, while the remnants of the fur trade still persist. Finally, north of the tree line lies the lonely land of the arctic tundra, empty save for a few Eskimos, administrators, weathermen and defense personnel. This is the simple, basic pattern of Canadian regions (*see* also NORTH AMERICA). (D. F. PU.)

III. NATIVE PEOPLES

1. General.—Anthropologically, as well as geographically, Canada is an integral part of the North American continent. The boundaries between Canada and the United States (including the boundary with Alaska) do not conform to ethnic divisions among the aborigines, nor is native culture significantly different on each side of the borders.

The early European explorers found the seacoast of Canada inhabited by people with brown complexions and lank hair. When it later became apparent that they were similar to the natives met by Columbus in the West Indies, his term for them, "Indians," came into general use. Since Columbus had chosen this name in the belief that he was in the vicinity of India, a geographical error was thus perpetuated. In later years the same designation was given to the various tribes encountered by adventurers, French and English, as they penetrated westward across the continent. In the north, however, the hunters dwelling on the shores of the Arctic were so different both in appearance and culture that the term Indian was inapplicable, and Eskimo was used instead.

Certain physical characteristics are common to all Canadian Indians. The colour of the skin is dark brown—red is a misnomer and yellow an exaggeration; the black hair is smooth; the cheekbones are prominent; the face is broad in comparison with the breadth of the head; the nose is usually well developed, though not flattened; and the brow is somewhat low. But it must be emphasized that there is no absolute uniformity of type. On the coast of British Columbia the natives have relatively short stature, are of heavy build, with round heads, broad faces and a certain amount of facial hair. On the plains the stature is greater, the body more lithe and graceful, and facial hair is limited to an occasional sparse mustache. The eastern type generally resembles that of the plains, although several tribes have longer heads, and a few prehistoric dolichocephalic (distinctively long-headed) skulls have been found.

The Indians of Canada are part of the Mongoloid branch of mankind. A homogeneous stock does not exist in North America and the physical differences suggest that the migrations from Asia came in waves, comprising various Mongoloid groups. Furthermore, environmental factors have probably produced considerable variation within America itself.

The ancestors of the Indians and Eskimos came by the northwestern route across Bering strait. Even at the present time the passage occasionally freezes so solidly that it is possible to walk from Asia to America, while the Diomede Islands would have offered convenient steppingstones for sea voyagers. *Homo sapiens* undoubtedly developed in the old world, but he spread to the new at an early period—during the last interglacial period. Archaeological remains have been found beneath glacial deposits in Alaska, at Sheguindah in Ontario, and elsewhere. Culturally, artifacts from Cape Denbigh and other sites in Alaska and the northwest are related to the Eurasiatic Mesolithic Age culture of Lake Baikal in Siberia (*see* ESKIMO: *Eskimo Archaeology*). Even with the aid of carbon 14, it is impossible to put an accurate date on the coming of man to the new world. It was probably between 15,000 and 25,000 or more years ago.

The Eskimos (*q.v.*), who inhabit the shores of the Arctic from northwest Siberia to Greenland, are somewhat different from the Indians. Their hair is equally straight but the skin colour lacks the warm brown of their southern neighbours. The large, long head tends to be high, somewhat keel-shaped in general form; the nose is narrow and inconspicuous, which, combined with prominent cheekbones and unusually broad face, gives a frontal appearance of flatness; the eyes are black with the epicanthic fold at the inner eye frequent; the hands and feet commonly are even smaller than those of the Indians, and the stature usually less. It is clear, however, that the Eskimos, like the Indians, are part of the general Mongoloid stock, of which they may be regarded as a highly specialized offshoot. After spreading across the northern Canadian mainland and the coasts of the southern arctic islands, they probably reached Greenland over 2,000 years ago.

2. Culture.—Diversity characterizes the culture of the Indians of Canada. Some of this is due to differences in the background of different groups migrating from Asia at different periods. Furthermore, all immigrants to Canada had to move through a corner of Siberia and across Bering strait; this inevitably led to the loss of all culture elements which could not be practised under arctic conditions. These included, of course, horticulture, the domestication of animals except the dog, and the working of metals. In the new world man began life afresh with only a few heritages from the old. These were the polishing of stone implements, probably the domestication of the dog, the use of the spear thrower, certain religious beliefs and traditions, and language. Isolation for centuries, geographical diversity and the sparseness of population in the new world facilitated the cultural diversity so characteristic of aboriginal Canada.

In the obtaining of food, for example, the Iroquois of southern Ontario were primarily farmers, the Indians of the northwest coast were fishermen, and those of the Prairies and the Arctic were hunters. Villages varied from the relatively permanent settlements of the Iroquois and of coastal British Columbia to the mobile family units of northern Ontario and Quebec. So, likewise, in chieftainship there were all degrees from the aristocratic stratified government of the Haida of the northwest coast, or the matrilineal structure of the Iroquois, to the rugged individualism of the northern Athapaskans of the Northwest Territories. In religion, in warlike pursuits, in language, in social practices, in housing and in clothing, the tale was the same; that of diversity resulting from varied geographical surroundings as well as from the accidents of history. Only in deficiencies was there uniformity; nowhere in Canada was there use of the wheel, of iron, or of any system of writing.

3. Regional Distribution.—The culture of tribes living within regions of geographical and ecological similarity tended to conform to a type, irrespective of linguistic or physical classifications. On this basis the following areas can be distinguished:

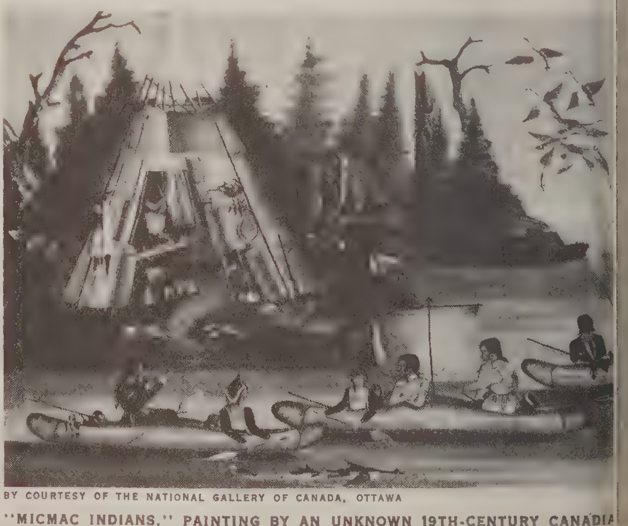
Arctic Region.—About 13,600 Eskimos inhabit the coast of the Arctic mainland and the adjacent islands. Before the period of European contact, and even in later times, they depended largely on seals for food, clothing and (from seal oil and blubber) warmth and light. Caribou, when available, are killed for meat and skins, while fish, birds and white whales are supplementary foods in the diet of these almost entirely carnivorous hunters. Before the acquisition of iron from white traders, their tools were ma of stone, bone and ivory, and were characterized by great sk and ingenuity. The dog is used for drawing the sledges and f locating the breathing holes of seals, at which the animals a speared. The skin clothing is well tailored and admirably adapt to the extreme cold; equal ingenuity is shown in the manufactu of two types of skin boat (the kayak and the umiak) and t circular winter house of snow blocks, the igloo.

Eskimo political organization is limited to the simple ban comprising a number of related families. Such a group wande over a vaguely defined area, returning year after year to t same camping grounds following the movements of game. T leader is the most skilful hunter, but he is entirely without autho ity, and hereditary chiefs with executive or judicial power are u known. Shamans have much influence, especially with regard the enforcement of multitudinous hunting taboos, but there a few communal religious rites.

The coming of the white man began to alter the Eskimo way life in the 19th century, and the process of adjustment becan more and more accelerated with mining developments and t building of the Distant Early Warning (DEW) line after Wor War II. The trapping of white foxes for their fur has grown into major industry, and the Eskimo has become increasingly depende upon the white man's economy. The Eskimo developed a uniq style of stone and ivory carving. Most Eskimos have adopted son form of Christianity.

The North-Eastern Woodlands.—At the time of European co tact Newfoundland, the maritime provinces and the wooded are of northern Quebec and Ontario were sparsely inhabited by loose organized hunting tribes. With the exception of the Beothuk Newfoundland, who were exterminated before the close of the 19 century, languages of the Algonkian stock were spoken througho this whole area. The Micmac occupied Nova Scotia, northern Ne Brunswick and Prince Edward Island; the Malecite and Abna lived in the river valleys of southern New Brunswick and southe Quebec; the Montagnais and Naskapi ranged over Labrador ar Quebec north of the St. Lawrence; while northern Ontario and a jacent parts of Manitoba were the home of the Cree and the Ojibw

In every respect these Algonkian-speaking Indians were part their environment. Skilled hunters of moose, caribou, bear, ra bit and beaver, they also utilized a wide range of wild plants, n only for food, but for medicines and dyes, as well as for utilitari purposes. Birch bark was used for canoes and wigwams; basswo fibre for cordage; animal skins for clothing; and strips of wove rabbit fur for blankets. In former times there were season movements in the quest for meat, fish and berries. Political stru ture was weak, bands were loosely organized, and religion centre in the personal quest for power through vision experience.



BY COURTESY OF THE NATIONAL GALLERY OF CANADA, OTTAWA

"MICMAC INDIANS," PAINTING BY AN UNKNOWN 19TH-CENTURY CANADI ARTIST

By the 20th century much of the old life had disappeared, ough its influence in religious beliefs and in the dependence n local ecology continued to be important. Most of the Indians ved in their old home areas; guns and metal tools entirely replaced nplements of stone, and employment as guides, loggers and ommercial trappers became the basis of life instead of subsistence onomy.

Southern Ontario.—Very different from the hunters of the orthern forests were the Indians of the north shore of Lake Erie nd Lake Ontario. Though equipped only with stone tools, they eared large fields in which they planted corn, beans, pumpkins nd tobacco. Deer, fish, berries and nuts were hunted and colcted, but as farmers they lived in relatively permanent villages f 1,000 or more inhabitants. Their houses were huge communal wellings of saplings covered with bark, occupied by many families; ottery was made on a large scale and bone was utilized exnsively. In fact, life was on a plane of comfort and security nknown further north.

The tribes of southern Ontario were the Huron, Tionontati Petun) and Attiwandaronk, or Neutrals, all speaking languages the Iroquois stock. In the 1640s they were destroyed in war or corporated by the Five Nations of the Iroquois from New York ate; a century and a half later, after the American Revolution, any of the latter came to Ontario as royalist allies of the crown. olitical organization was highly developed among all the Iroquois ibes, with chieftainship passing through the female line, and a mplex system of religious rituals and an intertribal association, e League of the Iroquois. By the 19th century the military and olitical importance of the Iroquois had passed away, although emories of the past are proudly retained by those who have come essentially participants in the agricultural life of southern ntario.

Plains Area.—The prairies of Manitoba, Saskatchewan and lberta were inhabited by tribes having a general cultural uniform-, although speaking languages of three distinct stocks, Athapasn, Siouan and Algonkian. The centre of life was the bison. The sh was eaten in quantities, either fresh, or dried and pounded as mmican; the skins provided clothing and covering for the ovable tent, the tipi, or tepee; the bones were used for arrow ints and scrapers; and the dung served as fuel. The dressing of son, elk and deer skins reached a high development, and rawhide ceptacles were used for storage vessels, basketry and pottery ing unknown.

Martial achievement, in accordance with a strict code of beviour, gave prestige, but not necessarily authority. The basis all types of success, including war prowess, was attributed the aid of a guardian spirit, acquired at adolescence. The llection of certain symbolic objects was sometimes recommended a dream or vision, and these, carefully preserved, often for nerations, served as tangible articles of religious veneration.

Socioreligious rites are extremely important on the plains, the attered divisions of a tribe assembling annually for the perrmance of elaborate symbolic celebrations, of which the sun nce is the best known. An important place in all such rituals s played by the members of semisecret societies of men. Most the Plains Indians now reside on reservations, and their life patterned on that of the white settlers.

The Northwest.—This term may be used for the huge area ocpied by the Dene, or Athapaskan-speaking peoples. It comses two sections: (1) the Mackenzie and Yukon valleys and the rubby forest west of Hudson bay: the home of the Hares, the gribs, the Kutchin, the Caribou-Eaters, the Yellowknives—soled because of their copper tools—the Slaves, the Chipewyan d the Beaver; and (2) the upland plateau of British Columbia, st of the Rocky mountains, inhabited by the Nahane, the Sekani, Carrier and the Tsilkotin (Chilcotin). Athapaskan languages end even beyond this range. Political organization comprises y the simple band, a loosely knit patrilineal unit without definite dership, and few regulations.

The staple food supply of this area is the caribou; deer, rabbits, d fowl, fish and berries are eaten when obtainable, but, especially the north, the roving hunting bands depend on the caribou. The toboggan simplifies transportation in winter, the canoe in summer. Material culture is scanty; baskets are plaited of spruce roots; clothing was formerly of skins; and one of the few distinctive traits of culture is the double lean-to. Though few white men penetrated into these regions, metal tools and the fur-trading economy modified much of the native life. The aboriginal languages have, however, been retained.

Interior Area of Southern British Columbia.—The wooded valleys of southern British Columbia were inhabited by the Kutenai and the Salish-speaking Ntlakyapamuk (Thompson), Shuswap and Lillooet. The rivers flowing westward were filled with salmon, which the natives caught in large numbers and smoked or pulverized for winter use. Deer and mountain goats were hunted and berries collected. Clothing was of deerskin, while blankets were made of rabbitskin. Pottery was lacking, but wood was used more extensively than on the plains and excellent basketry was produced, including watertight vessels. Rush-covered lean-tos served for shelter, replaced in winter by permanent semisubterranean houses.

Semihereditary leaders exercised considerable influence over local groups, but they lacked prestige based on martial prowess, as on the plains, or the respect dependent upon wealth as among the coast groups. Ceremonial rites were also weakly developed, although puberty ceremonies were performed, and the Kutenai held an elaborate ritual before departing to the plains on their annual bison hunt. In addition to guardian spirits, there was a belief, among the Kutenai at least, in the sun as a vague sky being of great power. The culture of this area is, in many respects, intermediate between that of the plains and the Pacific littoral.

Coastal Area of British Columbia.—This region had the most specialized and distinctive Indian culture in Canada. The northern part was occupied by the Haida of the Queen Charlotte Islands, the Tsimshian of the Skeena river, and the Tlingit of Alaska; the central, by the Kwakiutl of Vancouver Island and the Bella Coola; and the southern, by the Nootka and the Coast Salish, with many tribes of northern Washington.

In contrast to linguistic diversity, there was relative cultural uniformity. The chief food was salmon, which was smoked for storage; deep-sea fishing was practised by several tribes. Berries and shellfish were collected, deer and mountain goats were hunted, and the Nootka formerly captured whales at sea. These abundant sources of food supported a relatively dense population, living in permanent villages. The even-grained cedar was split into planks with which large, communal, rectangular houses were built; smaller boards were steamed and bent into serviceable watertight boxes; and large dugout canoes were hollowed from the cedar trunks.

Upright house posts were carved with elaborate designs of ancestral crests, from which developed the totem poles of the 19th century. Pottery was unknown, but baskets and mats of bark and roots were manufactured. Clothing was either made of skins or bark, or woven from mountain goat or dog hair. Nephrite, a jade stone, was extensively used and a little copper was pounded out from rich deposits in the north.

Political organization was marked by the importance of hereditary rank, with a stratified class society extending from aristocratic chiefs down to slaves. In contrast to the principle of hereditary rank was that of the potlatch, whereby prestige was obtained by a lavish bestowal of goods to validate the assumption of prerogatives. The strongly organized northern tribes were matrilineal, the southern were patrilineal. Secret societies, employing masks and ingenious mechanical devices, complicated social life in the winter. There was a firm belief in supernatural beings, whom the Bella Coola organized into a pantheon which was dominated by a supreme deity.

By the middle of the 20th century, most of the old way of life had disappeared. Motor boats and power tools had replaced stone tools. The potlatch and native beliefs had largely passed away, and the modern Indian operated his own fishing vessel or was a member of a trade union in the fishing or logging industries.

See also ALGONKIAN TRIBES; ESKIMO; INDIAN, NORTH AMERICAN; INDIANS, NORTHWEST COAST; PLAINS INDIANS.

(T. F. McI.)

IV. HISTORY

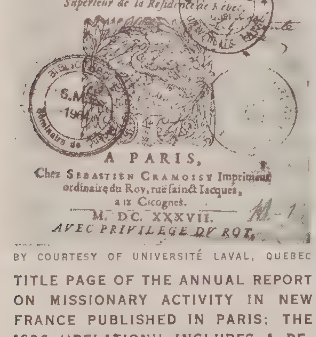
About A.D. 986 a Norseman, Bjarni Herjolfsson, sighted what may have been the east coast of Canada. About the year 1000 another Norse voyager, Leif Ericsson, set out from Greenland and found the land spotted by Bjarni. The Norsemen had spread over the North Atlantic islands by a northern sailing route, and apparently made some attempt to settle in America but failed (*see* VINLAND; NORTH AMERICA: *Exploration and Settlement*).

There were still traces of the Norsemen in Greenland when the English explorer John Davis visited that island in the 1580s. But English and French seamen had followed the old northern route to Iceland and Greenland long before. In the 1490s an Italian navigator, John Cabot, led seamen of Bristol to a landfall somewhere on the Canadian coast, which he visited in 1497 and 1498, if not earlier. He also discovered the fishing banks off Newfoundland, and from 1500 on English, French, Portuguese and Spanish fishermen sailed every spring to the great cod fishery there.

A. NEW FRANCE

The shores of what are now the Bay of Fundy, Nova Scotia and Newfoundland were explored in the 1520s. Then in 1534 the French seaman Jacques Cartier entered the Gulf of St. Lawrence and took possession of "New France" for King Francis I. In succeeding years he ascended the St. Lawrence as far as the Lachine rapids, to where Montreal now stands, and attempted with the sieur de Roberval to found a colony near what is now Quebec. The colony failed, but out of these explorations and the fisheries the fur trade with Indians of the gulf and the river began. By 1600 it was well established and, because the Indians desired European goods, already extended inland at least as far as the Great Lakes. Monopolies of the fur trade were granted to a succession of traders on condition that they begin colonization, but they either evaded the condition or failed to carry it out.

At the beginning of the 17th century appears the first great name in Canadian history. Samuel de Champlain (*q.v.*) was employed in the interests of successive fur-trading monopolies and sailed into the St. Lawrence in 1603. In the next year he was on the Bay of Fundy and had a share in founding the first French colony in North America—that of Port Royal, now Annapolis Royal, N.S. In 1608 he began the settlement which was named Quebec, selecting a commanding site which controlled the narrowing of the St. Lawrence river estuary. From 1608 to his death in 1635 Champlain worked unceasingly to develop Canada as a colony, to promote the fur trade and to explore the interior. He passed southward from the St. Lawrence to the beautiful lake which still bears his name and also westward, up the St. Lawrence and the Ottawa, in the dim hope of reaching the shores of China. He reached Lake Huron and Lake Ontario, but not the Great Lakes that stretched still farther west. At his death, the fort at Quebec had only 85 adult residents.



RELATION
DE CE QVI S'EST PASSE'
EN LA
NOVVELLE FRANCE
EN L'ANNE'E 1636.
Enuoyée au
R. PERE PROVINCIAL
de la Compagnie de IESVS
en la Prouince de France.
Par le P. Paul le Ieune de la mesme Compagnie,
Superieur de la Residence de Kébec.

A PARIS,
Chez SEBASTIEN CRAMOISY Imprimeur
ordinaire du Roy, ruë sainct Iacques,
aux Cicognes.
M. DC. XXXVII.
AVEC PRIVILEGE DV ROY.

BY COURTESY OF UNIVERSITÉ LAVAL, QUEBEC

TITLE PAGE OF THE ANNUAL REPORT ON MISSIONARY ACTIVITY IN NEW FRANCE PUBLISHED IN PARIS; THE 1636 "RELATION" INCLUDES A DETAILED REPORT ON HURONIA BY JEAN DE BRÉBEUF

1. The Company of One Hundred Associates.—This failure to build up the colony had led Cardinal Richelieu, the chief minister of France, to found in 1627 the Company of New France, popularly known as the Company of One Hundred Associates. It was granted the colony of New France, then comprising the whole St. Lawrence valley, and for 15 years from 1629 it was to have complete monopoly of the fur trade. In return it was to take to New France 200 to 300 settlers a year. But war with England began, the company's first fleet was captured, and in 1629 Quebec itself surrendered to th English.

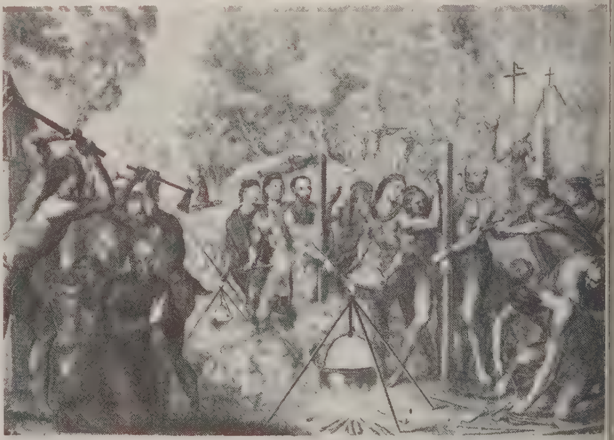
It was restored by the treaty of St. Germain-en-Laye in 163 but the Company of New France never recovered from the blo although it controlled New France until 1663. Colonization w slow for many years. The fur trade remained the chief concern everyone except the missionaries. Jesuit fathers had begun mi sionary work in Acadia in 1611, and Récollect friars (Franciscan at Quebec in 1615. The main effort was made in 1625 when Jesu missionaries advanced to the country of the Huron Indians settl on Georgian bay. There the fathers returned in 1634 and built their principal mission in the hope of establishing a Christi Indian community.

2. Iroquois Wars.—Their hope was destroyed by the beginni of the Iroquois wars of New France in 1640. Cartier had foun Iroquois Indians at Quebec in 1535. The Algonkin (or Algonquin tribes had driven them back into New York by 1600, whe Champlain, with the Algonkin as allies, had warred on them. Aft the founding of New Netherland by the Dutch in 1609, the Iroquo began to obtain knives and hatchets and in 1640 they got som firearms from Dutch traders. They began to raid the Algonkin ar Huron trading parties, and soon they were attacking the Frenc allies of these Indians. Finally they resolved to destroy the Hur confederacy which they did in 1648–50. Fathers Jean de Brébe and Gabriel Lalemant, now canonized, were tortured to death wi many of their Huron people (*see* also HURON; BRÉBEUF, SAIN JEAN DE).

The destruction of "Huronia" drove all the interior India friendly to the French west of Lake Michigan. The missionari and the traders followed them, and there was a second great ou burst of exploration. Two fur traders, Médard Chouart d Groseilliers and Pierre Radisson, pushed into the region of Lal Superior in the late 1650s and brought down furs from that ne territory. Soon French missionaries and traders were to be foun throughout the country which is now Wisconsin.

Radisson and Groseilliers were able to get their furs down Montreal in 1660 only because of a heroic battle fought again the Iroquois by Adam Dollard and 16 companions at the Long Sau rapids on the Ottawa river in that year. So desperate was t plight of the colony of New France that an appeal was made the French king for help. The Hundred Associates had failed bring out colonists. So had most of the men, called seigniors seigneurs, to whom the company had made large grants of land condition that they settle them with tenants. New France h only about 2,300 European inhabitants in 1660.

3. Royal Province.—The king responded to the colony's appe by canceling the charter of the Hundred Associates and mak New France a royal province with a governor, the ceremonial a military head of the colony, an intendant in charge of justic finance, police, and the organization of the militia, a bishop a



BY COURTESY OF UNIVERSITÉ LAVAL, QUEBEC

THE DEATHS OF FATHERS JEAN DE BRÉBEUF AND GABRIEL LALEMANT, 16 DURING THE IROQUOIS WARS; FROM DU CREUX, "HISTORIAE CANADENSIS PUBLISHED IN PARIS, 1664 a superior council, which was a court of appeal. The first bishop was François de Montmorency-Laval (*q.v.*), who arrived at Quebec in 1659. New France was then still a mission, but as popuation increased, parishes were formed and parish priests put in charge of them. To the Society of Jesus and the Franciscans the Ursuline nuns and the Sulpician fathers had been added. The church not only performed its ordinary duties, but provided the hospitals and schools of the colony as well.

In addition to creating a royal colony the king sent a military commander, Alexandre de Prouville, the marquis de Tracy, and a regiment of soldiers who in 1666 defeated the Iroquois and forced them to make peace.

It was then possible to proceed to populate and develop New France. Over 3,000 settlers, including girls of marriageable age, were sent out in the 1660s. Few followed thereafter, but by natural ncrease the population began to mount rapidly.

The first intendant, Jean Baptiste Talon (1665–68 and 1670–72), stimulated colonization and industry. He also pressed the exploration of the far west. Louis Jolliet explored the Mississippi until he was sure it flowed into the Gulf of Mexico, not into the Pacific ocean. In 1671 Simon François d'Aumont, or Daumont, sieur de St. Lusson, at Sault Ste. Marie took possession of all the interior of the North American continent for France as an extension of New France.

Louis de Buade, comte de Frontenac et Palluau, became governor n 1672. There is little agreement on what kind of governor Frontenac was. But it does seem to be agreed that he used his ffice to enrich himself, and perhaps that he pursued policies which would help do so. New France was full of young men anxious to ollow the profitable fur trade rather than to clear the land for arming. Frontenac encouraged many of these *coureurs de bois* ("wood rangers"), as they were called, to follow leaders like Daniel Greysolon, sieur Dulhut (or Duluth), and René Cavelier, ieur de la Salle, into the far west to explore and trade. The reult was a tremendous expansion of the French fur trade and La Salle's discovery of the mouth of the Mississippi in 1682.

Frontenac's policy of encouraging the fur trade led to a struggle with the Jesuits and Bishop Laval, who sought to protect the ndians from the ravages of brandy used in the fur trade. The missionaries were only partly successful in stopping the trade n brandy, but they did succeed in having Frontenac recalled in 682. The expansion of the fur trade under Frontenac and La Salle, however, had aroused the jealousy of the Iroquois and led hem to attack the Illinois Indians, who were friends of the French. Both missionaries and traders demanded that Joseph Antoine Lefebvre de la Barre, the new governor, attack the Iroquois. He did, but failed badly. He in turn was recalled and his successor, the marquis de Denonville, had to resume the attempt to curb the roquois. This he did with a measure of success in 1686.

4. War With England.—Not only the Iroquois but also English colonists and traders were menacing New France by that time. ince 1664, when the English took the colony of New Netherland from the Dutch, New York traders had supported the Iroquois. New England coveted Acadia (Nova Scotia) and its fisheries, which the English had captured in 1613 and again in 1654, only to restore to New France in 1667. And in Hudson bay territory the Hudson's Bay company, founded in 1670 at the suggestion of Groseilliers and Radisson who had deserted New France, was rawing furs away from French traders. Now those traders and their governor thought the time had come to strike back.

In 1686–87 they captured the Hudson's Bay company posts in ames bay and held them. Before this matter could be settled, war had broken out in Europe between England and France, and in New France the Iroquois had attacked the colony with even more than their old ferocity, massacring the people of the village of Lachine on Montreal Island in 1689.

The prospect of war had led to the reappointment of Frontenac. New England fleet and army under Sir William Phips seized cadia but Frontenac defied Phips's attempt to take Quebec in 690. Then he began a series of border raids on New England, and nally marched into the Iroquois country. Meanwhile the brilliant young Canadian, Pierre le Moyne, sieur d'Iberville, had conquered Hudson bay, saved Acadia and overrun Newfoundland. The war was ended by the treaty of Ryswick (1697) with New France holding Hudson bay (but not Newfoundland) as well as all its former possessions. This was the work of Canadians, with little help from France. D'Iberville then set off to found Louisiana, another part of New France, in 1699. And in 1700 and 1701 peace was made between the Iroquois and New France, and between the Iroquois and the Indian allies of New France. There were to be no more Iroquois wars, and New France stood at the height of its fortunes.

Its decline began almost at once. The English and their American colonists were to conquer all New France, but it was done in two stages. The first ended in 1713 with the end of the War of the Spanish Succession. In 1710 Acadia had been seized again by the British, but in the next year an English expedition under Sir Hovenden Walker suffered serious losses in the St. Lawrence river and returned home. Most of the fighting was done in Europe, however, and the English victories there enabled them, by the treaty of Utrecht that concluded the war, to recover Hudson bay, limit French rights in Newfoundland, force the cession of Acadia (without Cape Breton Island) and to get a foothold in the western fur trade.

5. Years of Peace.—These were serious losses, but 30 years of peace followed, which the French used to build the great fortress of Louisburg on Cape Breton and to add to their empire of New France in the mid-continent.

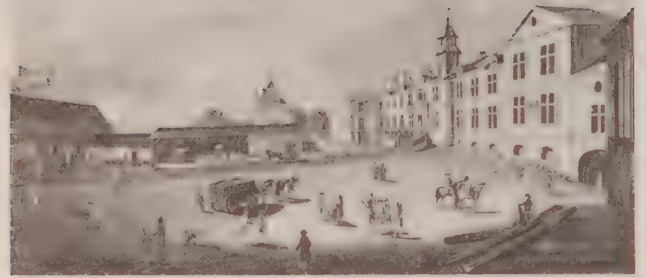
This last was the work of Pierre Gaultier de Varennes, sieur de la Vérendrye, who obtained a licence to engage in the fur trade beyond Lake Superior on condition that he seek a route to the Western sea. In 1730 he began his advance, and by 1738 reached the Missouri by way of the Red river. He and his sons then turned their attention to the fur trade of the Saskatchewan river until their licence was revoked in 1744. They did not find the Western sea, or even the Rocky mountains, but they did take many furs from the Hudson's Bay company.

In these 30 years of peace New France flourished. Its population grew until in 1739 there were 42,000 people and in 1754 there were 55,000. Farming prospered and flour and wheat were exported to the West Indies. Lumbering, shipbuilding and even ironmaking were developed. Quebec and Montreal became flourishing towns, and schools, hospitals and convents increased in number. The seigniorial system of land grants had been reformed in 1711 to compel seigniors to settle their lands and to make tenants, or habitans, clear theirs. There were settlements with white houses and stone churches with tall spires along the St. Lawrence from below Quebec to Montreal Island and up the Richelieu river to Lake Champlain.

6. British Conquest.—In 1740 the War of the Austrian Succession began, pitting England against France once again, and in 1745 the New Englanders attacked and captured Louisburg on Cape Breton Island. There was little other fighting in North America and by the treaty of Aix-la-Chapelle the war in Europe was ended in 1748 and Louisburg was recovered by New France. But both sides regarded the peace as a truce.

The truce was marked in North America by a struggle for control of the Ohio valley. Both English and French traders needed the friendship of the Indians. Virginian planters were planning to take up lands. The French laid claim to the Ohio valley in 1749 and in 1754 built Ft. Duquesne at the forks where the Monongahela and Allegheny rivers join to form the Ohio, and where Pittsburgh now stands. The young Virginian officer, George Washington, was sent to drive the French away but was defeated, and in the next year, 1755, the British general Edward Braddock was defeated and killed in a similar attempt. That same year Ft. Beauséjour in Acadia was captured by British and New England forces and the Acadians, who had refused to swear allegiance to the British crown, were deported.

In 1756 the Seven Years' War in Europe began and the American phase of this conflict, the French and Indian War, was to settle the fate of New France. For two years the French troops and Canadian militia were victorious. Then the British and American strength, fed by British sea power, began to tell. In 1758 Louis-



BY COURTESY OF THE PUBLIC ARCHIVES OF CANADA

THE INTENDANT'S PALACE, QUEBEC, BY RICHARD SHORT, 1759

burg fell; in 1759 James Wolfe captured Quebec; in 1760 Montreal surrendered and with it all of New France.

See also French and Indian War.

B. Canada as Quebec

When the war was finally ended and peace was made by the treaty of Paris in 1763, all New France east of the Mississippi, outside the environs of New Orleans, was ceded to Great Britain. Only two little islands, St. Pierre and Miquelon near Newfoundland, and the French fishing rights in Newfoundland, were left to France. But in what now became the province of Quebec more than 60,000 French Canadians became British subjects. As it was expected they would soon be swamped by settlers from New England, Quebec was promised by the proclamation of 1763 a government like that of the other British colonies.

The New Englanders, however, went to Nova Scotia to take up the Acadians' lands. Since 1758 Nova Scotia had had its own assembly and was becoming a standard English colony. Prince Edward Island became a separate colony in 1769, but its lands were granted to absentee landlords who did little to settle them. Since the New Englanders did not go to Quebec, and when it became apparent Quebec would remain French, British policy changed. It was decided to give Quebec French civil law, which was established side by side with the English criminal law, to protect the position of the Roman Catholic Church and to allow Roman Catholics to hold public office; and to rest the government in a governor and council, without an elected assembly. All this was provided for by the Quebec act (*q.v.*) of 1774.

That act, however, while it became something the French Canadians valued, angered the Americans because it included in the province of Quebec, or Canada, all the territory France had claimed south to the Ohio and west to the Mississippi. Thus it was one of the causes of the American Revolution by which Canada was once more separated from the old British colonies. These, of course, were recognized as the independent nation of the United States of America by the treaty of Versailles (1783).

By that treaty Nova Scotia, Newfoundland and Canada (now without the Ohio valley or the lands which later became Michigan, Wisconsin, and Minnesota) became what was known as British North America. To it came refugees from the United States, perhaps about 40,000 in number. These were the United Empire Loyalists, who had lost their lands and homes in the old colonies because they had opposed the revolution. They increased the population of Nova Scotia (*q.v.*), and added to the French population of Canada about 10,000 English-speaking people (*see* Ontario: *History*).

Their coming helped bring about a reorganization of the remaining British colonies. Nova Scotia was divided and the province of New Brunswick created in 1784. Then in 1791 Canada was given representative government by the Constitutional act (*see* Constitutional Act, Canadian) which provided for an appointed legislative council and an elected legislative assembly. The governor had an executive council to assist him, and a revenue he controlled without vote by the assembly. The province wa divided into the two provinces of Lower Canada (the futur Quebec) and Upper Canada (the future Ontario). Lower Canad was almost wholly French. Upper Canada, like New Brunswick was almost wholly British. Provision was made for the endowment of "a Protestant clergy."

During the years from 1763, British fur traders from Montrea aided by French-Canadian *voyageurs* (frontiersmen who followe the wilderness rivers and portages trading, trapping and transporting furs), were carrying the fur trade of Canada into the fa northwest. Alexander Mackenzie reached the Arctic ocean i 1789 and the Pacific in 1793. Canada, as explored by the fu traders following its long rivers, reached from sea to sea.

C. British North America

The French Revolutionary and Napoleonic wars overshadowe British North America from 1792 to 1814. War created a deman for timber by which the colonies prospered. But out of the Britis blockade of France and similar war measures came a war betwee Great Britain and the United States, the War of 1812 (*q.v.*).

That war seemed to Americans to offer a new opportunity t liberate Canada and add it to the United States. To Canadians i was a war of defense against invasion and, if possible, to recov the lost lands of the west. The war ended in stalemate. If th Americans failed to conquer Canada, the British failed to force a alteration of the boundary of 1783. The treaty of Ghent, 181 put things back as they were before.

The real results of the war came later. By the Rush-Bagot co vention of 1817 the naval armaments of Great Britain and th United States on the Great Lakes were ended. By the conventio of 1818 the Canadian-United States boundary was extended fro the Lake of the Woods to the Rocky mountains, and the Oreg territory beyond the mountains was to be jointly occupied for te years. The continent was peacefully partitioned.

1. Protest and Rebellion.—Up to this time there had been li tle political life in the Canadas, or indeed in British North Americ The communities were too small, and the long years of war tende to silence political differences. Only in Lower Canada did som manifestations of French nationalism appear and some controvers arise with the government, notably when the first newspaper i French, *Le Canadien,* was begun in 1806.

This peacefulness ended after 1820. As the war years recede and with the beginning of a large immigration from the Briti Isles to all parts of British North America, political agitation t change governments and persons that had become entrenche during the war years became vigorous in the two Canadas and No Scotia, and in the other colonies. The colonial governments le themselves to rigidity. All officers except the governor held offi for life. They could not be changed by popular wish, and neith could their views nor policies. As liberal and democratic idea spread in British North America, this situation became ever mo irritating to liberal-minded men. And while most of the officia were honest and conscientious men who discharged their respons bilities justly, there were instances of corruption, injustice an more often, of delay.

In Lower Canada, this friction of immovable officials and liber ideas was intensified by the fact that nearly all the officials we English and nearly all—though not all—the opposition was Frenc Moreover, the English dominated the executive and the legislati councils, while the French dominated the assembly. Thus t conflict involved nationalities and institutions as well as politics.

In Nova Scotia and Upper Canada conflict between French a English was absent, but an edge was given to political controver by the fact that many Nova Scotians and Upper Canadians we of nonloyalist American descent. They were regarded with susp cion by the official class as being potentially disloyal. As ma were also Baptists or Methodists whose churches derived the ministers largely from seminaries in the United States, and al members of the political oppositions, or Reformers, the official cla tended to equate political opposition with disloyalty.

The basic difficulty, however, was how to make the official cla responsive to the needs and wishes of society. The Reforme put forward two suggestions. One was that the legislative council—and by implication even the governor and other officials—should be made elective. The leader of the French opposition, Louis Joseph Papineau (*q.v.*), endorsed this proposal, as did William Lyon Mackenzie, the most controversial of the Reform leaders in Upper Canada.

A second proposal was that the officials and advisers of the governor—his executive council—should be made responsible, or accountable, to the legislative assembly elected by the people. This proposal was first put forward by W. W. Baldwin and his son Robert, of Upper Canada, and was taken up by Joseph Howe (*q.v.*), the leader of the Nova Scotia Reformers (*see* BALDWIN, ROBERT).

Both suggestions had the disadvantage that they seemed to lead to full self-government, or independence. The supporters of responsible government therefore proposed that it should apply to ocal matters only.

These ideas were more vigorously agitated in the 1830s. The July Revolution in France, the victory of Jacksonian democracy n the United States and the fall of the Tories and the passing of he first Reform bill (1832) in the United Kingdom all stimulated political agitation in Canada. The Whig government of the United Kingdom tried to satisfy the Reformers but failed, and its failure led to the Canadian rebellions of 1837.

The rebellion in Lower Canada was partly planned by Papineau and his followers. It was also partly provoked by the official class and its partisans. But it was largely a spontaneous and despairing outburst caused by the collapse of wheat farming during the 1830s in the Montreal area, owing to soil exhaustion, and to the widespread commercial depression of 1837. There was some stiff fightng between the rebels and the British troops and militia around Montreal before the leaders fled to the United States or were aptured.

In Upper Canada the uprising was unplanned. As all the troops had been sent to Lower Canada to deal with the serious situation here, Mackenzie seized the opportunity to try to take the capital, Toronto, by a sudden raid. His force was scattered by the local militia and he himself barely escaped over the border.

2. Union of Upper and Lower Canada.—Small as the insurections were, they served to condemn the old system of government. An English statesman of the first rank, Lord Durham (*q.v.*), was sent out as governor general and royal commissioner o inquire into the causes of the rebellions and to make recommendations. His famous "Durham report" embodied two Canadian ideas and one English-Canadian fallacy. The ideas were that he Canadas should be reunited, as the Montreal businessmen wished, and that colonies should have responsible, or self, government in local matters, as the moderate Reformers like Baldwin and Howe wished. The fallacy was the idea that the French Canadians would be swamped by English immigration and then assimilated into an English population, a fallacy as old as the proclamation of 1763.

The British government still thought responsible government would lead to independence and did not explicitly grant it. But it did unite the Canadas by act of parliament in 1840, uniting Lower and Upper Canada as Canada East and Canada West. The rebellions had driven the radicals from Canadian politics and in the new assembly it was soon apparent that all moderates, whether Reformers or Tories, English or French, were prepared to accept, if not to demand, some measure of responsible government. Thus when the British government became convinced after 1846 that esponsible government might be conceded safely, and sent Lord Elgin as governor general to Canada to govern as the queen governed in the United Kingdom, the last remaining obstacles were emoved. In 1848 the principle was recognized in Nova Scotia and Canada, where in 1849 its significance was underlined by the riotous objections taken to the Rebellion Losses bill by the reactionary Montreal Tories and the Montreal mob. As the bill passed by the Canadian legislature proposed to compensate those, including French Canadians, who had suffered loss in the uprisings of 1837, it was viewed as payment to rebels. Elgin was petitioned to veto it but refused on the ground that in domestic affairs the Canadian parliament was supreme. A Tory mob then pelted the governor and burned the parliament buildings.

Much of the anger of the Montreal Tories was caused by the repeal in 1846 of the British Corn laws, under which Canadian exports had a preference in the British market. The commercial shock Canada suffered was increased by the slump of 1847. So despairing were many of the Montreal businessmen that they saw a commercial future only in annexation to the United States.

Other remedies were found, however. One was reciprocal trade in natural products with the United States. This was finally arranged by the reciprocity treaty of 1854. Another was the beginning of railway construction in Canada. In 1849 there were only 66 mi. of railway in Canada; in 1860 there were 2,065. Much of this mileage was in the Grand Trunk railway, built from Sarnia on the Detroit river to Montreal and Portland, Me., in the 1850s. In consequence of these developments, and of the inflated demands for raw materials brought on by the Crimean War (1853–56), Canada enjoyed a boom until the slump of 1857.

Meantime, the British North American legislatures had been using the self-government won in the 1840s to remodel their laws and institutions. In Canada primogeniture, for example, was removed from the law of inheritance. The French civil law was codified. Municipal government was made elective. The Clergy reserves, public lands granted for the support of the Church of England and the Church of Scotland, were abolished, and church and state separated in Canada. Seigneurial tenure was abolished. The French language was made an official language in Canada. Systems of public education were begun. The legislative council of Canada was made elective.

These advances, in which the other British American colonies took part, ceased after 1858. The union was becoming unworkable. It had never been a complete union. Moreover, the representation in parliament had been fixed by the act of union at the same number for each section, Canada East and Canada West. Until 1851 Canada East (French Canada) was underrepresented. After that date Canada West was. A fierce protest built up against this alleged injustice, with a demand first for "representation by population" as advocated, for example, by George Brown (*q.v.*), then for a change in, or even a dissolution of, the union. The controversy became so fierce that parliamentary government by parties broke down. Attempts to govern by "the double majority"—a majority for a law in each section—also failed. By 1864 parliamentary government in Canada was deadlocked.

D. CONFEDERATION

For several years a proposal had been before the Canadian parliament to resolve the difficulties of the union by making it a

BY COURTESY OF THE PROVINCIAL ARCHIVES, VICTORIA, B.C.

FREIGHTING ON THE CARIBOO ROAD, BUILT 1862–65 IN THE FRASER RIVER VALLEY, BRITISH COLUMBIA, DURING THE CARIBOO GOLD RUSH federal rather than legislative union and by merging it in a confederation of all British North America. This was itself a very old idea, going back to before the French and Indian War, but it had never entered practical politics until Alexander Galt of Montreal sponsored it in the Canadian parliament, and the governor general, Edmund Head (later Sir Edmund), urged it on the British government in 1858.

1. The Northwest.—The prospects of wider union had first become realistic in the 1850s. The northwest, once the preserve of Canadian fur traders, had been lost to the Hudson's Bay company in 1821. In that year the North-West Fur Company of Montreal and the Hudson's Bay company, after years of bitter rivalry which had threatened to destroy Lord Selkirk's colony on Red river, united under the name of the Hudson's Bay company. Thereafter the connection between Canada and the northwest became very slight. The great fur company traded in and governed all the north half of the continent from the Labrador coast on the east to the coasts of Oregon and Alaska on the west.

For two decades it was undisturbed and then two events began to threaten its remote and isolated monopoly. One was the advance of U.S. traders from St. Paul, Minn., to Pembina on the border in the 1840s. The result was that Red river settlers began to defy the company's monopoly and to trade with St. Paul. After the abortive trial of a half-breed settler, Guillaume Sayer, for illegal trading, the company could no longer enforce its monopoly in the Red river country. The other was the beginning of U.S. settlement in the Oregon country, also in the 1840s. The coming of settlers ended the joint occupation of 1818, and by the Oregon treaty of 1846 the 49th parallel of latitude was extended to the Strait of Georgia. Vancouver Island was left to the Hudson's Bay company and made a crown colony in 1849. The American frontier was beginning to press on the great fur preserve of the northwest.

In the 1850s the pressure was greatly increased. Gold was discovered on the Fraser river in British Columbia and a rush of miners, mostly from the western United States, followed. Gov. James (later Sir James) Douglas of Vancouver Island acted to establish law and order on the mainland and to preserve British dominion of the area, and in 1858 the crown colony of British Columbia was created.

At the same time British Canadians began to take an interest in the Red and Saskatchewan valleys. A parliamentary inquiry was held in 1857 to determine whether the trading monopoly of the Hudson's Bay company should be renewed after it expired in 1859. The interest the inquiry aroused led Canada to dispatch an exploring expedition led by geologist Henry Youle Hind, who described the northwest as fit for settlement. The British government also sent an expedition. Its leader, geographer Capt. John Palliser, was much more skeptical of the agricultural possibilities of the western plains.

The result in Canada was an agitation in Canada West for the union of the northwest with Canada. French Canadians were somewhat doubtful of a proposition which would greatly increase the English majority. But in the early 1860s Canada West found an ally in Edward Watkin, an English financier sent out to report on the financial condition and future development of the Grand Trunk railway. He recommended that the railway be extended to the Pacific, and for which purpose he organized the buying out of the Hudson's Bay company in 1863. Meanwhile, the continuing political deadlock between Canada East and Canada West and the slump of 1857 contributed to check the movement for the union of the northwest with Canada.

2. The Atlantic Colonies.—The events in the northwest which led Canada to think of a union extending to the Rocky mountains, if not to the Pacific, were matched by developments in the Atlantic colonies of British North America—Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland. These also led to thoughts of political union, but a union of the Atlantic colonies, not of their union with Canada. All these colonies were now fully developed, with representative and responsible governments. Newfoundland, it is true, had been regarded for years as a fishery and not a colony. It had obtained resident law courts only in 1791 and an assembly only in 1832.

During the 1850s the trade and commerce of the Atlantic colonies had prospered as never before. The fisheries enjoyed good markets, a particular necessity for Newfoundland. Lumber was in demand in the United States and Great Britain, and New Brunswick throve. Farm produce flowed to New England, and Prince Edward Island and New Brunswick benefited. But beyond all these, the shipping of Nova Scotia flourished in the heyday of the clipper ships. That province was at the peak of its development and its wealth may be gauged from the fact that two great busines firms arose from its prosperity at that time, the Bank of Nov Scotia and the Cunard Steamship company.

Over this golden age of the Atlantic, or maritime, provinces shadow began to pass in the 1860s. It was a realization that thei further development would depend not only on their fisheries shipping and overseas commerce, but also on their commercial an political relations with the rapidly developing continent behin them. One way to deal with the changes which seemed to b coming with the railway, the steamship and the probable end o the reciprocity treaty with the United States was to end the political fragmentation of the Atlantic colonies by a union. This ha been discussed in the late 1850s; now the discussion was renewed A conference of governments was arranged for Sept. 1864 at Charlottetown in Prince Edward Island.

In Canada, meanwhile, the political deadlock had become s serious that the chief political leaders, John A. Macdonald and Georges Étienne Cartier of the Conservative party and George Brown of the Liberal, agreed to join in a coalition government t attempt to bring about a federal union of British North America The Canadian government asked to join the Charlottetown conference, and it was agreed there to meet later at Quebec to discuss a union of all British North America.

3. The Quebec Conference and the Canadian State.—At the Quebec conference in October a scheme of federation was decided upon, which after few, if substantial, modifications was enacted by the parliament of the United Kingdom as the British North America act (1867). By this act four colonies, Nova Scotia New Brunswick, and the Canadas, now named Quebec and Ontario united federally. Newfoundland declined to come in, as did Princ Edward Island. The name of the new union was Canada, and i became in fact a subordinate and allied kingdom of the British crown. The Canadian request to call it the "Kingdom of Canada was refused by the British government, as there had been some protest in the United States at the setting up of a monarchy in the ne world. A substitute was found in the word "Dominion," and thu the true character of the Canadian state, which is a monarchy, wa veiled until Queen Elizabeth II was proclaimed queen of Canada on Feb. 6, 1952.

The union was technically a federal union. The powers of government were assigned to the federal government, or to the provincial governments. General authority and the residue of power w given to the federal government in order, as it was thought, to avoi a weakness revealed in the government of the United States by th outbreak of the Civil War. The whole plan of government wa modeled not so much on that of the United States as on that o the British empire from the 1840s, in which the imperial government had a supreme and overriding authority, but in which th colonies had wide and real powers of self-government.

Over and above legal technicalities, however, the act of confederation was a compact, not legal or political, but moral and const tutional, between French and British Canadians—French Canad was given freely what its leaders requested as necessary to ensur the life of the French community in Canada. This included th control of civil law and education by the provinces, the rights o the French language in Quebec and the federal parliament and th courts, and the guarantees given the educational rights of religiou minorities in the provinces. On the observance or violation o these terms of the compact between French and English, the ha mony of their relations and the strength of the Canadian unio have depended since confederation.

E. THE DOMINION OF CANADA

The Dominion of Canada came into being on July 1, 1867; ar

FOR the comfort and convenience of settlers going to the CANADIAN NORTH-WEST, the
CANADIAN PACIFIC RAILWAY
Provides a Special Form of Passenger Equipment, known as
COLONIST CARS

[illegible]

pillow and blanket for $2.50 (10 shillings), which they can retain at the

[illegible]

cut shows the interior of a Colonist Car, with a portion of the berths

[illegible]

Holders of COLONIST or SECOND-CLASS TICKETS are allowed FREE USE OF THESE CARS FROM THE BEGINNING TO THE END OF THEIR JOURNEY OVER THE [illegible]

COURTESY OF (LEFT) THE PROVINCIAL ARCHIVES, VICTORIA, B.C., (RIGHT) GLENBOW-ALBERTA INSTITUTE, CALGARY

(LEFT) ARRIVAL OF THE FIRST TRANSCONTINENTAL PASSENGER TRAIN AT VANCOUVER, B.C., ON MAY 23, 1887.
(RIGHT) BACK COVER OF A CANADIAN PACIFIC RAILWAY BOOKLET ENCOURAGING SETTLEMENT OF THE WEST, 1888

ly 1 has since been the national holiday of Canada. That date arked only the beginning, not the end, of the process of confedation as the Conservative prime minister, Sir John Macdonald, new. The rest of British North America had to be brought into e union, as the act of confederation provided.

Even before that work could be got well under way, the terms confederation had to be revised to conciliate Nova Scotia. hat province, led by Joseph Howe (*q.v.*), resented the way it ad been brought into confederation without the question being bmitted to the people in a general election. The anticonfederaonists also argued, with much justice, that the financial terms of nion given Nova Scotia were unfair. The dispute was adjusted d financial concessions were granted early in 1869. (*See* also OVA SCOTIA.)

1. First Riel Rebellion.—Scarcely had Nova Scotia been acified when trouble broke out in the Red river country. The ansfer of the Hudson's Bay company territories of Rupert's Land d the North-Western Territory had been negotiated with the ritish government. For the nominal sum of £300,000, together ith one-twentieth of the lands of the prairies as they were sureyed and about 45,000 ac. of land around its various posts, the mpany agreed to transfer its territories and rights of government Canada.

In all this the people of the northwest had been neither conlted nor informed. More surprisingly, neither had the local ficers of the Hudson's Bay company. In addition, the Canadian vernment had, with the best of intentions, and with the permisn of the local Hudson's Bay company governor, William Macvish, anticipated the transfers by sending into the territory a ad-building party and a survey party. Both groups had alarmed d offended some of the local people.

Almost 12,000 people were settled in the Red river colony of ssiniboia. About one-half were French and one-half Scottish. he great majority had some Indian blood. They had been isolated r over half a century and had developed a distinctive way of life their own. This was particularly true of the French-speaking ople of mixed blood, known as the métis. They were mainly ffalo hunters and *voyageurs*, a proud people who thought of emselves as a "nation" with rights in the northwest. They now ared a threat to their French culture and their religion, and pecially to the titles to their lands, in the prospect of a rush Protestant farmers from Ontario. They resented not being nsulted and they found a leader in one of their own people, an ucated métis, Louis Riel.

Under Riel, the métis organized a council of war, and when the w lieutenant governor, William McDougall, whom the Canadian ministry had appointed, arrived at the border by way of the United States, he was not allowed to enter the territory. Riel seized Ft. Garry and set up a provisional government to negotiate terms of union with Canada. In the spring of 1870 these were agreed upon, and embodied in the Manitoba act, by which the province of Manitoba was established. But the rest of the northwest was made a territory, and Riel was driven into exile for ordering the execution of an Ontario man, Thomas Scott, in the course of the rebellion.

2. Territorial Expansion.—Canada then extended to the eastern boundary of British Columbia. That colony had been united with Vancouver Island in 1866, and a movement for union with Canada began. As the most important condition of union, British Columbia wanted a railway to the east. Early in 1870 delegates went to Ottawa and were granted generous terms of union. In particular, the Pacific railway was to be begun within two years of the union and completed within ten. The assumption of this enormous undertaking—one far greater than the building of the Union Pacific in the United States—was the measure of Canada's determination to bring the Pacific colony in and to extend from sea to sea. British Columbia entered confederation in 1871.

Despite high hopes held by Prime Minister Macdonald, Newfoundland refused to reconsider its decision to remain outside confederation. In 1873, however, Prince Edward Island won terms sufficiently generous to bring it in. The territorial expansion of Canada was greatly speeded when in 1880 the British government by order-in-council transferred to Canada jurisdiction over the Arctic archipelago. With that the territorial expansion of the dominion was complete until the entrance of Newfoundland in 1949.

In 1871 the drawing of the boundary with the United States in the Gulf of Georgia was submitted to arbitration and the island of San Juan was awarded to the United States in 1872. That boundary was now defined from Atlantic to Pacific, but the boundary of the new U.S. possession of Alaska remained uncertain. Relations with the United States were also put on a new footing by the treaty of Washington, 1871, which ended the tension between the United States and Canada caused by the supposed sympathy of the Canadians with the Confederacy in the American Civil War. Canadians were aggrieved, however, that they obtained little compensation by the treaty for rights granted to U.S. fishermen in Canadian waters, and none for the raids made on Canada by the Fenians (*q.v.*) from the United States.

3. Transcontinental Railroad.—This resentment made it difficult for the government of Prime Minister Macdonald to win the general election of 1872. To assist in a hard-fought contest, he and his colleagues obtained large sums from Sir Hugh Allan, a railway and steamship magnate who was interested in building the Pacific railway. Macdonald won the election, but a royal commission was appointed to investigate the transaction. Although Macdonald was acquitted of personal corruption, his government was overthrown by the "Pacific scandal," and a Liberal ministry came into office.

The Liberal government of Prime Minister Alexander Mackenzie tried to fulfill the terms of union with British Columbia and build the railway. But it thought the undertaking too big for Canada to assume alone, and in the depression that began in 1873 it could find no private interests to undertake the task. Then it attempted to negotiate a change in the time in which the railway was to be finished. In British Columbia there were angry charges of breach of faith, and there was talk of secession. But the Mackenzie government could only proceed with the railroad in sections, as the revenues of the country permitted.

4. The "National Policy."—Meantime the Conservative opposition had been looking for a policy on which to win the next election. There was a movement of national feeling, inspired by the annexation of the northwest and called "Canada First." At the same time there was the demand of Canadian industrialists for protection against the dumping of U.S. goods in Canada during the depression. Since the coming of the railway Canada had ceased to be a country producing only export staples like fish, fur, lumber and wheat. Daniel Massey had opened a foundry in 1847 and had begun to manufacture agricultural machinery, and other small industries had sprung up in the 1850s and 1860s.

These two things, national sentiment and industrial protection, Macdonald combined in what he called a "National Policy." The policy was a promise of protection for Canadian industry if the United States did not renew the reciprocity treaty which it had terminated after the Civil War, in 1866, as there was little likelihood of its doing. In 1878 the Conservatives returned to power on the National Policy platform and in the next year the Canadian tariff, hitherto a revenue tariff, was made in part a protective one.

The policy was one which strengthened the country, and with the return of prosperity enabled the Conservative government to push the building of the Pacific railway. A new company, the Canadian Pacific Railway company, was formed and was subsidized to the extent of 25,000,000 ac. of land in the west and $25,000,000 to proceed with the completion of the railway. The task was finished in 1885 and by 1887 the Canadian Pacific railway extended from the Atlantic to the Pacific, a truly transcontinental railway system.

5. Second Riel Rebellion.—This triumph of nation-building had been marred by one outbreak of the old order in the northwest. On the Saskatchewan river the Indians and the métis were alarmed by the vanishing of the buffalo herds and the coming of white settlers. Also, some settlers were disappointed in their expectation that the railway would follow the Saskatchewan river to the Rocky mountains instead of crossing the southern plains. These stirred up the métis to send for Louis Riel to come from Montana and lead them in making new demands on the Canadian government. In the spring of 1885 Riel formed a second provision government and defied the authority of the Canadian governmen Fortunately, only a few Indians joined Riel, and this rebellion wa crushed by troops sent from eastern Canada and Manitoba. Ri was captured, as were the Indian leaders, Poundmaker and B Bear. The rebellion had two sets of consequences. One was th remedying of some of the grievances of the Indians and métis wit respect to the issuing of rations and land titles, together with th granting of representation in parliament to the territories. Th other was the trial and execution of Riel for treason, and the stor of protest which his death aroused in Quebec. (*See* RIEL, LOUIS The protest began a chain of events which was to destroy the Co servative government.

BY COURTESY OF THE GEOLOGICAL SURVEY OF CANADA, OTTAWA

BIG BEAR'S CAMP AT MAPLE CREEK, SASKATCHEWAN, 1883; TWO YEARS LATER THE CREE INDIANS JOINED LOUIS RIEL IN THE NORTHWEST REBELLION

At the time, other things seemed more urgent than the fate Riel. The National Policy had been put into effect but Canad after a brief boom in the 1880s, settled down into a prolong depression which lasted for a decade. The Canadian Pacific rai way was built, but the northwest did not fill up with settler Emigrants from the British Isles and Europe still went mainly the United States. Canadians were going there in large number too, and the Liberal opposition added to their criticism of the N tional Policy and the Canadian Pacific railway sarcastic commen on the exodus of Canadians in which these measures, they allege had resulted. Nonetheless, the Conservative party survived th next two elections, those of 1887 and 1891, in both of which th Canadian tariff and commercial relations with the United Stat were the leading issues. In 1891 the Conservatives won mainly b an appeal to patriotic sentiment against the Liberal policy of u restricted reciprocity with the United States, the Conservativ holding that commercial union inevitably would lead to politic unification. But Sir John Macdonald died immediately after th latter victory, and already the issue had arisen which was to brea up his government and his party.

6. French-Canadian Nationalism.—The execution of Ri had cost few seats federally. But in Quebec it had led to the ri of a strongly French-Canadian nationalist government led b Honoré Mercier. Mercier succeeded in passing the Jesuit Estate act to compensate the Society of Jesus for lands that had been co fiscated after the dissolution of the order in 1773, and asked th pope to decide how the money should be awarded. This reque gave offense in Protestant circles in Ontario and a brilliant you Conservative politician, D'Alton McCarthy, began an agitati against the act and papal intervention in Canadian affairs.

In 1889 he went to speak in Manitoba, where he found the ne Liberal government of Thomas Greenway embarrassed by a ra way scandal and concerned with the cost of extending schools newly settled districts. The Manitoba schools were, by the Ma toba act of 1870, denominational schools. McCarthy's attack the growing influence of Catholicism touched off an attack on th French language and the Catholic schools in Manitoba. Fren ceased to be an official language of the province and the scho system was made nondenominational by the Manitoba School a of 1890.

The attack on the constitutional rights of the French and Roman Catholics of Manito was contested in the courts. Th right of the province to legisla as it had done was upheld. Th Roman Catholics then soug remedial legislation under th British North America act 1867, and in 1895 the courts he that parliament had the oblig tion to pass such legislation. B when the distracted Conservati government under its fourt prime minister since Macdonald death introduced a remedial b to restore Catholic schools, failed to carry it before the li of that parliament ended.

In the ensuing election (189

Pulp and paper plant at Powell River, B.C., reputed to be the world's largest

Steelmaking at Hamilton, Ont., the "Pittsburgh of Canada"

INDUSTRIAL CANADA

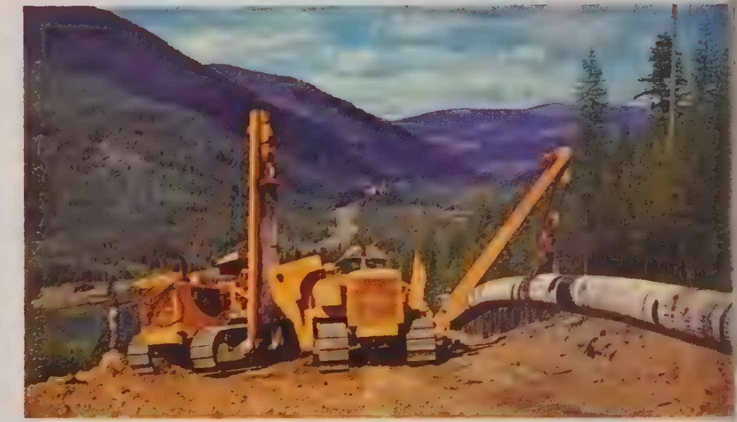
Mine and smelter at Flin Flon, Man.

Potash mine and refinery at Esterhazy, Sask.

PHOTOGRAPHS, GEORGE HUNTER FROM PUBLIX

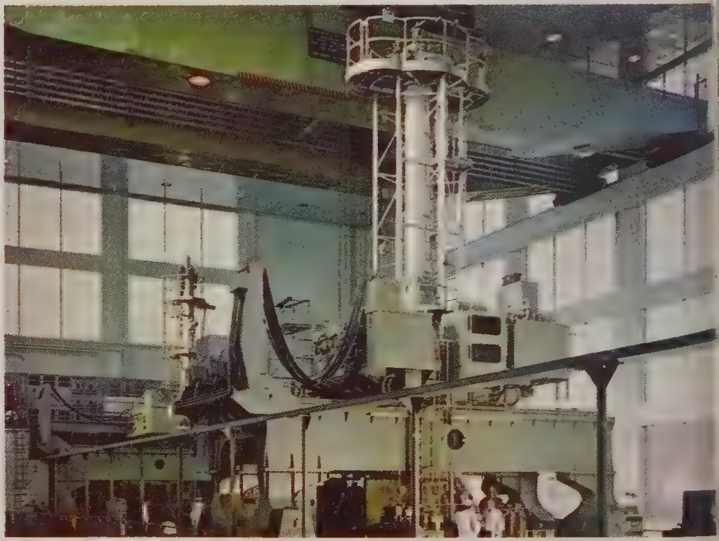
CANADA

Casting pig iron at Sorel, Que., on the S Lawrence river about 45 mi. N.N.E. o Montreal



Pipeline construction in the Kimberley area of British Columbia

Lumberjack loosening a log jam on the St. Anne river during the spring log drive



One of the reactors at Canada's main atomic research and development centre at Chalk River, Ont.

INDUSTRIAL CANADA

PHOTOGRAPHS, GEORGE HUNTER FROM PUBLIX

BY COURTESY OF THE PUBLIC ARCHIVES OF CANADA

TROOPS FROM THE EAST EN ROUTE THROUGH THE TOUCHWOOD HILLS TO HUMBOLDT, SASKATCHEWAN, DURING THE NORTHWEST REBELLION

the Manitoba school question was a burning issue, especially in Quebec. Should the French voter support the Conservatives who had tried to impose remedial legislation on Manitoba, or the Liberals who held that education was a provincial subject and that the Manitoba government could be persuaded by a Liberal government to do justice to a minority? The Liberal plea was put by Wilfrid (later Sir Wilfrid) Laurier, a French Canadian who in 1887 had succeeded Edward Blake as leader of the Liberal party.

The Liberals won a decisive victory partly because Quebec gave Laurier a large majority. The Manitoba school question was then compromised by Laurier and Greenway agreeing on legislation which allowed religious instruction under limited conditions and instruction on prescribed conditions in English and French "or such other language on the bilingual system."

7. Imperial Preference.—The problem of the tariff was urgent, for the Liberals had preached the doctrines of free trade. They had, however, to face the condition that many industries had grown up under protection and that to open the door to the more highly developed manufactures of the United States would involve disaster. The year 1897 was the 60th of the reign of Queen Victoria, and Laurier met his difficulties with a brilliant stroke. Though he made but slight changes in the tariff, he used the occasion of the jubilee to give Great Britain a reduction of 25%, later increased to 33⅓% of the tariff.

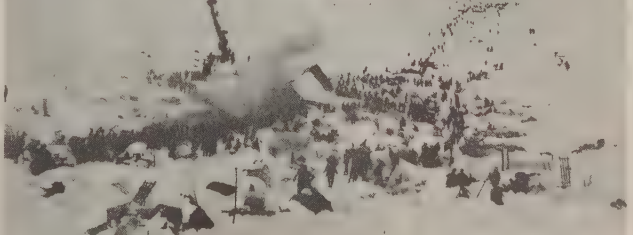
More important to Liberal success than these measures, however, was the fact that they came into power as the great depression of the 1880s and 1890s gave way to a prolonged boom. From 1896 to 1912 Canada prospered as never before, a prosperity which was advertised to the world by the last of the great gold rushes, the Yukon rush of 1897–98. With prosperity the west began to fill up at last. The last free land in the United States was gone, and emigrants from south of the border, from the British Isles and from Europe poured into Manitoba and the Northwest Territories in a last great land rush. To deal with it, and the rapidly swelling wheat crop of the prairies, two more transcontinental railways were built, the Canadian Northern, and the Grand Trunk Pacific in conjunction with the National Transcontinental. The two new provinces of Alberta and Saskatchewan were created in 1905 with self-government on the lines of the other seven provinces. This was done not without friction, for again the demand was made for the right to separate schools, supported by the state, in which should be taught the Roman Catholic faith. Minor compromise eased the friction and Regina and Edmonton, so recently little more than trading posts, soon had impressive parliament buildings as capitals respectively of Saskatchewan and Alberta. The political framework of Canada from the Atlantic to the Pacific was thus completed.

At the time that the farming frontier of the west was being taken up, a new mining frontier was being opened up on the Pre-Cambrian shield of northern Ontario and Quebec. The Cobalt strike of 1903 touched off a rush of prospectors in search of the precious and the base metals of the shield. The shield also began to yield the hydroelectric power of its many rivers, and the wood pulp of its spruce forests. A whole new complex of primary and secondary industries began to develop, and even while Canada's boom depended mostly on western wheat, the industrial development of the country was being rapidly advanced.

8. Support of the Empire.—Canada was not allowed to proceed in peace with its internal growth. In 1899 the South African War raised the question of Canadian participation in imperial wars. Laurier took his stand on the principle that only the Canadian parliament could decide to what extent Canada would participate. But the matter remained a live one. It recurred at successive imperial conferences from 1902 on, and especially in Quebec. There Canada's limited role in the South African War of recruiting Canadian contingents who were, however, paid by Great Britain had aroused the opposition of Henri Bourassa, a grandson of Papineau. Finally, the question became one of what contribution Canada should make to the imperial navy. Laurier's decision was to create a Canadian navy which might in war come under imperial command, but even this decision cost the government a by-election in Quebec in 1910.

9. Anti-American Feeling.—Then in 1911 the Laurier government fell before an outburst of anti-American feeling. The Yukon gold rush had made necessary a settlement of the vaguely drawn boundary of the Alaskan panhandle. It was settled in 1903 in favour of the United States claim by a joint tribunal, but Canadians felt the British representative had given in to American pressure and yielded up Canada's right. The result was a feeling that Canada must handle its own affairs and that the United States had once more imposed its views in a boundary dispute. But when in 1911 Canada was asked by the United States to discuss a reciprocity agreement, and one was made, the Laurier government supposed that Canada, which had wanted reciprocity since 1886, would approve and return the Liberals to power. The farmers of the Canadian west welcomed the proposal; it would give them wide markets and cheaper agricultural implements. But industry was naturally alarmed at any intrusion on a protected field; the railways feared diversion of traffic from the long lines running east and west to north-south lines to the United States; and banking interests were alarmed lest closer relations should lead to the financial dominance of New York city. These considerations were reinforced by the strong British sentiment in Canada, which resented giving the United States advantages in trade superior to those of Britain. Laurier dissolved parliament with confidence, but a violent campaign in defense of the national policy of tariffs and east-west railway traffic, aided by tactless American statements that Canadian union with the U.S. was only a matter of time, defeated the Liberals. (*See* also LAURIER, SIR WILFRID.)

10. World War I.—The Conservatives thus came to power un-



BY COURTESY OF THE PUBLIC ARCHIVES OF CANADA

PROSPECTORS SCALING THE CHILKOOT PASS FROM ALASKA DURING THE YUKON GOLD RUSH OF 1897–98

BY COURTESY OF THE PUBLIC ARCHIVES OF CANADA

SIR WILFRID LAURIER CAMPAIGNING IN BERLIN, ONTARIO, 1908

der Robert (later Sir Robert) Laird Borden at the end of a great boom and on the eve of a great war. Canadian doubts about the degree of participation in wars to which Great Britain was committed were resolved by the German invasion of Belgium in World War I; Canada went to war united. At first Canadian troops were under British command, but by the end of 1916 four divisions had been built up, and were formed into a Canadian army corps under a Canadian commander, Gen. Sir Arthur Currie, in 1917. The army became the symbol of the stimulated national feeling.

Canada also contributed food to the war effort and, on a rapidly increasing scale, munitions also. The war greatly accelerated the industrialization of the country. The demand for materials and manpower led to a price inflation and a demand in 1917 for conscription. Prime Minister Borden proposed a coalition government to carry military conscription, but Laurier declined, largely because of opposition in Quebec. Conscription was enacted and a Union government formed which in Dec. 1917 won the general election. But the Liberal party was split and French Canada alienated.

Canada shared from 1917 in the conduct of the war through the imperial war cabinet, on which Prime Minister Borden sat. When the peace was made, Canada, with the other dominions, took a separate seat at the conference, signed the peace treaties as a nation of the British empire, and entered the League of Nations in its own right. Canada's share in the victory was thus recognized by its being accepted as an autonomous nation within the empire, but the implications of the new status had yet to be worked out.

11. Postwar Unrest.—Within Canada war had less pleasing results. The Canadian Northern and Grand Trunk railways had gone bankrupt, and had to be taken over by the federal government and organized as the Canadian National railway between 1917 and 1923. By 1920 the slump from the prosperous war years had set in; wheat had fallen from its 1919 level of $2.15 a bushel to 60 cents. The prairie farmer was hardest hit. Wheat farming had to be conducted on a large-scale basis and with machinery, necessitating a large capital outlay, which was usually found in the form of bank loans. Under these circumstances, forms of co-operation became popular. The most successful were the Grain Growers' associations, which originated in the Northwest Territories in 1901 and spread to Manitoba, and the United Farmers of Alberta, organized in 1909. Those associations had created the United Grain Growers' Grain company in 1907 and the Saskatchewan Co-operative Elevators company in 1911. These were joined after 1923 by the co-operative elevator companies of the wheat pools.

The period of postwar deflation presented a curious paradox. While the prices of primary products and wages fell, the prices of other commodities and services remained high. Protected by the tariff, or sustained by government subsidy, industry generally weathered the difficult years between 1919 and 1924. There was no reduction of the tariff until 1923, when the reductions were offset by bonuses to favoured industries. Taxes, such as the sales tax, income tax and a variety of "nuisance" taxes which fell on individuals, rather than on corporations, remained.

Labour unrest was widespread, caused partly by the high cost of living, partly by the spread of industrial unionism in western Canada, partly by the revolutionary ferment of the times. This unrest flared up in strikes across the country. The chief was the Winnipeg strike of 1919. In that city a strike to force recognition of the right to bargain collectively in the metal trades became a general, sympathetic strike which involved the police and other public services. A bitter struggle followed, and after six weeks the strike was broken by the arrest of the strike leaders. This harsh and drastic action greatly strengthened the labour movement in Canada, which was henceforth a force to be reckoned with.

Agrarian unrest had also been building up since the defeat of reciprocity in 1911. In 1916 and 1919 the Canadian Council of Agriculture published "farmers' platforms." In 1920 and 1921 the unrest was greatly increased when the farmer was caught between falling agricultural prices and a still high cost of living. The farmers began to enter politics against the old political parties They captured, or threatened to capture, several provincial governments, and then formed a farmers' federal political movement which was called the National Progressive party.

In Quebec the French voters remained alienated from the Union government and the Conservative party. When the Liberal party elected a leader to succeed Laurier, he had to be a man acceptable to Quebec. He was found in William Lyon Mackenzie King, a grandson and namesake of the rebel, a young man of advanced ideas and a Liberal of rank. All these forces determined the outcome of the election of 1921. The Union government of Prime Minister Arthur Meighen, who had succeeded Borden, was defeated. The Liberals elected the whole provincial representation of Quebec, 65 members, but only half the house of commons in all. Farmers and workers had revolted from both old parties to elect 65 Progressives. The new Liberal leader formed a minority government which could count on some support from the Progressives. A constitutional crisis occurred when King resigned in 1926 and the succeeding Conservative government, although defeated a few days later, held office for several months until the election in September returned King with a stable majority.

Domestically the decade of the 1920s was marked by a depression in the first half and a boom in the second. Improved conditions, which had been apparent as early as 1925, produced an unparalleled period of prosperity. A rise in the price of agricultural products helped the farmer, who was further assisted by the extension of branch lines of railway through the wheat-growing region of the west. Industry was stimulated by the influx of foreign capital. Another feature was the establishment of branch factories of United States or British origin. The government's steady reduction of taxation was popular, and the tariff was progressively scaled down, especially as it affected textiles. The Liberal party continued to hold the allegiance of Quebec and gradually reabsorbed all but the most militant of the Progressives

PRIVATE
FREE TRIP TO EURO
= STEP ABOAR
BIT

BY COURTESY OF THE JAMES COLLECTION OF EARLY CANADIANA

STREET CAR RECRUITING IN TORONTO FOR WORLD WAR I ome mild reform legislation and the building of the Hudson Bay ailway alone distinguished these years.

12. External Affairs.—The major developments were in exernal affairs. A growing North American point of view was demnstrated in an emphatic fashion in 1921, when Canada was largely esponsible for inducing Britain to abandon its alliance with Japan, hiefly in deference to United States opinion. Indicative of its ncreasing independence was Canada's refusal to be bound by imerial agreements unless formally engaged in by Canada. This was hown dramatically in 1922 when Prime Minister King refused o accede to Britain's request for troops in the impending crisis ith Turkey until parliament had been consulted. In the various ostwar European settlements, Canada had little part. It refused o ratify the treaty of Lausanne or the Locarno security pact, aserting that, not having been consulted and not having signed, it ad no obligation. The right to separate diplomatic representation as successfully asserted as early as 1920, although it was not until 927 that the first legation was opened at Washington, D.C. After hat date Canada established legations at Paris and Tokyo. In 1923 reaty-making power was asserted in negotiating and signing the alibut treaty with the United States. Assertions of autonomy s sweeping as these demanded a restatement of Canada's relations o the British empire. The formula was found at the Imperial conerence of 1926, which declared the dominions to be partner ations with Britain, equal in status, and bound together only y an allegiance to a common crown. In 1931 the Statute f Westminster gave legal effect to the declaration of the conerence.

13. Economic Changes.—The 1930s found Canada sinking into e world-wide depression which was accompanied by prolonged rought on the prairies. The depression had been ushered in by e spectacular crash of the Montreal and Toronto stock markets n Oct. 29 and Nov. 13, 1929. Canada suffered severely, and the heat economy and the government services of the prairie provices were prostrated. Only heavy federal aid kept them going. lassive industrial unemployment plagued the cities and bankupted municipal finances. The rise of the gold mining industry of ntario and Quebec, which received an immense boost from the nited States revaluation law raising the price of gold from $20 to 35 an ounce, helped the country to bear the cost of the depression.

Economic distress so widespread had inevitable political reperussions. The Liberal party had been defeated in the general lection of 1930, and the Conservatives under Prime Minister ichard B. Bennett governed the country until 1935. But they ere swept from office by the Liberals in 1935. The depression lso gave rise to a number of other parties. One was the Coperative Commonwealth federation (C.C.F.), a farmer-labour arty with a socialist intelligentsia. Another was the Social Credit arty, which captured the province of Alberta in 1935 and atempted to end the depression by sweeping reform of the monetary ystem. The Social Credit party, which vocalized agrarian disontent, also appeared in British Columbia in 1952 and won conol when the provincial Conservative party almost disappeared. till another party was the Union Nationale which won power in uebec in 1936. The political unity of Canada, slowly restored in e 1920s, was shattered once more.

It was more than apparent by 1935 that Canada was in serious ouble. Over the years the provinces had gained by judicial interretation powers and responsibilities greater than their financial esources permitted them to exercise and discharge. This was articularly true of the poorer Atlantic and prairie provinces. The ederal government had great financial resources but its powers ad been progressively narrowed by the same process of interretation. An attempt to adjust the balance by constitutional mendment failed, and a royal commission on dominion-provincial nancial relations was set up to study the problem and make recmmendations; its report, however, was made in 1940, when anada was already once more at war.

Canadian entrance into World War II was made deliberately a overeign act of an independent nation by delaying it for one week fter the declaration of the United Kingdom. Nonetheless, Canda was once more at war united with Great Britain. In Canada after World War I the ideals of the League of Nations had had a wide acceptance. Nevertheless, as a group, Canadians were unwilling to support League action, as witness their equivocal stand in 1932 in refusing to uphold sanctions against Japan at the beginning of the Sino-Japanese War, and the repudiation of the Canadian delegate to the League on the application of economic sanctions to Italy when it invaded Ethiopia in 1935. In British Commonwealth affairs Canada made full use of existing machinery, the imperial conference and the high commissionership, and seemed to have expected to be "informed" but not necessarily "consulted" on the various moves of British European policy. In its relations with the United States, Canada was much more forthright, thus indicating increasing commercial interdependence and an increasing American consciousness. Yet Canada's growing concern in the Americas was not sufficient to carry it into the Pan American Union, in spite of substantial investments in Peru and Brazil. To the various world crises, Canada's response was by no means clear-cut. In official circles the Munich appeasement policy was tacitly accepted, and as late as the spring of 1939 the government refused to countenance any program which would involve Canada in war. Only the manifest menace of Hitler's aggression, made evident after Munich, united the nation and took it into war.

14. World War II and After.—The war at once pulled Canada out of the depression and drove its industrial development ahead at a furious pace. It restored the national morale after the sapping effect of the depression. Despite crises on the manpower (compulsory service) question in 1942 and 1944, unity between French and English Canadians, though strained, was maintained without an open breach like that of 1917. Canada came out of the war with greatly increased strength and greatly enhanced morale.

U.S.-Canadian relations reached a new high in co-operation during World War II and included agreements on defense, production and peace questions. From the summer of 1940, with the conference on defense of the northern half of the western hemisphere held at Ogdensburg, N.Y., at which the Permanent Joint Board On Defense was created, until a few months before the close of the war, when the two countries reached a wartime agreement on military transport routes, excellent relations existed. These extended into the postwar years during which the radar warning lines in Canada were built and a joint agreement for the air defense of North America, the North American Air Defense command (NORAD), was put into operation (1958).

The effects of the war showed themselves both in domestic and external affairs. At home the constitutional problem of ill-adjusted powers and resources was met by using the need to avoid a postwar slump to institute a number of social security measures, such as unemployment insurance and family allowances, which in fact established the welfare state in Canada. This was followed by instituting a system of federal payments to the provinces to enable even the weakest to maintain a minimum level of services. As all these measures came into effect, not in a postwar depression, but in the greatest boom Canada had ever known, they of course were successfully initiated.

In external affairs, Canada took an active part in founding the United Nations. While it pressed for the possession by the Security council of a police power sufficient to maintain the peace, the Canadian government claimed for Canada the status of "middle power," and argued that power should be judged by the functions a nation could discharge. As Canada was relatively weak militarily, but strong economically, it hoped to exercise a decided influence in the economic and social, if not in the political, agencies of the United Nations. In fact, it exercised much political influence because of the personal confidence inspired by Lester B. Pearson, Canadian secretary of state for external affairs in the late 1940s and the 1950s.

Louis St. Laurent and Pearson were Canada's representatives in the creation of the North Atlantic Treaty organization. This body was of peculiar interest to Canada, because in the association of Atlantic powers it found an offset to Canadian isolation in America face to face with the United States.

Canadian external relations continued to operate in the general framework of the United Nations, NATO, and NORAD, always with special care in its relations with the United States. Its concern for the success of the United Nations was shown by the maintenance of Canadian military forces under United Nations direction in the Gaza Strip, Cyprus, and India-Pakistan. NATO and NORAD both, however, raised serious questions with respect to American-Canadian relations. When in 1966, Pres. Charles de Gaulle withdrew the French forces from under NATO command, Canada showed itself understanding of De Gaulle, while the United States was critical. Much more important, the Cuban missile crisis of 1962 had raised awkward questions of the need to consult the Canadian government before taking action under the agreement. It also revealed how Canadian opinion, including that of the government, wavered between the need to honour the agreement for North American defense, and the need to preserve the diplomatic independence of Canada before the world. Confidence between the two governments was shaken, and a related dispute over the arming of Bomarc surface-to-air guided missiles sited in Canada with nuclear warheads led to the fall of the Diefenbaker government. A statement issued by the U.S. department of state, while intended only to put the record straight, was in fact the only public intervention by the government of the United States in the political affairs of Canada. The episode revealed how close and delicate relations between the two countries had become since 1940. So also did their respective policies toward Communist China, the U.S.S.R., and Cuba. Canada exercised its right to trade freely with all three in non-strategic commodities, and beginning in 1961 was to enter into a succession of large wheat sales with both China and the U.S.S.R. Moreover, Canadian opinion, both public and official, favoured the diplomatic recognition of Communist China, and this view survived both the Korean war, in which Canada took part, and that in Vietnam, in which it did not.

15. National Sovereignty and Unity.—The exercise of full national sovereignty was accompanied by the removal of all but the last vestiges of the old imperial connection. Appeals to the privy council of the United Kingdom from Canada's supreme court were ended in 1949. But the ending of the formal ties perhaps only increased Canada's interest in the informal association of the commonwealth. It was in this completion of the development of national status that the work of Prime Minister King terminated. Having served 20 years as prime minister, he stood down for St. Laurent in 1948. Under St. Laurent the boom continued, but the flow of reform legislation stopped. For almost a decade Canadian politics were lulled in a golden apathy and the opposition parties despaired of ever shaking the long rule of the Liberal party.

The boom was based partly on new resources, such as the oil of the prairie provinces and the uranium of the Precambrian shield. It was based still more on a roaring industrial development of central Canada. In 1921 Canada was still by a slight margin an agricultural and rural country. By 1951, it was overwhelmingly industrial and urban.

With the boom went an acceleration of the rate of population growth. A population of 3,689,257 in 1871 had become 8,787,949 in 1921; in 1956 it was 16,080,791 and by 1966 it was 20,014,880 and was growing rapidly both by immigration and by natural increase. About one-third was French, less than one-half British, and the remainder in the great majority European in origin.

In 1932 the St. Lawrence Deep Waterways treaty was signed with the United States, providing for widening and deepening the river and Great Lakes channels to accommodate ocean-going vessels, and for increased production of electric energy. The agreement was finally ratified by the United States in 1954 and the seaway was completed and opened to shipping in 1959. The Columbia River treaty providing for the co-operative development of the river was signed with the United States in 1961.

Perhaps the most memorable developments of these years, however, were in the arts rather than in economic growth or political change. A royal commission on the arts, letters and sciences resulted in national aid to universities and, through the Canada council, to the arts and to scholarships in the humanities and social sciences. The Canadian Broadcasting corporation also greatly contributed to the development of the arts. In the arts and literature, in science, scholarship and criticism, Canada gave evidence in the 1950s and 1960s of a vigour, maturity and sophistication previously unknown. Names that may be selected in evidence of such a statement are Hugh MacLennan and Gabrielle Roy, Margare Lawrence and Leonard Cohen in literature; Glenn Gould in music; the Royal Winnipeg Ballet; Northrop Frye, Alan Gowans, Mar shall McLuhan in criticism; D. G. Creighton and Guy Frégault i history; Wilder Penfield, Hans Selke and Tuzo Wilson in science More important, among the younger generation there was a fer ment and independence promising even greater achievement.

After the mid-1950s the economic boom began to slacken. A the same time, there was an outburst of criticism in parliamen against the Liberal regime, to which the public responded. The Progressive Conservative party had just elected a new leader i John Diefenbaker and was able to turn the public reaction to it advantage. In 1957 the Liberal party was defeated after 22 year in power. A minority Conservative government came into office t grapple with a recession and to maneuver for advantage in a new election. St. Laurent retired and was succeeded by Lester B Pearson as leader of the Liberal party. In the general election o 1958 the Conservatives won 208 seats out of 265 in the house o commons in the greatest electoral victory in Canadian history winning even in Quebec, the Liberal stronghold. In the 196 elections, however, it emerged with only 116 seats, and in 196 the Liberals came back into power under Pearson, but without majority. The same fate befell them in a third general election i 1965. None of the parties could win the confidence of the Cana dian electorate. In December 1967 Pearson announced his de cision to resign; he was succeeded in April 1968 by Pierre Elliot Trudeau, the country's third French-Canadian prime minister.

This repeated failure of the Conservative and Liberal partie (the New Democratic party had not yet reached the size tha would make it likely to win power) to win a majority in Canad not only revealed doubts with respect to the parties, their programs, and their leaders, but also certain developments made th winning of a national majority impossible in three elections. On was general. It was that since the Korean war, if not earlier there had been a steady loss of prestige and power by the federa government, and a steady and even greater gain by the provinces The reason was that the constitution of Canada as it had developed had greatly increased provincial and diminished federal powers. This was particularly so with respect to modern changes i society, social policy, welfare legislation, urban development, an the expansion of motor transport and highways. But while thei powers increased, their revenues had not increased correspondingly The result was the development, rapid after 1945, of the federa provincial conference to agree on the division of revenues amon the governments and to co-ordinate policies relative to medicare for example, which were to be applied by federal-provincial co-operation. The general result was a great growth of prestige o the part of the provinces, and of difficulty on the part of th

BY COURTESY OF THE CANADIAN CORPORATION FOR THE 1967 WORLD EXHIBITION

MUSEUM OF CONTEMPORARY ART, MONTREAL; THE BUILDING WAS ERECTE FOR THE 1967 INTERNATIONAL EXHIBITION ederal parties to find issues that would have a national appeal.

The second factor was a regional one. The Prairie Provinces, nown in the 1920s and 1930s for their radicalism, supported John)iefenbaker's Conservative party almost solidly after 1958. In 965 only one Liberal was elected in these provinces. This "Solid Vest" deprived the Liberals of a majority in 1963 and 1965.

The third factor was one of profound importance. It was the utbreak of the "quiet revolution" in the province of Quebec when 1 1960 the provincial Liberal party under Jean Lesage defeated he Union Nationale. All the nationalist policy which in fact the Jnion Nationale had lacked, and all the frustration felt by French-'anadian intellectuals and young people seeking employment in nglo-American-dominated industry, broke out and was given its ead by Quebec. What in fact Lesage tried to do until his defeat y the Union Nationale in 1966 was to create in Quebec a 20th-entury society capable of developing its own economic and potical life and its own culture, and of achieving the maximum posble autonomy within Canada. (A not inconsiderable body of pinion demanded "separation"; *i.e.*, secession.) This period of ower in fact saw Quebec transformed. The repercussions on the est of Canada were great. The quiet revolution was a specially orceful expression of the growth of provincial powers in Canada. t also raised the whole question of whether in fact the Canadian ederal state could give satisfactory autonomy to its French-speakng citizens, both in Quebec and also in the other provinces, notably ew Brunswick and Ontario. The Pearson government in 1963 ppointed a Royal Commission on Bilingualism and Biculturalism. n its preliminary reports the Commission sombrely warned Canaians that unless better relations could be established between rench and English serious trouble would result. There was a rowing realization throughout Canada that there must be a new efinition of relations between English and French Canada, perps by constitutional revision and a reshaping of the country's initutions and symbols.

This balance was shifted in June 1968, when Trudeau won a lear majority for his Liberal Party in the national elections.

Very ironically also, the outburst of French national feeling revented the fulfillment of the plans worked out for the compleon of Canadian national autonomy, the transformation of the anadian constitution from an Act of the British Parliament in 67 into a Canadian act. This was only a formality, but was evertheless an intricate legal one, since it could affect the distribuon of powers between the federal and the provincial governments. n agreement, known as the Fulton-Favreau formula from the ames of a Conservative and a Liberal minister of justice, had een accepted by all provinces, including Quebec, with slight qualications from only two, and merely waited to be applied. Then a constitutional dispute in Quebec led to that province withdrawing its support, and the formula was at once killed. Canada, in all respects an independent nation and sovereign state, had to await quieter times to complete its internal unity in order to perfect its sovereignty. The whole country, which had seemed ready in 1960 to have its constitutional development taken into its own hands, and to change such of its institutions and symbols as its people might decide, saw only one such change made. That was superficial, and not without difficulty. After much controversy, the Canadian flag, consisting of a red maple leaf on a white field with a vertical red bar on each side, was adopted in 1964 to replace the red ensign with the Canadian coat of arms.

The 100th anniversary of confederation, 1967, was marked by year-long celebration highlighted by Expo 67, a "Universal and International Exhibition" on a 1,000-ac. site largely on two man-made islands in the St. Lawrence river at Montreal. More than 60 nations participated in the exhibition, designated by the Bureau International des Expositions, Paris, as of the "first category," the first such to be held in North America. The centennial was celebrated in all provincial capitals and was marked in hundreds of cities and towns by special observations and projects.

(W. L. Mo.)

V. POPULATION: TRENDS AND DISTRIBUTION

1. Geographic Distribution.—The population of Canada, which was 20,014,880 according to the 1966 census, was estimated to have reached 20,400,000 in June 1967, up from 15,000,000 in 1954. Growth was rapid after World War II, but Canada is still a country of sparse settlement and vast area. Average population density is about 5.2 persons per square mile, but most of the far northern area is barren. Most Canadians, about 90%, live in a belt about 200 mi. wide along the U.S. border.

Ontario accounts for about one-third of Canada's population and Quebec for more than one-quarter. British Columbia is the fastest growing and in 1966 made up almost one-tenth of the Canadian total. Alberta follows British Columbia and Ontario in population growth. Saskatchewan's population declined from 1931 to 1951; by 1961 it had surpassed the 1931 level. Manitoba's growth has been steady, but below the national average. The four Atlantic provinces account for only 10% of the Canadian population. (*See* also Table III.)

In three of the Atlantic provinces, Newfoundland, Nova Scotia, and New Brunswick, settlement is mainly on the coasts, in fishing villages and port cities. Agriculture is limited since most of the interior is forested, rocky, or marshy. Lumbering and pulp and paper manufacture support settlements in all three provinces. Mining, manufacturing, transportation, and commercial and gov-

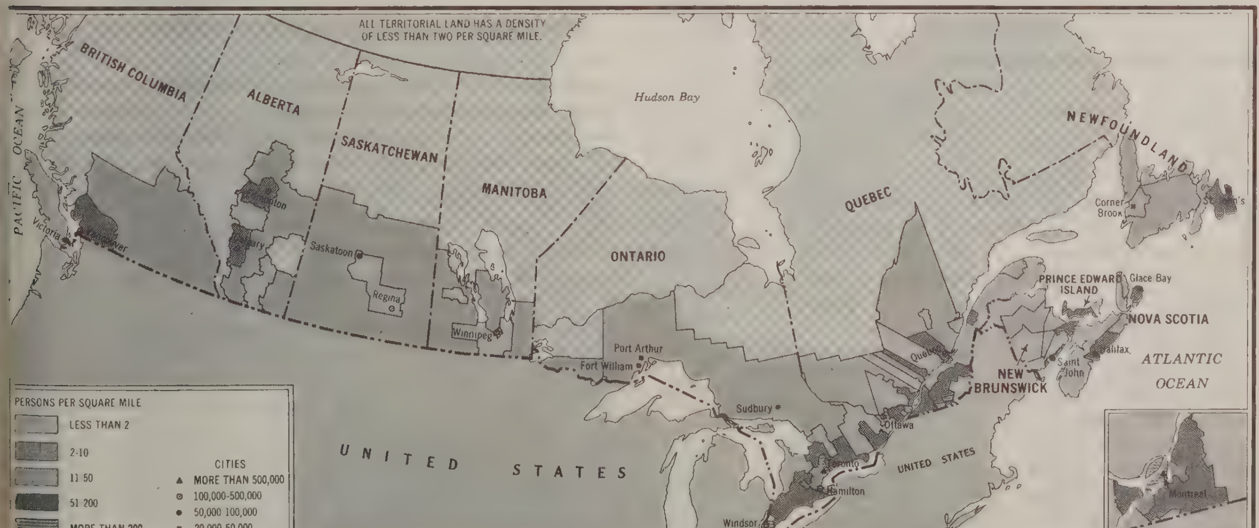


FIG. 3.—POPULATION DENSITY OF CANADA

TABLE III.—*Population by Provinces, 1931-66*

Provinces and territories	1931	1941	1951	1961	1966
Newfoundland	. . .	. . .	361,416	457,853	493,396
Prince Edward Island	88,038	95,047	98,429	104,629	108,535
Nova Scotia	512,846	577,962	642,584	737,007	756,039
New Brunswick	408,219	457,401	515,697	597,936	616,788
Quebec	2,874,662	3,331,882	4,055,681	5,259,211	5,780,845
Ontario	3,431,683	3,787,655	4,597,542	6,236,092	6,960,870
Manitoba	700,139	729,744	776,541	921,686	963,066
Saskatchewan	921,785	895,992	831,728	925,181	955,344
Alberta	731,605	796,169	939,501	1,331,944	1,463,203
British Columbia	694,263	817,861	1,165,210	1,629,082	1,873,674
Yukon	4,230	4,914	9,096	14,628	14,382
Northwest Territories					
Franklin Keewatin Mackenzie	9,316	12,028	16,004	22,998	28,738
Total	10,376,786	11,506,655	14,009,429	18,238,247	20,014,880

ernmental services provide employment for urban population. Unlike the other Atlantic provinces, Prince Edward Island, with fertile soil, is closely settled. Agriculture is the main support of its population, which remains just over 100,000.

In Quebec, beginning in the 17th century, French-Canadian agricultural settlement spread back from the St. Lawrence River in long, narrow farms and maintained the same distinctive linear pattern back from the early roads. English-speaking settlers established farms north of Vermont in the 19th century, but this enclave receded, as French-Canadians took over the farms and populated the urban centres. By 1966, 78% of the people of Quebec lived in cities and towns of over 1,000 population, indicating that Quebec had become one of the industrial and commercial centres of Canada. The rocky hills of the Precambrian shield, north of the St. Lawrence lowlands, have deterred settlement except for forestry camps, mining towns, and railway divisional points. Agricultural settlement in northern Quebec is confined to the Lake St. John area and the clay belt adjoining Ontario near the upper Ottawa River.

Ontario is the most populous province (6,960,870 in 1966), but, as in Quebec, most of its people live in a small lowland area—about 50,000 sq.mi. between Lakes Ontario, Erie, and Huron, and along the St. Lawrence and Ottawa rivers. About one-third of the cities of more than 30,000 persons in Canada are in southern Ontario, and they produce almost half of the manufactured wealth of Canada. To the north, again the Precambrian shield discourages agricultural settlement, though towns based on mineral, forest, and water-power resources have been established there since the 1920s. In Ontario, as in Quebec, the region north of the transcontinental railway lines is virtually uninhabited.

The Prairie Provinces have a wedge of population which broadens westward, following the plains and grasslands. Settlement expansion and railway building went together in the early 20th century, until most of the grasslands had been plowed for grain. In Manitoba, farm settlement is mainly in the southern quarter of the province. In Saskatchewan it occupies the southern half, while in Alberta farming extends as far as the Peace River district, north of the 55th parallel. Population is fairly evenly distributed over the Prairie region, and there are many small trading centres and market towns. In the second half of the 20th century urban population grew rapidly, and rural population declined, owing to changed farming methods, which reduced the necessary farm labour force. Oil and natural-gas resources of the region, particularly in Alberta, stimulated the growth of industry and the major cities. Alberta's population passed the 1,000,000 mark in 1953, making it Canada's fourth-largest province.

British Columbia has three-quarters of its population concentrated in the small southwestern corner. Apart from the port city of Vancouver, the lower Fraser Valley farming region, and southern Vancouver Island, most settlement is in mining towns, forest-industry settlements, transportation centres, the orchard district of the Okanagan Valley, and the wheat area of the Peace River. Discoveries of natural gas in the latter region encou aged industrial settlements in the northern interior, while th coastal aluminum-smelting town of Kitimat, with a population nearly 9,700, was built entirely since 1950 to take advantage nearby hydroelectric power.

2. Rural-Urban Distribution.—In 1966 urban areas (mean ing all cities, towns, and villages of 1,000 persons or over, whethe incorporated or not, as well as all parts of metropolitan areas held 73.6% of the population. This reflected a major chang since the beginning of the century; in 1901, only 37.5% of th population was classed as urban (*i.e.*, living in incorporated citie towns, and villages of 1,000 population and over), and in 192 only 49.5% of the population was classed as urban. Since 19 the urban growth has increased rapidly, from 4,400,000 in 192 to 14,700,000 in 1966, while the rural population has grown ver little, from 4,500,000 in 1921 to 5,288,000 in 1966. The part the rural population living on farms has actually declined fro 3,200,000 in 1931 (the first year for which a figure on farm pop lation became available) to 1,914,000 in 1966. Table IV sho populations of major metropolitan areas in 1966. Populations suburban communities, many of which are separately incorporate are included in these figures.

3. Natural Increase, Immigration, and Emigration.—Th rapid growth of Canada's population in the 20th century has bee mainly because of natural increase; *i.e.*, the excess of births ov deaths. Compared with natural increase, net immigration, or t excess of immigration over emigration, has contributed relative little to population growth, except in the first decade of t century and again in the years after World War II. A popula balance sheet for the years 1901–66 makes clear the relative in portance of the sources of growth. (*See* Table V.)

As in other industrialized countries, the birthrate showed long-term decline, from approximately 46 per 1,000 population 1850 to 20.1 in 1937. It rose with the war and was maintain between 27 and 29 per 1,000 during the period 1946–59. It th decreased sharply to an all-time low of 19.4 in 1966. In 196 women ever married who were completing their childbearing riod had had an average of 3.2 children. The crude rate of mo tality is under 10 per 1,000 population since 1944 and was as lo as 7.5 in 1966. Life expectancy was 71.3 years for both sex in 1961, which is one of the highest in the world. But the infa mortality rate (23.6 per 1,000 live births in 1965) is still far b hind the rate of some European countries.

Immigration fluctuates greatly from year to year. The perio of rapid immigration correspond with periods of prosperity a rapid economic expansion. For example, in the first three decad of the 20th century, rapid immigration was associated with t rapid agricultural settlement of the western prairies and the grow of industrial cities in eastern Canada. In the depression deca of the 1930s immigration virtually ceased, but after World War there occurred both a revival in immigration and an econom expansion based on the exploitation of resources in hitherto-und veloped regions and on the continued growth of industrial citi Immigration is both a result and a cause of this economic expa sion: immigrants have included a high proportion of young wor ing-age men and women, of whom there was a shortage in Cana owing to the low birthrates of the 1930s.

Emigration from Canada has been substantial in most perio when the United States has been prosperous. Canadian-bo persons, as well as immigrants to Canada, have been attracted

TABLE IV.—*Populations of Metropolitan Areas (1966 census)*

Area	Population 1961	Population 1966
Calgary, Alta.	279,062	330,575
Edmonton, Alta.	337,568	401,299
Halifax, N.S.	183,946	198,193
Hamilton, Ont.	395,189	449,116
Kitchener, Ont.	154,864	192,275
London, Ont.	181,283	207,396
Montreal, Que.	2,110,679	2,436,817
Ottawa, Ont.	429,761	494,535
Quebec, Que.	357,568	413,397
Regina, Sask.	112,176	131,127
Saint-John, N.B.	95,563	101,192
St. John's, Nfd.	91,654	101,161
Saskatoon, Sask.	95,564	115,892
Sudbury, Ont.	110,799	117,075
Toronto, Ont.	1,824,589	2,158,496
Vancouver, B.C.	790,165	892,286
Victoria, B.C.	154,152	173,455
Windsor, Ont.	193,365	211,697
Winnipeg, Man.	476,543	508,759

Table V.—*Population Balance Sheet, 1901–66*
(in 000)

Period	Births	Deaths	Immigration	Emigration	Net migration	Population at end of period
1901	...	...	...	...	...	5,371
1901–11	1,931	811	1,759	1,043	+ 716	7,207
1911–21	2,338	988*	1,612	1,381	+ 231	8,788
1921–31	2,415	1,055	1,203	974	+ 229	10,377
1931–41	2,294	1,072	150	242	− 92	11,507
1941–51	3,186	1,214	548	379	+ 169	14,009†
1951–61‡	4,468	1,320	1,543	462	+1,081	18,238
1961–66§	2,245	731	538	275	+ 263	20,015

*Excludes extra mortality associated with World War I, estimated at 120,000.
†Excludes Newfoundland, which became a province of Canada in 1949, and had 361,416 inhabitants in 1951.
‡Includes Newfoundland.
Preliminary estimate.

the large cities south of the international border, and have contributed a high share to the professions and skilled occupations there. At the 1960 census of the United States there were approximately 925,000 Canadian-born persons in that country. This equaled 6% of the Canadian-born population in Canada itself, as reported in the 1961 census. In other words, for every 16 Canadian-born persons who have remained in Canada, one has emigrated to the United States.

An interesting development, however, has been the decline of emigration since 1930. It appeared that the forces of attraction to the United States were diminishing. There were fewer Canadian-born persons in the United States in 1960 than in 1930, the peak year. In the decade 1951–61, of the approximately 462,200 persons who emigrated from Canada to all countries, two-thirds were Canadian-born, and the remainder were re-emigrants.

4. Ethnic Composition.—Canadians are made up of a wide range of ethnic or national stocks, but almost 44% (1961 census) of them are of British origin. The original French-speaking Canadians had a high birthrate and have multiplied in southern Quebec and expanded into other provinces, particularly into northern New Brunswick and northeastern Ontario. Canadians of French origin now number about 30% of the Canadian total.

Immigrants from Europe came in increasing numbers after 1900 and helped to settle the prairie farmlands or became workers in the industrial cities of Ontario. As a result, many Canadians have a European (non-British) national background. The largest numbers have been classified as from France, Germany, the Ukraine, and Italy. Native Indians in the 1960s were steadily increasing and in 1965 were estimated to number about 217,800, of whom 42% lived in the Prairie Provinces. The other aboriginal inhabitants, the Eskimos, were estimated to have numbered 13,600 in 1966 and were scattered in small groups across Arctic Canada. (*See* also *Native Peoples*, above.) (J. He.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

A. Government

Canada is one of the self-governing nations of the Commonwealth of Nations. At the Imperial Conference of 1926 Canada and the other dominions were declared to be "equal in status, in no way subordinate one to another in any aspect of their domestic or external affairs, though united by a common allegiance to the Crown and freely associated as members of the British Commonwealth of Nations." In 1931 the British Parliament incorporated this principle into the Statute of Westminster, and in general removed any remaining disabilities from which legislatures in Canada had suffered. The governor-general, as the representative of the queen, is appointed on the recommendation of the Canadian Cabinet, although it seems to be customary to ascertain the queen's wishes by consultation previous to the appointment. Canada remained dependent on the British Parliament for legislation only with respect to the amendment of the British North America Act (*q.v.*), which was still beyond the legislative jurisdiction of either the federal or provincial parliaments, although this power was exercised only on Canadian request.

Both the Canadian and British parliaments passed the British North America Act (no. 2), 1949, in which the Canadian Parliament was given power to amend the constitution on matters lying solely within federal jurisdiction. There still remained for constitutional amendment, however, those areas which either belong to the provinces or directly affect the provinces, which are outside the jurisdiction of either the federal or provincial legislatures. The many unwritten conventions of the British constitution, such as the system of cabinet government and the office of prime minister, apply in Canada as in the United Kingdom. Canada also derives from the British constitution the structure of parliamentary monarchy and, generally, of British law based on parliamentary sovereignty (not on fundamental law, as in the U.S.).

The most important difference between the British and Canadian constitutions is that while the British is unitary (with power ultimately residing in one central organ, Parliament), the Canadian is federal (the member provinces retaining in part their own organizations and individuality).

The federal principle was embodied in the British North America Act, which laid down the subjects of legislation assigned respectively to the federal government and the provinces, and the narrow area in which there was to be concurrent jurisdiction. The federal Parliament has exclusive legislative authority in all matters relating to the regulation of trade and commerce, defense, navigation and shipping, banking and currency, etc. The federal government also has unlimited taxing powers and a broad residual power. Taxes (money bills are a special responsibility of the lower house) are based on revenues, expenditures, and proposed requirements as reported by the minister of finance in the government's annual budget (*see* Budget, Governmental: *Canada*).

The provinces have exclusive control over all matters relating to education, municipal government, property, and civil rights within the province, licences, etc. The provinces' taxing power is limited to "Direct Taxation within the Province in order to the Raising of a Revenue for Provincial Purposes," and the residual power is limited to "Generally all Matters of a Merely local or private Nature in the Province." It seems to have been the original intention of the promoters of the constitution to invest the federal Parliament with an overriding authority, but the judicial interpretation of the act to some extent nullified this intention, and the provincial legislatures were pronounced to be sovereign within the sphere assigned to them.

The capital of Canada is Ottawa. Provincial capitals are: Alberta, Edmonton; British Columbia, Victoria; Manitoba, Winnipeg; New Brunswick, Fredericton; Newfoundland, St. John's; Nova Scotia, Halifax; Prince Edward Island, Charlottetown; Ontario, Toronto; Quebec, Quebec; and Saskatchewan, Regina.

1. Executive Power.—Formal executive power rests in the hands of the queen, who is represented by the governor-general. He exercises such official authority as summoning and dissolving Parliament, and giving royal assent to bills passed by Parliament. The governor-general, however, acts only on the advice of the Canadian prime minister and his colleagues in the Cabinet, except on those rare occasions when there is doubt as to whether the

Prime Ministers of Canada

Name	Party*	Term
Sir John A. Macdonald	(C)	July 1, 1867–Nov. 5, 1873
Alexander Mackenzie	(L)	Nov. 7, 1873–Oct. 16, 1878
Sir John A. Macdonald	(C)	Oct. 17, 1878–June 6, 1891
Sir John J. C. Abbott	(C)	June 16, 1891–Nov. 24, 1892
Sir John S. D. Thompson	(C)	Dec. 5, 1892–Dec. 12, 1894
Sir Mackenzie Bowell	(C)	Dec. 21, 1894–April 27, 1896
Sir Charles Tupper	(C)	May 1, 1896–July 8, 1896
Sir Wilfrid Laurier	(L)	July 11, 1896–Oct. 6, 1911
Sir Robert L. Borden	(C)	Oct. 10, 1911–Oct. 12, 1917
"	(U)	Oct. 12, 1917–July 10, 1920
Arthur Meighen	(U-N-C)	July 10, 1920–Dec. 29, 1921
William Lyon Mackenzie King	(L)	Dec. 29, 1921–June 28, 1926
Arthur Meighen	(C)	June 29, 1926–Sept. 25, 1926
William Lyon Mackenzie King	(L)	Sept. 25, 1926–Aug. 6, 1930
Richard Bedford Bennett	(C)	Aug. 7, 1930–Oct. 23, 1935
William Lyon Mackenzie King	(L)	Oct. 23, 1935–Nov. 15, 1948
Louis Stephen St. Laurent	(L)	Nov. 15, 1948–June 17, 1957
John George Diefenbaker	(P-C)	June 21, 1957–April 17, 1963
Lester B. Pearson	(L)	April 22, 1963–April 20, 1968
Pierre Elliott Trudeau	(L)	April 20, 1968–

*(C) Conservative; (L) Liberal; (U) Unionist; (U-N-C) Unionist-National and Conservative; (P-C) Progressive-Conservative.

prime minister commands the confidence of the House of Commons. The active executive authority rests in the Cabinet, which is selected by the prime minister from among his followers in the House of Commons. The prime minister may select a member of the Senate to hold a Cabinet portfolio, but usually not more than one member is so chosen. The prime minister is normally the leader of the political party holding the most seats in Parliament, and in all cases he must be able to command the support of a majority in the House.

2. Legislative Power.—The federal legislature is bicameral; in addition to the representative of the crown it is composed of a Senate numbering, after the admission in 1949 of Newfoundland, 102 members, who are appointed by the governor-general in council; and a House of Commons numbering 264 members who are elected by the people for the duration of Parliament, which may not be longer than five years. In the provinces, the crown is represented by a lieutenant governor, appointed by the federal government. He is advised by an executive council composed of a premier and a varying number of ministers, all of whom sit in the legislature. In nine of the ten provinces the legislature is unicameral, being composed of a legislative assembly elected by the people for a term of not more than five years. Only in Quebec is there a second chamber, styled a legislative council, composed of nominees (for life) of the provincial government.

3. Judicial Power.—Canada has a single system of courts to enforce both federal and provincial law. The administration of justice, including the constitution of the provincial courts, comes within the jurisdiction of the provincial legislatures with the exception that the criminal law comes under the jurisdiction of the federal Parliament. The judges of the provincial courts are appointed by the federal government, and are removable only by the governor-general on address, or formal petition, by the Senate and the House of Commons. Canada's Supreme Court was established in 1875. Its justices are appointed in similar fashion, and all judges must retire at age 75. Legislation in 1949 abolished the right of appeal to the Judicial Committee of the imperial Privy Council in England, and made an enlarged Supreme Court the nation's highest tribunal. Police magistrates and the officials of some special courts, such as juvenile courts, are appointed by the provincial governments.

The Royal Canadian Mounted Police (*q.v.*) is a federal force charged with the enforcement of federal legislation. The provinces may maintain a provincial police force, and Ontario and Quebec do so, but all the other provinces hire the services of the RCMP to carry out provincial police duties. Municipalities may also employ their own police force, and most of the larger cities do so, but in many of the smaller communities, outside of Ontario and Quebec, the RCMP are also employed to carry out municipal police duties.

4. Taxation.—The division of powers and responsibilities of government, including taxation, between the federal and provincial governments is set out in the British North America Act. Responsibilities within various spheres of jurisdiction have changed greatly since 1867. By and large those responsibilities which were assigned to the provinces have expanded more rapidly than have the potential fields of taxation assigned to them. This has led to continued demands by the provinces for an increasing share of the tax dollar. Many conferences have been held to resolve this problem, particularly in the fields of personal and corporation income tax and succession duties, or estate and inheritance taxes (*q.v.*). A series of tax rental agreements under which the federal government rented, or took over, from the provinces the personal and corporation income taxes and succession duties and returned guaranteed minimum amounts ran from 1942 to 1957. The federal government passed the tax-sharing agreements act of 1956 which provided that the provinces could, by agreement, share in the revenues derived from the three standard taxes to the extent of 10% of the individual income tax, 9% of the corporation tax, and 50% of the succession duty. At the same time provision was made for an equalization payment by the federal government designed to bring the tax income, per capita, of each province up to the average of the two highest provinces. In 1958 the percentage of personal income tax allowed was raised from 10% to 13% in an effort to provide the provinces with sufficient revenues to meet their expanding operations. This agreement continued until March 1962, when it was replaced by a new agreement allowing the provinces more responsibility for levying their own income and corporation taxes.

In 1965 the Established Programs (Interim Arrangements) Act was passed, which allowed the provinces to "opt out" of certain shared-cost programs. The provinces that exercised the opting-out privilege were allowed further abatements of the personal income tax, or cash compensation for carrying out a similar program. Quebec exercised the opting-out privilege more than any other province, after 1966 receiving almost 50% of the persona income tax collected in the province. The Fiscal Arrangements Act of 1966 confirmed these agreements, and in the first year under its terms (1967) the federal government expected to pay ove $400,000,000 in equalization to the provinces.

There have been similar adjustments in revenue and responsibility between the provinces and the municipal authorities within their bounds. As the volume as well as the diversity of the public services and the sources and amount of the revenue required continue to change and expand, this problem must be constantly under review. Governments provide services and collect revenues unheard of in years past, but these accrue in ever changing proportions, and while adjustments cannot be continuous, they must be sought periodically to maintain equity and efficiency within the federal system. So long as the provinces are limited to such sources of revenue as gasoline tax, general sales tax, liquor profits, licences, and permits, many of the provinces have difficulty in meeting the ever increasing expenditures for highways, health and social welfare, education, and the development of natural resources. The municipalities, depending as they do for a large portion o their revenue on real-property taxation, find even greater difficulty in meeting the growing expenditures required in a modern industrial society.

B. Political Parties

Political parties, like so many Canadian institutions, reflec their British origin and the influence of North American environment. Party designation professes to be based on shades of opinion from right to left, as in Britain, but in practice there are frequently as marked differences in political thought within each of the major parties as there are between parties, as is the case in the United States.

There are two major parties in Canada which have alternated in power since confederation—Conservative (Progressive Conservative) and Liberal. The Conservatives took control of the Hous of Commons from the Liberals in 1957, but were in turn defeated by the Liberals in 1963. Quebec has been the Liberal stronghold and Ontario, and more recently the Prairie Provinces, that of the Conservatives. A third party, the Co-operative Commonwealth

AUTHENTICATED NEWS

LOWER TOWN AS SEEN FROM CITADEL HILL, QUEBEC

Federation (CCF), after its success in Saskatchewan in the 1940s, had a national organization, ran candidates in all sections of the country, and polled an appreciable popular vote, but it was never the official opposition, nor did it hold the balance of power between the major parties. The CCF was more socialist than the older parties, and drew its chief support from the prairie grain farmers, especially in Saskatchewan, and from organized labour in the larger cities throughout the country. In August 1961, at a national convention, the CCF was reorganized into the New Democratic Party, with a closer working arrangement with organized labour. T. C. Douglas, former premier of Saskatchewan, was elected national leader.

There are several smaller political parties whose support tends to lie in specific geographic regions. The Social Credit Party centres in Alberta, but it has also shown strength in British Columbia. The Union Nationale has been a potent factor in provincial politics in Quebec, operating with some degree of cooperation with the federal Conservative Party. The Labour Progressive (Communist) Party has frequently put up candidates in the cities, but with little or no success.

C. Living Conditions

1. Working Conditions.—Canada's labour force has grown rapidly with the expansion of the country, and the productive capacity of the economy has increased greatly. Technological improvements, higher wages, better working conditions, higher educational standards, and greater emphasis on vocational training have helped to raise the standard of living for the whole community of workers. General improvement in working conditions has been retarded or interrupted on several occasions due to general economic conditions (see *History*, above). Unemployment caused by cold weather, and to some extent by consumer buying habits, results in serious annual loss to the Canadian economy. Though some winter slowdown is inevitable, it has been possible, by concerted effort, to reduce its extent.

Developments in the field of labour have been assisted by legislation at both federal and provincial levels. Laws have been enacted to set minimum standards for hours of work, wages, and many other conditions of employment. Most Canadian workers, however, enjoy conditions of employment far better than those required by law. The right of workers to belong to labour unions of their own choosing is protected legally, and union membership has grown rapidly, particularly since 1940. By the late 1960s there were over 1,735,000 union members. The general average wage per hour was about $2.40.

Legislation, which may be federal, provincial, or in some instances municipal, plays an important part in securing safe and healthy working conditions. Under a Workmen's Compensation Act in each province, the worker who is disabled by an industrial accident or a disease caused by the nature of his employment is entitled to compensation based on the amount of earnings and, if the disability is permanent, upon the extent of the disability. In fatal cases wives, children, or other dependents are awarded fixed monthly sums. Compensation and medical aid are payable from an accident fund to which all employers are required to contribute and which provides a system of employee insurance. A compulsory scheme of employment insurance and a nationwide free employment service are in operation.

2. Housing.—Like most other countries, Canada faced a serious housing shortage at the close of World War II, but substantial improvements have been made. By the mid-1960s there were 5,200,000 dwellings in the country, and they were being added to at a rate of over 150,000 a year. About one house in every three that was built after 1945 was financed with government assistance. The National Housing Act provides for insurance of mortgage loans by private lenders and sets maximum rates of interest that may be charged. By reducing the risk to the lender it enables the borrower to get a larger loan on more favourable terms than would otherwise be the case. The National Housing Act also authorizes the national government's agency, Central Mortgage and Housing Corporation, to make direct low-interest housing loans for such special purposes as the construction of low rental housing and the building of rental units for primary industries. The general shift of population to urban centres, and particularly to suburbs, has brought an increasing awareness of the need for community planning.

D. Health and Welfare

1. Health Services.—The development of health and welfare services has provided a reasonable comprehensive network of assistance against most economic and health hazards. Health and rehabilitation services have been expanded and integrated to support the work of hospitals and the medical professions, although much remains to be accomplished before adequate facilities are available to deal with the problems of mental illness and the chronic degenerative diseases. There also continues to be variation between provinces in the type of service provided, and in the availability of the services to different groups in the population.

Canada has one of the world's healthiest populations, the death rate being less than 8 per 1,000 of population. This has been due chiefly to reducing the death rate from communicable disease. Public health is primarily the responsibility of the provinces. Federal participation in health matters is generally centred in the Department of National Health and Welfare, although important treatment services are administered by the Department of Veterans' Affairs and the Department of National Defence. The Department of National Health and Welfare controls food and drugs, including narcotics, and quarantine and immigration medical services, and provides for Indians, Eskimos, sick mariners, and other groups. In addition, it provides financial assistance to the provinces for the development of health and welfare services through the national health program, serves in an advisory and coordinating capacity, and makes grants to certain voluntary agencies.

Most health programs are administered by provincial health departments or by local health departments and units serving counties and municipalities. They include activities ranging from preventative and treatment services to the operation of public-health laboratories. Health responsibilities of the municipalities, particularly the larger ones, generally cover such public health services as sanitation, communicable disease control, child, maternal, and school health, public health nursing, health education, and vital statistics. Public mental-health programs consist chiefly of treatment and custodial care of persons committed to mental institutions. Hospital facilities expanded rapidly in the second half of the 20th century. Growth has been stimulated by the hospital construction grant under which the federal and provincial governments contribute toward construction costs. By the late 1960s Canada had approximately 11 hospital beds or cribs for each 1,000 of the population. Personal health care and public-health services cost the Canadian public over $1,000,000,000 a year, and about half of it was expended on hospital care. Prepaid hospital care was provided through public insurance programs in several of the provinces, and considerable progress had been made toward the development of the federal government's proposal for a federal-provincial system of prepaid hospital service.

2. Welfare Services.—Welfare needs in an increasingly industrialized society have led to an emphasis on social security problems that are beyond the financial resources of the municipalities or the provinces. Therefore the program of the federal government, proceeding either by constitutional amendment or by agreement with the provinces, has seen the greatest expansion. Family allowances and old-age security are the two most significant developments.

The federal government makes special provision for the welfare of veterans with payment of pensions through the Canadian Pension Commission.

Family Allowances.—All children under 16 years of age who are resident in Canada are eligible for family allowances. These allowances do not involve a means test and are not considered as income for taxation purposes. They were paid in the late 1960s at the monthly rate of $6 for each child under 10 years of age, $8 for each child aged 10–15, and $10 for each child 16 or 17 years of age attending school, or who could not attend because of disability.

Aid for the Aged, Blind, and Disabled.—To provide old-age security, under the Canada Pensions Plan, Old Age Security, and Old Age Assistance each person, at age 70, fulfilling the residence requirement, is guaranteed an income of $1,260 a year, or each married couple $2,260. Annual reductions of the age qualification were planned to make the guaranteed income available at 65 in 1970. For the Canada Pensions Plan and for Old Age Security there is no means test.

For needy blind persons 18 years of age or over who have been resident in Canada for 10 years, allowances were paid, of which the federal government paid 75%. The province administers the program, and in some cases provinces or municipalities add a supplemental amount.

Needy persons who are totally and permanently disabled, over 18 years of age, and resident in Canada for at least 10 years also receive monthly allowances. A means test the same as that for Old Age Assistance is applied.

Unemployment Assistance.—The Unemployment Assistance Act of 1956 provides for federal aid to the provinces for unemployment assistance, subject to an agreement between the province and the federal government. The latter reimburses each participating province by one-half of the cost of assistance provided to needy persons in excess of 0.45% of the provincial population.

Provincial Programs.—The provinces on their own also make considerable provision for the needy. A mother's allowance on behalf of needy mothers and their dependent children is paid in all provinces; the amounts so provided vary. Most of the provinces reimburse municipalities for a part of the cost of general assistance or relief that is provided for the needy, regardless of age. Child-welfare legislation including child protection, child care, and adoption, is administered in some provinces by the provincial child-welfare authorities and in others by the Children's Aid societies. These services are financed by the municipalities or by voluntary organizations, although there are some provincial homes. The maintenance of indigent old people in homes for the aged is primarily a municipal responsibility, but most provincial governments share in the cost, either through subsidies to meet the cost of operation or through grants on behalf of the indigent residents.

E. EDUCATION

Education is the primary occupation of one-quarter of the population of Canada. By 1968 there were over 5,265,000 boys and girls in the public elementary and secondary schools, as compared with 3,500,000 in the early 1950s; there were 233,000 in private schools, as compared with 145,000; and there were 325,000 full-time students in the universities, as compared with 86,000. The estimated number taking vocational training had declined by 40% to about 300,000. Total annual expenditure on education increased to over $4,000,000,000, or 6% of the gross national product, from about $1,000,000,000, or approximately 3%.

The British North America Act gave control of educational administration to the provinces. The nine English-speaking provinces operate English-Canadian schools, but in some areas the Roman Catholic Church maintains separate elementary schools. In Quebec the French-Canadian tradition is followed with Roman Catholic schools, but there are separate Protestant schools.

Education in each of the provinces is administered by its Department of Education, headed by a Cabinet minister responsible to the legislature. The deputy minister or superintendent is responsible for the administration of the provincial system, and in Newfoundland there is also provision for a chief executive officer for each of the leading religious denominations, namely Roman Catholic, Church of England, United Church, and Salvation Army. Each provincial department is concerned with the general administration and inspection of schools, the payment of provincial grants, teacher training, curriculum, schools for the blind and deaf, registration of private schools, provincial examinations, trade, vocational, and technical schools, public and traveling libraries, and correspondence courses.

The direct operation of schools is under local school boards which are composed of members usually elected for two- or three-year terms. The boards employ teachers, maintain buildings, and administer revenue derived from provincial grants and municipa taxes.

In the English-speaking provinces the elementary schools usually have eight grades, with pupils beginning at the age of five o six years. Secondary schools continue for another four or fiv grades and provide entrance qualification for university courses o from three to seven years. In a few provinces these schools ar organized on the basis of six years in elementary, three years i junior high school, and three years in senior high school.

There are over 450 institutions offering courses of universit standard in Canada. About 50 of these are active degree-granting institutions to which most of the others are affiliated. Al the provinces have provincial universities or their equivalent, giving courses in arts, science, engineering, medicine, theology, etc The universities derive their revenues from student fees, provincial grants, and endowments. The federal government pays the provinces 50% of the cost of post-secondary education.

In the French-speaking schools of Quebec, boys and girls are taught separately, taking primary courses to grade seven. Pupil may then enter either the church-operated *collège classique* which provides an eight-year course leading to the *baccalauréat* and entry to a university professional course; or they may enroll in the secondary division of the public school which provides further training preparatory to certain technical fields, trades, arts, or home economics; or, in a growing number of schools, the first fou years of the classical course. Higher schools of applied science commerce, or agriculture, affiliated with universities, are available to graduates of the secondary courses. Trade school or regional agricultural school training is optional.

The federal government through the Department of Northern Affairs and Natural Resources operates schools in the Northwest Territories, where it completely maintains some schools and assists others, operated by church missions, with grants. The Indian Affairs branch of the federal government maintains schools for the Indians who are its wards. Some of these schools are operated as day schools on the reservations and others as residential schools under some religious denomination. In the residential schools, grants are paid for each Indian child attending.

Most provinces require elementary teachers to have had high-school graduation or better, plus at least one year of professional training. High school teachers are required to have a university degree plus a year of professional study. In the post-World Wa II years, because of an acute teacher shortage, many province were unable to maintain these standards and had to accept lowe teacher qualification to keep schools open.

There are very few institutions in Canada devoted exclusively to adult education. It is sponsored by a variety of universities colleges, school boards, government departments, and voluntary associations, each of which has some other function which is primary. Universities have extension departments, school boards offer night classes, and provincial governments have divisions of community programs, adult education, or cultural activities. The Canadian Broadcasting Corporation, National Film Board, National Museum, National Gallery, and many provincial museums art galleries, and libraries engage in adult education as part of their work. The chief coordinating and documentation agencies in this field are the Canadian Association for Adult Education and the Institut Canadien d'Education des Adultes.

F. DEFENSE

The minister of national defense, a member of the Cabinet, exercises control over and management of the Canadian Armed Forces, the Defense Research Board, and all other matters relating to national defense. The duties and functions relating to civil emergency operations during both peace and war also are assigned to the Department of Defense. The chief of defense staff is responsible for the control and administration of the Canadian Forces Headquarters and is the Canadian military representative to NATO. The chairman of the Defense Research Board and the chief of defense staff are directly responsible to the minister. The Royal Canadian Navy, Canadian Army, and Royal Canadian Air Force retained their separate identities until the enactment of the anadian Forces Reorganization Act of Feb. 1, 1968, when they ere unified into a single service called the Canadian Armed orces. The total strength of the Forces in the early 1970s was 3,300: Army, 35,300; Navy, 17,000; Air Force, 41,000.

Effective Aug. 1, 1964, the Headquarters of the Royal Canadian avy, the Canadian Army, and the Royal Canadian Air Force were ntegrated to form a single Canadian Forces Headquarters (CFHQ) nder a single chief of defense staff. CFHQ provides military ad- ice to the minister of national defense and controls and adminis- ers the Canadian Forces. It is organized into four functional ranches headed by the vice chief of defense staff, the chief of per- onnel, the chief of technical services, and the comptroller general. ight logistics commands report to the chief of defense staff.

Liaison abroad is maintained through NATO, the Defense Liai- on staffs in Washington and in London, and military missions and ervice attachés in various countries throughout the world. De- ense matters of concern to both Canada and the United States are onsidered by the Permanent Joint Board on Defense, composed f representatives from both countries.

The Defense Research Board was created in 1947 by an amend- ent to the National Defense Act. It is responsible for scientific esearch and provides scientific advice to the minister of national efense and scientific and technical assistance to the Canadian rmed Forces. It also conducts research relating to the defense of anada and undertakes the development of, and improvements in, atériel.

The civilian administration of the department is organized under he deputy minister, who, with the aid of an associate deputy min- ter and assistant deputy ministers, maintains a continuing review nd control over the financial aspects of operational policy, logis- cs, personnel, and administration. Also responsible to the deputy inister are the judge advocate general, the departmental secre- ary, and the director general of information services.

Schools include the Royal Military College of Canada, founded Kingston, Ont., in 1876; Royal Roads, established in 1941 near ictoria, B.C.; and Collège Militaire Royal de Saint-Jean, estab- shed at Saint-Jean, Que., primarily to meet the needs of French- eaking cadets. Royal Military College and Royal Roads were onstituted as Canadian Services Colleges in 1948 and Saint-Jean as opened in 1952. In 1959 Ontario gave Royal Military College charter to grant degrees. In 1967 the Canadian Services Col- ges were redesignated Canadian Military Colleges in keeping ith unification plans. (R. O. MacF.)

VII. THE ECONOMY

Canada, occupying the northern half of the North American ontinent, possesses great variety of natural resources, as indi- ated under *Geographical Regions,* above. Nevertheless, unfa- ourable environmental factors—the severe climate of the north, e natural aridity of the prairie plains, the steep, high slopes f the mountain regions, the huge rocky expanse of the Precam- rian shield—have presented formidable obstacles to easy and apid exploitation of these resources. As a result, economic de- elopment is still represented, for the most part, by a narrow rib- on of settlement about 3,000 mi. long from east to west, and eldom more, usually much less, than 200 mi. wide from south north. The heavy burdens and persistent problems of trans- ortation are readily apparent in such a country. In spite of those atural problems, the Canadian economy has produced one of the ighest standards of living in the world. The basis for this achieve- ent has been the application of advanced Canadian and foreign chnology and a relatively well-trained and rapidly increasing bour force to the development of the nation's rich natural re- ources and to its growing manufacturing sector.

The economy's overall performance after World War II may be mmarized in this way: from 1946 to 1966 gross national product volume terms increased by 135%, or 4.4% a year. Per capita crease was 45%, or about 2% a year, for population increased om 12,292,000 in 1946 to 20,014,880 in 1966. Per worker em- oyed, the increase was slightly larger: over the period as a whole e labour force grew at about 2% a year, but the increase in the 60s was over 2½%.

Table VI.—*Output and Labour Income of Canadian Industries*

Industry	Gross Domestic Product at Factor Cost				Labour Income	
	1926	1946	1966		1966	
	Percent of total	Percent of total	Percent of total	$000,000	Percent of total	$000,000
Agriculture	18.1	12.3	5.8	2,952	.8	227
Fishing and trapping	.8	.8	.3	147	.1	37
Forestry	1.3	2.5	1.0	496	1.5	441
Mining, quarrying, and oil wells	3.2	3.4	4.0	2,013	2.6	785
Manufacturing	21.7	26.1	25.8	13,007	28.1	8,409
Construction	4.1	4.1	6.3	3,160	8.4	2,510
Transportation, storage, and communication	12.9	9.8	8.7	4,366	8.8	2,633
Electric power, gas, and water utilities		2.1	3.2	1,618	1.7	504
Wholesale and retail trade	11.6	13.9	13.3	6,722	14.2	4,257
Finance, insurance, and real estate	10.0	7.5	9.7	4,904	4.3	1,289
Public administration and defense	3.4	7.2	6.8	3,455	11.5	3,455
Service	12.9	10.3	15.1	7,636	18.0	5,398
Total	100.0	100.0	100.0	50,476	100.0	29,945

Both the relative size of the economy's major sectors and the major changes in its structure over selected years are shown in Table VI. In 1926 the initial primary industries of agriculture, forestry, fishing, and trapping accounted for 20.2% of output; 40 years later this had declined to 7.1%. Whereas 34% of the labour force was in agriculture in 1926, by 1966 the figure was only 8%. However, the primary industries remain a very important source of export income. The shift in output was largely to manufacturing, mining (iron ore, uranium, nickel, copper, zinc, silver, molybdenum, tungsten, asbestos, potash, sulfur, oil, natural gas), the power utilities, the service industries, and public administration. The labour force of 7,420,000 derived 28% of its income from manufacturing alone in 1966, and 18% from the service industries. Financing the nation's capital spending required huge amounts of savings, and about 9% of gross savings used annually came from abroad, mainly the United States, a significant portion of it being equity capital. This development has caused concern over the degree of foreign ownership of some industries.

While the regional distribution of the nation's production has not changed greatly over the last several decades, the shares (as measured by personal income) coming from the provinces of Ontario, Quebec, Alberta, and British Columbia have increased, and those coming from the other provinces have decreased. The figures for 1966 were: Ontario 39.6%, Quebec 25.4%, British Columbia 10.6%, Alberta 7.6%, Saskatchewan 5.0%, Manitoba 4.6%, Nova Scotia 2.8%, New Brunswick 2.2%, Newfoundland 1.5%, Prince Edward Island 0.4%, Yukon and Northwest Territories 0.2%.

A. Production

1. Agriculture.—Although the importance of both field crops and livestock production has declined relatively as other resources developed, agriculture in the second half of the 20th century still remained the most important of the primary industries in terms of number of persons employed. The census of 1966 showed that Canada had about 174,100,000 ac. of occupied farmland, of which almost 108,200,000 were under cultivation. (*See* Table VII.)

There were 430,500 farm units, ranging from small vegetable farms outside the larger cities to the large wheat farms and larger cattle ranches of the Prairie Provinces. The number of persons engaged in agriculture has steadily declined, following the mechanization and enlargement of farms. As in the United States, greater production has also come from fewer persons, owing to improved varieties, better tillage practices, chemical weed killers, more effective control of plant diseases and insect pests, and increased use of fertilizers. Consequently, whereas in the 1935–39 period one farm worker produced sufficient food and fibre for 11 people, in the 1960s he produced enough for 33.

Canada's agricultural area has not changed greatly since 1930; by that time most of the good lands were already occupied. The intensity of land use has increased in areas adjacent to metropolitan centres, although this has probably been more than offset by land disappearing from agricultural uses to support urban housing and industrial development. The expansion of agriculture

TABLE VII.—*Area of Farmland (1966 Census)*

Province or territory	Total land area (in 000 ac.)	Farmland (in 000 ac.)				Average acreage per farm
		Im-proved	Unimproved		Percent of total	
			Wooded	Other		
Alberta	159,232	27,276	1,859	19,847	30.8	706
British Columbia	229,939	1,614	800	2,878	2.3	277
Manitoba	135,536	12,446	1,212	5,425	14.1	480
New Brunswick	17,814	639	974	199	10.2	208
Newfoundland	91,549	21	14	15	0.1	29
Nova Scotia	13,057	486	1,084	282	14.2	192
Ontario	220,219	12,004	2,834	2,987	8.1	162
Prince Edward Island	1,398	570	280	77	66.3	146
Quebec	335,270	7,629	3,777	1,479	3.8	160
Saskatchewan	140,916	45,469	1,348	18,593	46.4	763
Yukon & Northwest Territory	933,622	1	1	3	—	225

northward, however, faces environmental problems of poorer soils, shorter frost-free periods, poor drainage, and high forest-clearing costs.

Agricultural income in Canada is obtained chiefly from the sale of wheat, other grains, oil seed crops, livestock, and livestock products. Wheat, oats, barley, rye, flax, and rapeseed are grown mainly in the three Prairie Provinces. Wheat and the feed grains were the main crops of eastern Canada in the first major period of agricultural settlement in the 19th century, but when the western grasslands were opened up by the railroads, the east turned to more specialized crops and animal products to feed its growing cities.

In the west, limited by marginal precipitation and threatened by unseasonable frosts, grains were the only crops that grew well, and even they failed in some years. About 25,000,000 ac. under wheat and another 15,000,000 ac. in other grains was the average annual prairie crop acreage in the post-World War II period, 1945–55, but the world surplus of wheat which developed after 1952, plus above-average crops, resulted in decreases in wheat acreage in the 1950s. However, in the 1960s, as a consequence of strong export demands, particularly from mainland China and the U.S.S.R., wheat acreage rose sharply, even exceeding 29,000,000 ac. after 1963. The annual wheat crop after World War II fluctuated between a low of 283,000,000 bushels (1961) and a high of 827,000,000 bushels (1966), with much of the volatility explained by environmental conditions rather than acreage changes. The hazards of wheat production include drought, frost, hail, plant rust, and grasshoppers.

The spring-wheat belt forms a crescent across the prairie provinces, coinciding for the most part with the dark-brown soil zone; it extends from southern Manitoba across Saskatchewan, including Regina and Saskatoon, into Alberta south of Edmonton, and bends southward to the Calgary region. In this belt wheat usually constitutes about 70% of the cultivated acreage. South of this crescent also, wheat is grown as the main crop, but because of low and variable precipitation most of the land remains in natural pasture, with ranching as the main occupation. In these semiarid regions, between Calgary, Lethbridge, and Medicine Hat, Alta., were also the main irrigated sections of Canada, totaling over 500,000 ac. and using water from the St. Mary, Belly, Waterton, and Bow rivers. Small irrigation projects had also been developed in southern Saskatchewan, but with the near completion of the South Saskatchewan River Development Project, including Canada's largest rolled-earth dam, near the town of Outlook, an additional 500,000 ac. could be irrigated. Irrigation agriculture produced specialized crops, notably sugar beets in southern Alberta, but also vegetables, alfalfa for livestock feeding, and even wheat when prices were high. Small irrigation projects, or "dugouts," were important for stock watering.

North of the wheat crescent, oats and barley assume greater significance, although wheat remains the most important single crop. Surplus grain of this belt enters the export market, but most of the oats and barley is fed to livestock, particularly beef cattle, and also to dairy cattle for butter production. Swine and poultry are also part of this mixed farming-grain economy.

The agricultural lowlands of eastern Canada are classified as part of the hay and pasture, or dairying, belt of North America. In southern Quebec almost 90% of the cultivated land consists of hay, pasture, and oats, used primarily to support the dairy industry. Cultivated hay, pasture crops, and oats are also the dominant land use in southern Ontario, although the more favourabl summer climate of this region encourages the production of othe specialized crops as well.

Although grain, hay, and pastureland uses constituted the larges areas of cultivated crops in Canada in the second half of the 20t century, there were sections where specialized production brough large cash returns from small acreages. Truck-garden vegetable were grown close to most of the larger industrial centres, with heavy concentration of canning crops in southwestern Ontari Potatoes and other root crops were grown in nearly all agricu tural areas, but specialized areas of potato production, particularl for seed and for export, were located on Prince Edward Islan and in the valley of the St. John River in New Brunswick.

The tobacco industry, starting in Essex County of southwester Ontario, moved eastward after 1920 to adjacent areas of sand soils which were ideal for tobacco. By the 1960s about 90% Canadian tobacco production centred on these soils north of th central section of Lake Erie and southwest of Brantford, On Protected by a tariff, this area supplied the Canadian market an had a surplus for export.

Fruit production is dispersed across Canada, but commerci production tends to be confined to a few areas where enviro mental conditions are favourable. The Annapolis Valley of Nov Scotia was Canada's chief apple-producing area prior to 1940, bu the loss of overseas markets resulted in sharply decreased produ tion. By 1960 the Niagara Peninsula, jutting eastward betwee Lakes Erie and Ontario, was the major centre of soft-fruit produ tion.

The lowland area facing Lake Ontario produces a large shar of Canada's peaches, cherries, plums, and pears, and in additio is the chief area of grape production. The other important fru region is the irrigated Okanagan Valley of south-central Britis

BY COURTESY OF THE GREAT LAKES PAPER CO., LTD.

PULPWOOD HARVESTER SHEARS A TREE IN A WOODLAND. PULPWOOD IS O OF THE PRINCIPAL FOREST PRODUCTS IN CANADA

Columbia. Aided by generally loudless and hot summer days, he valley terraces produce the argest share of the Canadian apple crops, having a surplus for xport. It is the centre of apricot roduction in Canada and sometimes equals Niagara for peaches, herries, and pears.

Other intensive and specialized rops produced in Canada are: oybeans in Essex and Kent counies of southwestern Ontario; ugar beets northeast of Lake St. Clair in Ontario and in the irrigated lands of southern Alberta; nd hops, flower bulbs, and seeds n southwestern British Columbia. Throughout much of east-rn Canada in particular an important source of farm income s from the sale of forest products ff the farm; these may take the orm of pulpwood or lumber logs, r maple syrup or maple sugar rom the deciduous forest areas.

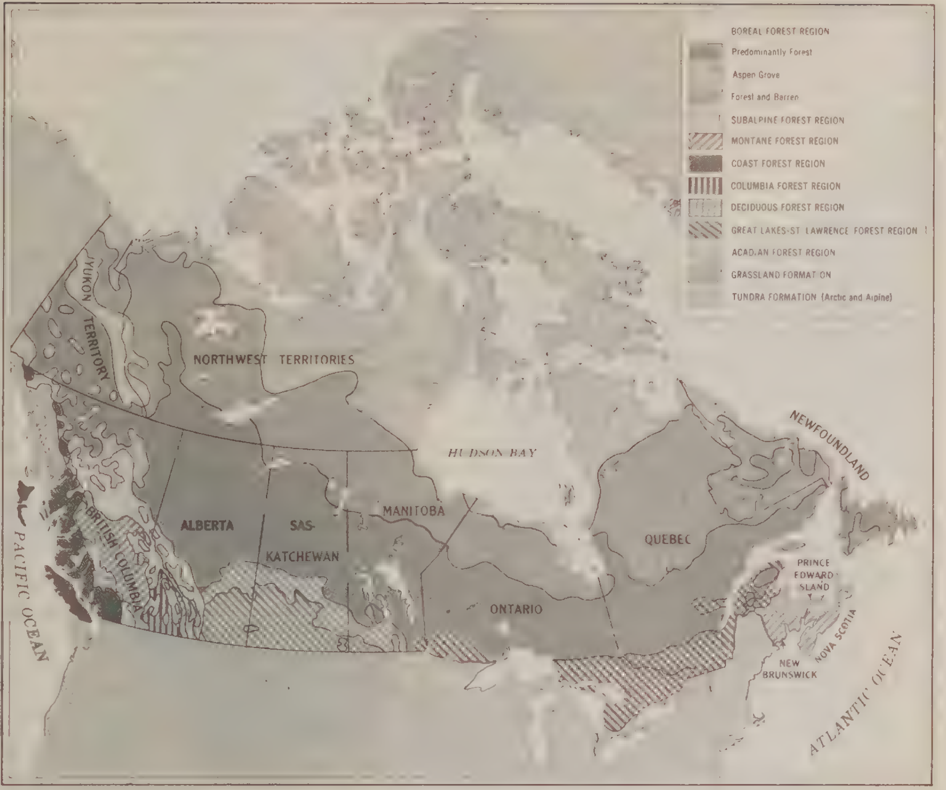
2. Forestry.—The forested rea of Canada has been estimated at about 1,700,000 sq.mi., which is about 44% of Canada's rea. Because of Canada's size hese forests rank as the third largest in the world, although environmental conditions have prevented forest growth over more than half of the country. In the north the Arctic and sub-Arctic regions of almost 1,000,000 sq.mi. are treeless. In the mountain eaks and uplands of the Cordillera, forest growth is generally not ound above 6,000 ft. in the south and 4,000 ft. in the north, deending on local site and exposure conditions. Other nonforested reas are the semiarid plains of the Prairie Provinces and the inumerable lakes, swamps, and muskegs of the Canadian shield.

Within the total forested area of Canada there are large sections where cool climate or low precipitation results in slow growth ates and scattered or stunted trees which cannot be classed as ommercial or productive forest. The productive forest area of Canada is estimated at about 968,000 sq.mi., which is about 27% f the country's land area.

About 91% of productive Canadian forests are owned by the government, primarily the provincial governments, which have control of natural resources within their borders. The federal government has control of certain forest reserves, the timber in national parks, and the relatively small forest areas of the two northern territories.

The forest regions of Canada were described in the section on *Vegetation.* These regions, and the species of trees which are contained in them, are closely related to the climate of Canada. In ll of Canada it is estimated that 63% of the productive forest is made up of softwood (generally coniferous) species. The most solid stands of these species for commercial use are located in he northern, boreal, forest region and along the Pacific coast. About 12% of the forest is classified as hardwood (generally deciduous), with the most extensive stands in southern Ontario, and across the parkland of the Prairie Provinces. The remaining 25% of the forest, which is classed as mixed, is found in the Maritime Provinces and along the southern edges of the Canadian shield.

The type of forestry production in Canada varies from region to region. The mixed forest of the Atlantic provinces was used or lumber, particularly for shipbuilding, in the 19th century; but in the 20th century the pulp and paper industry, using the softwoods, became of increasing importance. Pulp and paper mills were located at several river mouths in New Brunswick and Newfoundland, using the river and its tributaries as a means of transport to float logs to the mills during the summer, and also using the river water in the papermaking process. Partly because of the shorter rivers in peninsular Nova Scotia, pulp production remained secondary to lumber.

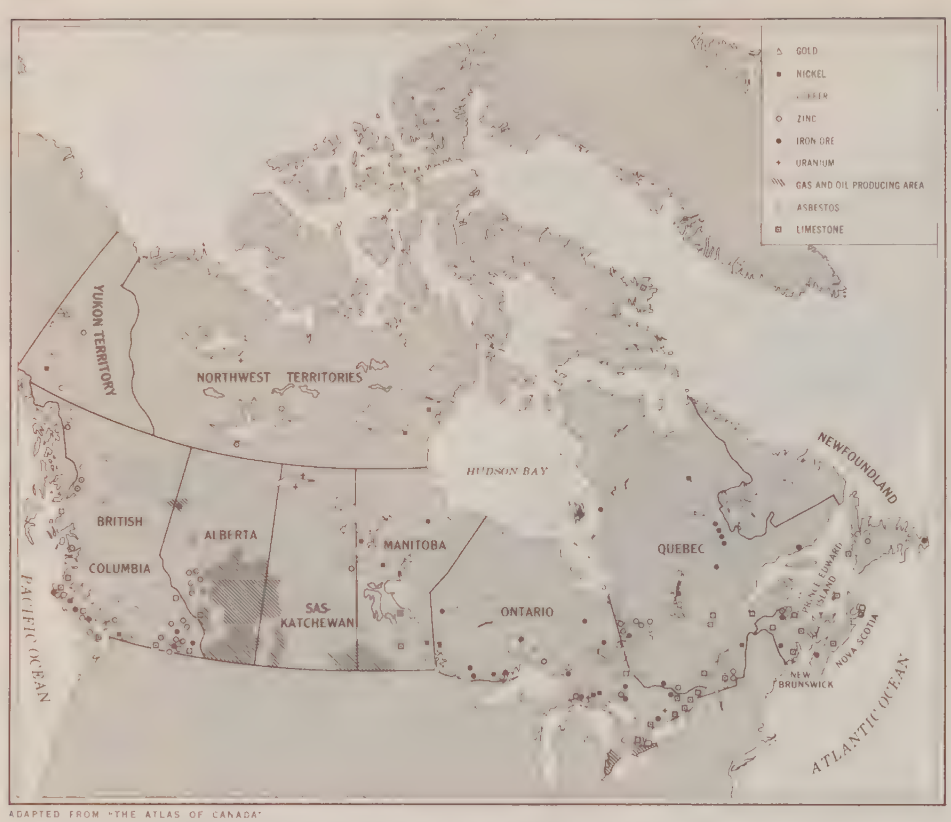


FROM "THE ATLAS OF CANADA"

FIG. 4.—FOREST REGIONS OF CANADA

Much of the area of hardwood forest in southern Quebec and Ontario was cleared in the 19th century to become agricultural land. At the end of that century the lumbering industry was moving into the mixed forest of the Canadian shield, following several rivers, notably the Ottawa, which drained to the urban and overseas markets of the lowlands. Lumbering is still carried on, but in the 20th century the pulp and paper industry expanded enormously along with the greatly increased world demand for newsprint. In the second half of the 20th century Quebec, which has a large share of the softwoods of the boreal forest, and the longest southward-flowing rivers tapping this forest, produced nearly one-half of the pulp and paper of Canada. Ontario has a smaller forest area and shorter southward-flowing rivers, but better rail transport, and produced about 30% of the pulp and paper. The largest share of Quebec pulp and paper mills was located at the mouths of shield rivers where they could use the rivers for log transport and the drop at the shield edge for power. In addition, their location along or near the St. Lawrence River gave the mills access to ocean shipping to export markets. Rivers such as the Saguenay, St. Maurice, Lièvre, Gatineau, and Ottawa were important to the industry.

In Ontario the pulp mills had a distribution pattern similar to that of Quebec in that the plants were located along the edge of the shield, particularly along the shores of Georgian Bay and Lake Superior. However, Ontario mills were also located on some of the northward-flowing rivers, such as the Moose and its tributaries, where they were crossed by railroads. In Ontario and Quebec both pulp mills and pulp and paper mills were generally located within the forested regions, but paper mills were frequently built in industrial cities of the southern lowlands. The largest share of their production was for export, notably to the adjoining sections of the United States for newspapers.



ADAPTED FROM "THE ATLAS OF CANADA"

FIG. 5.—PRINCIPAL MINERALS OF CANADA

The forestry industry is of lesser importance in the Prairie Provinces. Pulp and paper mills were located on the westward- (and outward-) flowing rivers of the shield in northwestern Ontario and eastern Manitoba, but the remainder of the western shield forest was untapped. Lumbering was of local importance in all three provinces, but did not supply the demand of the region. There are good reserves of pulpwood across central Saskatchewan and northern Alberta. Development has been retarded because of transportation costs to major markets, but has begun, with the establishment in the late 1950s of a large pulp mill at Hinton, Alta., and of Saskatchewan's first pulp mill in 1966.

The large and tall trees of British Columbia, particularly the Douglas fir, are Canada's chief source of lumber products, especially structural timbers. In the 1960s the west-coast province produced about two-thirds of the Canadian lumber, much of it shipped by rail or ocean transport to eastern Canada, but about half of it going for export. Timber cutters had difficulties in the 19th century because of lack of equipment to handle the big trees. Expansion came rapidly, however, after the building of the Panama Canal opened up markets in the eastern industrial areas of the United States and Canada. Pacific-coast tree growth is rapid, because of the year-round moderate and wet climate; exploitation is assisted by the numerous long fiords and inlets which penetrate into the forests; transportation in large rafts along the coast has the protection of the sheltered waters of the inside passage. Most of the large sawmills were located near the mouth of the Fraser River—in the Vancouver area and along the east coast of nearby Vancouver Island. After 1946 the coast forest industry began to produce increasing amounts of pulp and paper, in some instances based upon small growth and mill remnants once abandoned by the lumber industries. The coast forest industry appeared to be cutting at about the maximum in proportion to growth rates, and expansion in lumber production came from opening up new forest areas in the central interior and southeast of the province.

Canadian lumber production in the second half of the 20th century came from more than 7,000 sawmills, ranging from giant-sized ones in British Columbi which could cut almost 1,000,00 bd.ft. per day, to small portabl mills producing a few thousan feet per day. Pulp and pape production was supplied by abou 130 mills in the late 1960s, mo of them large and involvin sizable capital expenditure; mor than half of these mills wer classified as combined pulp an paper mills, and about 20% we purely paper mills.

Canadian forestry productio is an important item in Canada balance of trade. In the 196 newsprint and wheat were the tw leading exports by value fro Canada. Wood pulp and lumbe came third and fourth.

3. Mining and Minerals.— The geological regions of Canad indicate the kinds of minerals tha may be found. The flat-lyin geologically more recent sedimentary rocks of the interior plai and St. Lawrence lowlands hav been the source of nonmetall minerals such as petroleum, natural gas, coal, salt, potash, and gypsum. The ancient, hard Precambrian rocks of the Canadian shiel have yielded such metals as gol silver, copper, lead, iron, nicke and uranium. On the peripher of Canada the complex geology of the Cordillera Mountains an the Appalachian Hills, as well as the Arctic islands, contains combinations of both hard and soft rocks, and therefore has both metallic and nonmetallic minerals.

The expansion of the mining industry in Canada is a fairl recent development in Canadian history. Although the mining o coal and other minerals goes back to the French regime, more concentrated efforts in prospecting and discovery began around th turn of the 20th century. Many of the mines discovered at tha time were still in production in the second half of the 20th century. A further major expansion in the mining industry, howeve came after 1946 and was still in progress in the 1960s, aided b transportation and power developments.

Because the Canadian shield section of Ontario was well serve by transcontinental railway systems and feeder lines, mining developed there early, and for much of the 20th century Ontario ha produced annually more than one-third of the value of Canadia mineral production, and Quebec has usually ranked second, havin about 20%, chiefly from the shield but also from its Appalachia section. In recent years, however, oil and natural-gas discoveri in Alberta have increased that province's mineral production t 21% of the nation's total, exceeding in value even that of Quebec while oil, natural-gas, and potash discoveries in Saskatchewa have increased its share to about 9%, surpassing British Columbia's share from 1958 onward. Ontario's share has decline to about 26%. Mainly because of iron-ore developments, Newfoundland's total is 6%. While still small in absolute amount substantial increases in mineral production in the 1960s have occurred in New Brunswick (lead-zinc-copper-silver), Manitob (nickel), and the Northwest Territories (lead-zinc).

The regional importance of minerals in the Canadian econom shows wide variations. The folded sedimentary rocks and crysta line cores of the Appalachian-Acadian system have not yielde any wide variety of important minerals. Iron ore was produce after the turn of the century on Bell Island in Conception Ba of Newfoundland, and was transported over water to the extensiv coalfields around Sydney on Cape Breton Island, N.S. The Be

Island mine ceased production in the 1960s. The base metals, lead, zinc, and copper, were mined in central Newfoundland and on the east coast of Nova Scotia, and production expanded following base-metal discoveries in northeastern New Brunswick. In the second half of the 20th century Nova Scotia produced the largest share of Canadian gypsum, chiefly from the Minas Basin area at the head of the Bay of Fundy. In the Quebec section of the Appalachians mineral resources were somewhat richer. More than one-half of the world's asbestos was mined in a belt of serpentine rocks extending through the eastern townships, including the main asbestos-producing centre of Thetford Mines. Short-fibre asbestos was obtained in large open-pit mines, with crushing plants at the surface, near great piles of rock slag which scar the landscape. The Quebec Appalachians produced copper intermittently, the largest mine being operated in the central Gaspé Peninsula.

The sedimentary rocks of the St. Lawrence lowlands underlie the chief industrial area of Canada but played a small part in assisting the economic development of the area. Much of Canada's salt was produced near Windsor, Ont. Southeast of Sarnia, Ont., were some of the earliest oil wells in North America, but production was insignificant after about 1950. Small amounts of natural gas were also produced. Of greater importance was limestone, quarried particularly along the Niagara escarpment, which becomes an industrial raw material for the chemical and fertilizer industries. The widespread glacial deposits of the lowlands supplied important sources of sand and gravel used in great quantities by the construction industries.

The Canadian shield, the mineral storehouse of Canada, produced about 50% of the country's mineral wealth. In the second half of the 20th century there were about 100 mines producing in the shield region, almost one-half of them in the Ontario section. Although the shield covers almost 2,000,000 sq.mi. of the mainland of Canada, most of the mines were located on the outer edges of the region, suggesting greater development as more detailed geological information becomes available.

The geology of the eastern sections of the shield was little known until the exploration of large deposits of hematite iron ore along the Quebec-Newfoundland (Labrador) boundary during World War II. Reserves estimated in excess of 500,000,000 tons resulted in a railway being completed in 1954 from Sept-Iles, on the estuary of the St. Lawrence River, to the ore fields. This was the first railway or land transport to penetrate into this section of Canada. Nearer the coast another post-World War II development was the opening of North America's largest ilmenite or titanic iron-ore deposit, northeast of Mingan Airfield.

The central section of the shield, across the Quebec-Ontario border, had some of the oldest mines of the shield and also some of the newest ones. In the second half of the 20th century the largest share of Canada's gold came from the Timmins and Kirkland Lake fields of Ontario, and the gold belt extended across the boundary through Noranda and Val d'Or in Quebec. The Quebec section of the gold belt also produced base metals and copper; silver and zinc were found north of Timmins, where a major copper-silver-zinc find was reported in 1964. To the northeast, copper-gold discoveries near Chibougamau, Que., resulted in another new railway into previously unsettled regions.

One of the oldest of modern mining districts was the Sudbury basin in Ontario. Discovered as a copper deposit during the building of the Canadian Pacific Railway in 1883, the area in the second half of the 20th century produced about 50% of the world's nickel, was the world's main source of platinum, Canada's chief source of copper, and also produced selenium, tellurium, rhodium, gold, silver, cobalt, and by-product iron ore. To the southwest, Blind River on Georgian Bay was one of Canada's main uranium producers.

In the Lake Superior region of Ontario, iron ore was mined at Michipicoten Harbour, on the northeast shore, and at Steep Rock Lake, to the northwest. Other mines north and northwest of Lake Superior produced gold and copper.

Little was known of the mineral possibilities of the western sections of the shield prior to 1940. Remote from eastern mining centres and lacking transport, this development proceeded more slowly. On the southern fringe of the shield, and on the Manitoba-Saskatchewan border, Flin Flon was a well-established zinc-copper region. Northward at Lynn Lake, Man., Canada's second nickel deposit came into production in 1954, following the construction of a new railway, and in 1961 the world's only integrated nickel-production facility began operations at Thompson, Man. The Saskatchewan section of the shield lacked road or rail transport, so that the large pitchblende deposits north of Lake Athabasca, around Uranium City, were supplied during the uranium boom of the late 1950s by air or water transport, largely from the Athabasca River in Alberta.

Mineral deposits rich enough to withstand the high costs of transportation in the Northwest Territories were discovered along the western edges of the shield. Gold was mined after 1937 at Yellowknife, on the northeast shore of Great Slave Lake, and Canada's first pitchblende deposits were in production from 1933 to 1960 at Port Radium on the rocky east side of Great Bear Lake. In 1965 regular shipments of lead-zinc ore were begun on a new railroad from Pine Point on the south shore of Great Slave Lake.

The interior plains are Canada's chief source of fuels. Nearly three-quarters of Canada's coal reserve of about 100,000,000,000 tons is in Alberta and Saskatchewan; it is mainly bituminous, subbituminous, and lignite quality. The coal belts parallel the folding of the Rocky Mountains, being exposed in the foothills, and also eastward on the plains. Alberta led Nova Scotia in coal production prior to 1954, but mining declined there with the expansion of petroleum and natural-gas production, leaving Nova Scotia as the major producer.

Within a decade Canada rose from being an insignificant producer of petroleum (less than 8,000,000 bbl. in 1947), and a major importer, to becoming one of the world leaders in produc-

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AN OIL WELL COMING IN, THE EDMONTON OIL FIELDS. GUSHER IS SURROUNDED BY FARM LANDS tion, exceeding 300,000,000 bbl. for the first time in 1966. Most production came from fields discovered in the Edmonton, Alta., region—Leduc-Woodbend in 1947, Redwater in 1948, Pembina in 1953, Swan Hills in 1957, and Rainbow in 1964. After 1955 important discoveries were made in Saskatchewan, and by the mid-1960s that province accounted for about 30% of crude-petroleum shipments, most of the remainder coming from Alberta, with smaller amounts from British Columbia, Manitoba, Ontario, and the Northwest Territories. Oil pipelines were built eastward to Ontario, crossing through parts of the United States south of Lake Superior, and westward to southwestern British Columbia and adjoining Washington, and by 1965 there were 45 oil-pipeline companies with over 8,000 mi. of trunk lines and over 4,000 mi. of gathering lines. Recoverable crude-oil reserves exceeded 7,000,000,000 bbl., and the undeveloped Athabasca oil sands of Alberta, northeast of Edmonton, had reserves estimated in excess of 100,000,000,000 bbl. Many of the oil fields were also producers of natural gas, and in addition there were separate natural-gas fields. After reserves proved large enough to supply all Alberta's requirements, the natural gas was piped eastward to Ontario and Quebec, following a Canadian route north of Lake Superior, and another pipeline was constructed from northern gas fields in the Peace River district to southern British Columbia and Washington. By the late 1960s over 1,700,000,000 thousand cubic feet (MCF) of Canadian natural gas was being consumed, including more than 400,000,000 MCF of exports to the United States. Reserves amounted to 44,400,000,000, of which 82% were in Alberta and 15% in British Columbia.

In addition to the fuels, the interior plains also produced smaller quantities of sodium sulfate, salt, sulfur (obtained from cleaning natural gas), gypsum, clay, and building stone. Production of potash began in central Saskatchewan in late 1958 from deeply buried deposits believed to be the largest and richest in the world. By 1966 over 2,000,000 tons were being produced, and new mines were being rapidly developed which would place Canada in first position among world producers of this fertilizer ingredient.

In the Northwest Territories section of the plains, prospecting was hampered by the thick layer of glacial deposits across the Mackenzie River Valley, and by the lake and muskeg cover which is almost impassable in summer. In the late 1950s a small oil field produced at Norman Wells, on the Mackenzie River. Development of a large lead-zinc deposit on the south side of Great Slave Lake proceeded with the building of a railroad to Pine Point.

The Cordilleras of British Columbia and the Yukon contain minerals in several places, but prospecting is difficult on the steep and heavily forested slopes. The alluvial gold discovered around 1856 in the central Fraser River and tributaries brought the first settlers to interior British Columbia, and changed the political status of what had been a small British colony on the southern end of Vancouver Island. Many mines began production in the Kootenay region at the turn of the 20th century, only to become ghost towns in a few decades. In the second half of the 20th century mineral production was dominated by the lead-zinc mines at Kimberley in the southeast, which ranked among the world's largest. These and other mines shipped their ore concentrates to smelters at Trail, on the Columbia River. In addition to lead and zinc the Trail refinery yielded silver, gold, tungsten, bismuth, cadmium, tin, antimony, and indium. British Columbia produced copper around the flanks of the Coast Mountains, both at Britannia on the south coast, and near Stewart on the north coast. The province also had begun to mine iron ore, which is shipped mainly to Japan, molybdenum, and asbestos.

Alluvial gold was of minor importance, but lode gold was produced from a few mines around the edges of the interior plateau. Alluvial gold was still produced from the Klondike region of the Yukon, although not in the quantities that created the colourful gold rush of 1897–98.

The Arctic islands have a variety of rock types, but the detailed geology is not known. Low-grade coal is widespread throughout several of the islands, and the central islands of the Queen Elizabeth group have structural possibilities for petroleum. Any possible economic development would have to overcome transportation difficulties such as the short navigation season, which ranges from about four months off southeastern Baffin Island to less than one month in the northwestern islands.

Value of the annual production of Canadian minerals varie each year depending on market prices and new mineral discoveries. Petroleum, which was unimportant in 1946, had risen to first place by 1956. In 1966 it accounted for 20% of Canada' mineral production, and the figure for nickel was 10%, iron ore 11%, copper 12%, zinc 7%, natural gas 5%, asbestos 4%, gold 3%, lead, potash, and coal 2% each, and silver, platinum group uranium, and sulfur about 1% each. Canada leads the world in the production of nickel, zinc, and asbestos. It is second in gold uranium, molybdenum, gypsum, selenium, sulfur, and titanium; third in iron ore, aluminum metal, cobalt, platinum metals, and tellurium; fourth in lead, silver, and magnesium; and fifth larges in the production of copper and barite. About 30% of Canada' merchandise exports are composed of metals and minerals.

4. Fisheries.—Although Canada has a great number of inland lakes, many of them among the world's largest, most of the commercial fishing takes place off the Atlantic and Pacific coasts British Columbia ranks as the leading producer, by value, with about one-third of the Canadian total, but the combined Atlantic provinces, plus the Gaspé coast of Quebec, constitute the main fishing region, accounting for about 60% of total fish values. Fishing plays a much less important part in Canadian economy than do the other leading primary industries. In local economies, however, the fisheries are vital to Newfoundland, and to a lesser degree Nova Scotia, and are important to communities around the shores of the Gulf of St. Lawrence and along the central and north coasts of British Columbia.

Canadian fishermen catch about 2,500,000,000 lb. of fish annually, with a value of about $150,000,000, of which about two-thirds comes from the Atlantic coast and one-third from the Pacific coast. Because Canadians are not particularly fisheaters and the main population concentrations are inland, away from the fisheries about one-quarter of the fish catch enters export markets. In some years Canada is the world's leading fish-exporting nation noted for its fresh, frozen, or dried fish from the east coast, and for canned fish from the west coast.

On the Atlantic coast much of the catch is obtained from waters within a few miles of the shore; the day's haul is brought to the many small fishing villages in sheltered bays and harbours. With increased capital, however, more and more fishermen in the second half of the 20th century were obtaining bigger and better equipped boats, and were working out to sea in international waters above Sable Island, Banquereau, and Grand Bank. At the same time, fish processing was being centralized in larger settlements along the coasts in order to give a standardized and higher-quality product.

Lobster and cod are the mainstay of the Atlantic coast fisheries; haddock, scallops, and flounder are also important, while herring, mackerel, and alewives supply a pickling indusry. The lobster catch is marketed alive, fresh boiled, canned, or as fresh or frozen meat, and a significant part of it is sold in the United States.

The west-coast fishery is dominated by several species of Pacific salmon, the most valuable of Canadian fish. Salmon are netted off the river mouths when they appear in summer to begin their migrations to inland spawning waters. Most of the coastal rivers are salmon rivers, but the largest, the Fraser and Skeena, have the greatest numbers caught off their mouths. The fish-canning industry is concentrated in the Vancouver area, although other canneries are located northward on the coast. The halibut fishery ranks second in importance, being shared by international agreement with U.S. fishermen, and centres around the Queen Charlotte Islands. Prince Rupert is the port for the halibut fleet and for processing the product.

Inland fisheries in freshwater lakes are relatively unimportant. Catches declined notably in the Great Lakes after the mid-1940s principally because of the destruction caused by the lamprey, which was finally eliminated in the 1960s (*see* GREAT LAKES, THE). The great lakes of Manitoba (Manitoba, Winnipeg, and Winnipegosis) supply a fishery of local importance, part of the catch being exported to the midwest United States. Farther to the northwest the fishery established in Great Slave Lake in 1945 made that water body one of the leading fish-producing lakes in Canada. The inland waters attract many sports fishermen from Canada and the United States, forming a basis for an increasingly important tourist industry.

5. Fur Production.—The trapping of furs, historically one of the incentives to explore Canada, was by mid-20th century no longer a major primary resource. The annual value of the pelts in the 1960s ran below $40,000,000. Throughout the northern coniferous forest, fur trapping remained a winter occupation for some inhabitants in areas away from the largest settlements, and it was the chief livelihood of many Indians and most Eskimos. Since most fur-bearing animals have natural cycles of abundance and scarcity, the annual production of furs varies and the catch by species changes from year to year. Since these cycles appear to move across Canada, there are also regional variations in the year's production. Wild-fur production had declined steadily in relative importance, and in the 1960s constituted about 40% of total fur production.

Fur farms were started on Prince Edward Island in 1887 and spread across Canada until there were more than 10,000 prior to 1939. Changes in fashion, increased costs, and loss of European markets reduced the number to just over 2,000, mainly mink farms, with very few remaining in Prince Edward Island. About three-quarters of them were located in Ontario, British Columbia, and the Prairie Provinces.

Mink accounted for about 60% of total fur production, followed far behind by beaver, muskrat, seal, squirrel, fox, otter, lynx, marten, and ermine.

6. Electric Power.—In the mid-1960s Canada's electrical-power industry generated about 150,000,000,000 kw-hr. of electricity, of which about 82% was obtained from water. Thermal stations, using mainly fossil fuels but a few using nuclear energy and gas turbines, provided the remainder, the first mentioned having increased substantially in importance after the 1940s. Their growth reflected partly the growing scarcity of hydroelectric sites within economical transmission distance of load centres in Ontario. The largest thermal station is at Lakeview, Ont., with a planned capacity of 2,400,000 kw. The industry employed over 40,000 people and had revenues of around $1,000,000,000.

The most important users of electric energy were the pulp and paper, smelting, refining, and chemical industries, which took almost half of the total output, while households took about one-third. The provinces of Ontario, Quebec, and British Columbia, where most of these industries are located, generate over 80% of Canada's electricity, but the other provinces also generated and depended heavily on electric power. Absence of coal in the industrial heartland of southern Ontario and Quebec led to the development of hydroelectric power there as early as the 1880s.

Canadian electricity-generating capacity is expanding each year, paralleling the nation's real economic growth. Installed generating capacity in the 1960s exceeded 29,000,000 kw., of which almost 22,000,000 kw. was hydro based. Canada ranked second to the United States in hydroelectric generation and was the world's second-largest per-capita user of energy. Her undeveloped water-power resources probably exceed 60,000,000 kw., based on flow available 50% of the time, and these are located mainly in Quebec and British Columbia.

The waterpower potential of the Atlantic provinces is assisted by ample precipitation evenly distributed throughout the year, and by rough or rocky topography, but is limited in that many rivers are short and therefore lack volume. The largest hydroelectric installations in the Atlantic provinces are located on the island of Newfoundland, where they are used mainly for the pulp and paper industry. New Brunswick is able to make use of the St. John River, one of the largest rivers in the region, as at the hydroelectric site at Mactaquac.

In the second half of the 20th century the St. Lawrence lowland was the major consumer of hydroelectric power, but had only a few large power sites within its boundaries. Below Niagara Falls on the Niagara River in Ontario, and at Beauharnois Dam, west of Montreal, Que., on the St. Lawrence River, large power plants each produced in excess of 1,500,000 hp. The international power plant at Cornwall, Ont., constructed for the St. Lawrence Seaway, generated more than 2,000,000 hp., used in both Ontario and New York.

But a large part of the waterpower of Canada came from the north, in the Canadian shield. The innumerable lakes of the glaciated shield serve as natural storage basins, and potential power is found along the fall line where the rivers tumble through the shield escarpment above the St. Lawrence. Rivers such as the Bersimis, Saguenay, St. Maurice, and Ottawa produce power by utilizing several dams along the river course. The southward-flowing rivers of the shield in Ontario are shorter and produce less power. Ontario also has a northern fall line, where the northward-flowing rivers drop over the shield in the flat-lying sedimentary rocks west of James Bay. Except for the Abitibi River, however, this potential is poorly located for development. Waters flowing westward from the shield are utilized along the English and Winnipeg rivers as they drop toward Lake Manitoba.

Almost all of the economically located water power potential of Ontario has been developed, although some small sites are still being developed. Quebec is the richest of the provinces in water resources. It has large hydroelectric generating plants at Beauharnois on the St. Lawrence River, and on the Bersimis and Peribonca rivers, and is harnessing the headwaters of the Manicouagan and Outardes rivers with a planned installation of 5,800,000 kw. One of the largest potential sources of power in Canada, the falls on the Churchill River in Labrador, is also being developed, with a planned capacity of 3,914,000 kw.

Manitoba had depended on the Winnipeg River for hydro power, but has further capabilities on the Churchill, Nelson, and Saskatchewan rivers; while Saskatchewan, with fewer potential sites, completed its first hydro site at Squaw Rapids on the Saskatchewan River in 1963, is developing another at Coteau Creek, and has potential sites also on the Churchill and Fond du Lac rivers. Alberta has large hydro units on the Bow and Brazeau rivers.

The mountains and rivers of the western Cordilleras rank second to the shield as sources of potential power, and make British Columbia the second-richest province in terms of available waterpower resources. The mountain slopes receive the heaviest precipitation in Canada, although there is a problem of seasonal distribution toward the south. Many of the coastal rivers are quite short. The longer rivers which rise in the interior cut down through the Coast Mountains while they were being uplifted geologically, and thus do not have many falls or rapids. But power can be produced by dams across them. The chief power development, for aluminum production at Kitimat on the northern British Columbia coast, is obtained by damming an interior tributary of the Fraser River and backing up the flow through a long tunnel in the Coast Mountains to drop the water almost 2,000 ft. onto turbines located near tidewater. This same principle of diversion of interior plateau rivers through the mountains to potential coastal industries applies to other areas of western British Columbia. In northern British Columbia and southern Yukon such power developments are politically complicated, since the coastal locations for industries are in the U.S. state of Alaska. Other power developments in British Columbia had been located mainly on smaller rivers of the southwestern region to serve the large urban market of Vancouver, and on the tributaries of the Columbia River, such as the Kootenay, in the southeast, primarily for the mining industry. But in the 1960s the immense hydro-power potential of the Columbia and the Peace rivers began to be developed.

Canada and the United States in January 1961 signed a treaty making possible the integrated and basin-wide development of the water and power resources of the upper Columbia River, with water-storage projects in British Columbia creating downstream flood protection in Washington and increased power production at all United States dams from Grand Coulee to Bonneville. The agreement was based on 50–50 sharing of added power output and payment by the United States to Canada for one-half the added flood-control benefits. Planned development of the Peace and Columbia rivers includes a power capacity of over 3,000,000 kw.

7. Manufacturing.—Canadian manufacturing industries received their first major impetus during World War I, after which trends in the economy were toward further industrialization and away from a dominant agricultural base. Although the processing of agricultural products for a relatively small domestic market and for export remained a major activity, new industries came into prominence after 1920, led by pulp and paper, transportation equipment, and farm implements. World War II resulted in rapid and far-reaching industrial expansion, and Canada emerged from the war among the six leading industrial nations of the world. By 1946, the manufacturing industry produced 26% of Canada's gross domestic product at factor cost and employed over 1,000,000 workers, or about one-quarter of the nation's labour force. Those ratios did not change significantly in succeeding years.

Manufacturing is concentrated in southern Ontario and Quebec. The former province, by value added, accounted for about half of Canadian manufacturing output, and the latter for about 30%. Next in size was British Columbia with about 8%, the Prairie Provinces with about 7%, and the Maritimes with about 4%. However, all provinces pursued policies designed to attract manufacturing industries.

The lowlands of Ontario and Quebec had the historical advantage of an early start and had, for Canada, a relatively large regional population as a market. When industrial expansion came in the 20th century, the region could call on a fairly wide range of domestic raw materials nearby, an excellent transportation system, including ocean transport to Montreal and cheap movement on the Great Lakes, established banking and financial support, and, of major importance, a good supply of hydroelectric power.

Toronto and Montreal are the leading industrial cities in Canada. In the 1960s the value of Toronto's factory shipments was slightly higher than that of Montreal's, and was larger than the combined total for all the provinces excluding British Columbia, Ontario, and Quebec. The next-largest industrial cities were Hamilton, Ont., Vancouver, B.C., and Windsor, Ont.

The pulp and paper industry continued to rank in first place in the value of factory shipments, followed by motor-vehicle manufacturers, petroleum refining, slaughtering and meatpacking plants, iron and steel mills, dairy factories, sawmills and planing mills, smelting and refining, miscellaneous machinery and equipment manufacturers, and motor-vehicle parts and accessory manufacturers. These ten accounted for half of the manufacturing shipments, the remaining half being divided among 30 other manufacturing-industry groupings. Among the fastest-growing manufacturing industries in the decade ending with 1965 were textiles, because of the development of synthetic fibres; chemical and allied products of petroleum and coal, because of the discovery of large crude-petroleum resources in western Canada and because of technological innovations in chemistry; electrical apparatus and supplies, because of the appearance of television; and iron and steel products, as a result of the rapid growth of using industries such as motor vehicles, pipeline construction, and building construction.

The manufacturing industries that for many years have exported a large share of their output are newsprint paper, wood pulp, lumber, and the nonferrous metal products industries. While the proportion of Canada's exports accounted for by manufactured goods declined after World War II, because of the higher growth of the mineral industries, the manufacturing industry consistently exported about 15% of its production after 1948. In the 1960s there was a sharp increase in the export of highly finished manufactured goods, although still relatively small in relation to total exports. The greatest challenge in the late 1960s seemed to be the opportunities and problems posed by the trend toward freer trade, particularly as it related to trade with the United States.

B. TRADE AND FINANCE

1. Foreign Trade.—From about 1890 onward Canada became increasingly important as a trading nation. In the mid-1960s it was the fifth-largest trading nation, and per capita its trade was much larger than that of the other major trading nations. Over one-fifth of Canada's gross national product at market prices went into exports after World War II, and it stood at that level in the late 1960s. But in spite of the rapid growth of its exports, Canada was a net importer of capital, particularly U.S. capital, with the result that it had a deficit in the current account of its balance of international payments every year from 1950 to 1967, except in 1952.

Canadian export activity has always depended heavily on primary products, but the pattern has not been an unchanging one. At the turn of the century exports of primary agriculture and fisheries products accounted for 63% of exports, but in the mid-1960s only 22%; figures for other primary products were 28% declining to 25%, and exports of highly processed and manufactured goods (including wood pulp, chemicals, machinery and transport equipment, newsprint, and other highly processed products and manufactured items), which amounted to only about 9% at the turn of the century, had increased to 53% by the mid-1960s. The trend has been toward increased processing and fabrication of primary materials, and in the 1960s there was a notable increase in exports of highly manufactured products. In 1966 total merchandise exports of $10,325,000,000 were distributed as follows: wheat and wheat flour 11.1%, other farm and fish products 8.4%, newsprint 9.4%, wood pulp 5.0%, other forest products 7.3%, copper, nickel, and products 7.4%, crude petroleum and natural gas 4.2%, aluminum and products 3.7%, iron ore 3.6%, primary iron and steel 2.5%, lead, zinc, and products 1.8%, other metals and minerals 5.2%, chemicals and fertilizers 3.6%, other manufactured and miscellaneous goods 24.4%, reexports 2.4%.

Canadian imports were quite different in character, with emphasis on mass-produced manufactured goods, farm and industrial machinery and industrial materials, tropical and off-season fruits and vegetables, and fuels and lubricants to serve the eastern Canadian market, including Quebec, which is too far removed from the western fields to economically use Canadian oil. Many imported items, such as motor vehicles and parts, aircraft and parts, electrical machinery and supplies, engines, and textiles were also manufactured in Canada.

Around the start of the 20th century Canada was a part of a three-cornered trade movement with the United States and Great Britain, but steadily its economic ties became closer with the United States. About one-half of Canada's imports came from the United States around 1900; in the mid-1960s 70% came from there. By the latter period Canada's imports from the United Kingdom amounted to only 14% of its total imports, the same as for the rest of Europe. Canada's most important export markets in the mid-1960s were the United States with 60% of the total, United Kingdom 11%, and Japan 4%; and in individual years during the 1960s very large shipments of wheat went to the U.S.S.R. and mainland China.

2. Banking, Currency, and Capital Markets.—The nation's central bank is the Bank of Canada. It commenced operations on March 11, 1935, is now owned by the federal government, has its head office in Ottawa, and has an agency office in most provinces. The Bank of Canada has never engaged in commercial banking, and its principal role is to regulate credit conditions through its control of the supply of money, so as to help achieve desired price, employment, and economic-growth objectives. It is also the federal government's banker and fiscal agent, it manages the public debt, and it is the government's agent for managing the fixed rate of exchange on the Canadian dollar and, in addition, the nation's gold and foreign-exchange reserves.

The nation's supply of money is composed essentially of subsidiary coinage (1¢, 5¢, 10¢, 25¢, 50¢, $1.00), Bank of Canada notes ($1, $2, $5, $10, $20, $50, $100, $1,000), and deposits of the chartered banks, the latter in terms of value being more than seven times as large as the former two items. By law the chartered banks, from February 1968, had to maintain a fixed ratio of cash reserves to their Canadian deposit liabilities of 4% for savings deposits and 12% for demand deposits, and since the Bank of Canada controls the size of the cash reserves, it effectively controls the size of the deposits of the chartered banks.

The chartered banks, which first appeared in 1817, are the nation's commercial bankers, but over the years a wide range of other private financial institutions have emerged, including the following, with date of first appearance shown in parentheses: fire- and casualty-insurance companies (1809), savings banks (1819), mortgage-loan companies (1844), life-insurance companies (1847), trust companies (1882), cooperative credit institutions (*i.e.*, credit unions, or, as they are known in their North American birthplace, Quebec, *caisses populaires;* 1900), closed-end investment trusts (1901), installment-finance companies (1916), personal-loan companies (1928), mutual funds (1932), and trusteed pension plans. In the 1960s these private institutions accounted for about 80% of total financial intermediary assets, including the chartered banks with about 30%, while a number of special-purpose government institutions accounted for about 20% of the total.

Most significant was the decline in the relative size of the chartered banking system, which in 1870 accounted for approximately three-quarters of financial intermediary assets. This occurred mainly because of the growth of long-term savings institutions such as life-insurance companies, pension funds, and investment companies. There are eight chartered banks with over 5,800 branches. A peak of 51 individual banks was reached in 1871, but over the years this was reduced by insolvencies and mergers. The banks' charters expire every ten years, and so decennial revisions of the Bank Act have become customary. The 1967 Bank Act expanded the banks' lending powers to include conventional mortgage loans and expanded their borrowing powers to include the sale of debenture liabilities, and it relieved the banks of the 6% ceiling on loan rates. Supervision of the chartered banks is the responsibility of the federal government's inspector general of banks, since banking is exclusively a federal matter, while supervision of the other financial institutions is shared, for the most part, by the federal government and the provincial governments. Some financial institutions, particularly the trust companies, mortgage-loan companies, and *caisses populaires* and credit unions, carry on a deposit business very similar to the chartered banks, and they operate through a large number of local offices, as do the banks.

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(Above) Helicopter passes over a tractor train en route to northern power development. (Below, left) The Iroquois lock on the St. Lawrence Seaway, near Cornwall, Ont. (Below, right) The Canadian Pacific Railway yards in Winnipeg, Man., one of the largest privately owned facilities in the world

The Toronto Stock Exchange, incorporated in 1878, is Canada's largest exchange, followed by the Montreal Stock Exchange, incorporated in 1874, and the Canadian Stock Exchange in Montreal. There are small exchanges in Vancouver and Winnipeg. Mainly common stocks are traded on these exchanges, with bond trading being effected essentially through telephone communication between the investment dealers of Toronto and Montreal. These dealers are also active in underwriting new issues of bonds and stocks, and first appeared at around the turn of the 20th century. The central core of the foreign-exchange market consists of the eight chartered banks, one savings bank, and the Bank of Canada, trading with each other through one foreign-exchange broker located in Toronto and one in Montreal. The U.S. dollar is the most commonly traded currency on the Canadian foreign-exchange market. From May 2, 1962, the Canadian dollar-exchange rate was fixed at 92.50 U.S. cents, following 12 years of a freely floating rate.

3. National Finance.—Expenditures on goods and services of the three levels of government—federal, provincial, and municipal—in the 1960s amounted to about 19% of the gross national product, compared with under 14% for most years prior to 1951, excluding the war period, 1940 to 1946. All levels of government engaged heavily in capital spending after World War II, and all added to their outstanding debt to help finance their expenditures. At the end of 1966, for example, federal-government direct and guaranteed debt amounted to $21,111,000,000, that of the provinces was $13,424,000,000, and municipal direct and guaranteed debt was $5,793,000,000. In 1933 federal-government debt had been $4,382,000,000, provincial debt $1,490,000,000, and municipal debt $1,435,000,000. Almost all of the federal-government debt is Canadian-dollar debt, but the provinces and municipalities borrowed frequently in the United States, so that about one-quarter of their debt outstanding was payable in foreign currencies, mainly U.S. dollars.

The division of financial responsibility and tax powers between the federal government and the provincial governments has been one of the most difficult problems in intergovernment relations in Canada, the municipal governments being creatures of the provincial government. Of almost $10,000,000,000 in revenues collected in 1966, the federal government received 30% from direct taxes on individuals, 17% from direct taxes on corporations, and 37% from indirect taxes; while 15% of the provincial and municipal revenues of about $10,000,000,000 came from direct taxes on persons, 5% came from direct taxes on corporations, and 47% came from indirect taxes. Investment income and pension payments accounted for most of the remainder. The trend toward increased provincial- and municipal-government spending and debt is explained largely by their expenditures on roads, schools and universities, health, and social welfare; while defense expenditures, interest on the public debt, family allowances, hospital care, veterans' benefits, and payments to provinces were the largest federal-government expenditure items.

C. Transport and Communication

Canada has been primarily a new country with a small population exporting such bulky raw materials as wheat, lumber, pulp and paper, and minerals to densely populated industrial countries. Cheap water transportation has been fundamental. Canadian ports are seriously affected by geographic considerations and climatic conditions. Montreal is closed in the winter season, and Halifax and Saint John, N.B., although open through the winter, are too distant from the interior to compete effectively with U.S. Atlantic ports. Vancouver benefited as an export centre by the opening of the Panama Canal.

The export of wheat from the Prairie Provinces intensified the transport problem, since it produced a peak load in early autumn for Great Lakes shipping. The handling of great quantities of wheat during the rush season involved the use of specially constructed boats, "lakers," and of elaborate loading and unloading facilities at Port Arthur and Fort William, Ont., Port Colborne, Ont., Buffalo, N.Y., and the Georgian Bay ports. Opening of the St. Lawrence Seaway, completed in 1959 at a cost to Canada of about $340,000,000, provides a deep waterway for oceangoing vessels, extending about 2,200 mi. from the Atlantic to the head of the Great Lakes.

Railway facilities were improved in relation to the export of wheat from the Prairie Provinces. Especially after 1900, railways were rapidly extended for the development of traffic in western Canada; the marked increase in the export of wheat led to the construction of new lines from Winnipeg to Fort William and Port Arthur and from Georgian Bay ports to Montreal, as well as to the construction of a line from Winnipeg through Cochrane, Ont., to Quebec. An additional outlet for the trade of the Prairie Provinces was completed with a railway to Churchill on Hudson Bay in 1929. The development of the mineral industry and of pulp and paper mills in the Canadian shield was followed by construction of many lines in northern Ontario and in northern Quebec, including the Ontario Northland Railway and lines to the Saguenay country, and in northern Manitoba.

Railway construction virtually ceased between 1930 and 1950. After that date new northern lines were built to tap mineral developments in the shield region and in British Columbia. As in the case of canals, railway construction involved heavy expenditures on the part of both the federal and the provincial governments.

More than 95% of Canadian railway mileage (about 58,000 mi. in 1965) was under the control of two great transcontinental systems, the Canadian National and the Canadian Pacific. The Canadian Pacific was incorporated in 1881, and the company built up a strong organization with low-fixed charges and a large proportion of capital in the form of common stock, on which it paid 10% to 1930. The Canadian National is government owned and the result of the amalgamation of several companies, including the Intercolonial, Canadian Northern, Grand Trunk, Grand Trunk Pacific, and National Transcontinental, which found themselves in difficulties through dependence on government-guaranteed bonds and high costs of operation during World War I (*see* also *History*, above). Various units were joined and the organization rounded out as a system. Both systems have connections with U.S. roads and substantial mileage in the United States. The Ontario government owns a railway extending from North Bay to James Bay, and British Columbia operates the Pacific Great Eastern Railway between Vancouver and the Peace River area.

The east-west pattern of railways across southern Canada is supplemented by numerous branch lines, or feeders. Further extension was made by gravel roads or with river steamboats, as on the Mackenzie and the Yukon, and with the organization of air-transport systems in these and in newly opened mining districts.

Aircraft equipped with floats or skis were used in new districts chiefly for passenger and mail service and in government work of surveying, mapping, and prevention of forest fires. Government-owned Air Canada (Trans-Canada Air Lines until 1964), established in 1937, was developed to provide continuous transcontinental service, and east and south across the Atlantic. Canadian Pacific Airlines developed overseas services to Europe, the Orient, and Australia, and to South America, but its domestic services were confined largely to the north and west until it obtained authority to operate a limited transcontinental service in competition with Air Canada in 1959. Several smaller domestic airlines operated scheduled air services, and a number of carriers held licenses covering scheduled international services flying into Canada.

Railway rates were placed under the jurisdiction of the Board of Transport Commissioners, formed in 1903. It also regulates telephone, telegraph, and express rates and deals with problems of location, construction, and operation of the railways, of Great Lakes shipping, and of interprovincial and international oil and natural-gas pipelines. The Air Transport Board, established in 1944, exercises jurisdiction in all matters related to civil aviation.

Transport facilities were vastly extended with the construction of roads. In the 1960s there were about 126,000 mi. of earth roads, chiefly in the Prairie Provinces, and about 322,000 mi. of surfaced roads. The registration of more than 6,500,000 motor vehicles meant more than one vehicle for every three Canadians. The first paved highway across Canada, financed jointly by the federal and provincial governments, was completed in 1960. The northwest was given its first land-transport route with the building of the Alaska Highway during World War II, and of a road from the Peace River to Great Slave Lake in 1948. In Canada generally, improved roads have been accompanied by an exceedingly rapid expansion of the trucking industry, one of the most significant developments in transportation since World War II.

Construction of transcontinental systems of oil and natural-gas pipelines during the 1950s and 1960s made significant contributions to transportation in Canada. There are crude-oil pipelines extending from Edmonton, Alta., via Superior, Wis., to Sarnia and Toronto, Ont., gathering oil from the three prairie provinces and serving Canadian and U.S. refineries en route. Other main lines transport oil from Edmonton to Vancouver, B.C., and the Puget Sound area of Washington. By the mid-1960s Canada had a network of more than 12,000 mi. of oil pipelines linking oil fields with refineries and ports. A 650-mi., 30-in. gas pipeline was completed in 1957 to carry gas from the Peace River area of Alberta to Vancouver and the states of the Pacific northwest. Another pipeline, completed in 1959 at a cost of about $375,000,000, carried Alberta gas 2,290 mi. across northern Ontario to Toronto and Montreal and other industrial areas in eastern Canada. By the end of 1965 there were 43,360 mi. of gas pipelines of which 5,029 mi. were gathering lines, 13,806 were transmission lines, and 24,525 were distribution lines.

Canada is one of the world's leading trading nations, and much of the exports and imports move by ocean transport. Several steamship lines run between Canada and Great Britain and Europe on the Atlantic and between Canada and Asia and Australia on the Pacific. The Canadian Pacific operates an important subsidiary ocean-steamship company, and the Canadian National has smaller steamship lines under its control. However, the various forms of transportation have not all developed at the same pace, there having been a significant shift toward road, air, and pipeline transport. Of about 53,000 ton-miles of intercity freight hauled in 1938, 51% was by rail, 46% by water, 3% by road, a negligible amount by air, and none by pipeline; but in the 1960s, 42% of about 200,000 ton-miles annually went by rail, 27% by water, 9% by air, and 22% by pipeline. Passenger traffic has shifted heavily toward airlines and buses.

Increase in transport facilities was accompanied by vastly improved communications. In the second half of the 20th century telegraph-wire mileage totaled more than 545,000 mi., about evenly divided between the Canadian National and Canadian Pacific telegraphs. Seventeen external submarine cables landed in Canada. Wireless and radio stations served as communication links with northern Canada. Commercial radio and television stations were operated chiefly by the government-owned Canadian Broadcasting Corporation, but there were also more than 300 privately owned stations. Telephone service was in almost every home, there being an average of one telephone for every three persons, and over 600 calls per person each year.

See also separate articles on the several provinces and territories, as ALBERTA; YUKON TERRITORY; and references under "Canada" in the Index. (E. P. N.)

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CANADA BALSAM, an exudation of the North American balsam fir, *Abies balsamea;* called also Canada turpentine and balsam of fir. It is strictly speaking a turpentine (*q.v.*) and not a balsam (*q.v.*), and at ordinary temperature is a yellow solid. It belongs to the class of oleoresins, which are natural products consisting of resin (*q.v.*) dissolved in a volatile oil. It contains 24% of essential oil, 60% of resin soluble in alcohol and 16% of resin soluble only in ether.

Canada balsam is of importance in optics because of its refractive index, which is close to that of glass. Its chief uses are for mounting preparations for the microscope and as a cement for glass in optical work.

CANADIAN CONSTITUTIONAL ACT: *see* CONSTITUTIONAL ACT, CANADIAN.

CANADIAN LITERATURE (ENGLISH). The earliest Canadian literature in English was written at about the time of the American Revolution and was largely a result of that event. The 40,000 American loyalists who took refuge in the northern colonies which had not joined in the revolt were to determine the English-speaking character of Nova Scotia, New Brunswick and Upper Canada (Ontario), and to give them the slight beginnings of a literature. The Rev. Jonathan Odell (1737–1818), for example, has a minor place in the literary history of his two countries as the writer of convivial lyrics and of satire on Whig rebels. It is in the next generation, however, and among the sons of the loyalists that are found the clear beginnings of indigenous writing. Oliver Goldsmith (1794–1861), a grandnephew of the author of *The Deserted Village,* published an optimistic Nova Scotian imitation, *The Rising Village* (1825), which includes some interesting description but suffers at every point by comparison with the earlier poem. Joseph Howe (1804–73)—whose father, a proprietor of the *Boston News-Letter* at the time of the evacuation of the city, had taken the presses of that oldest of New England newspapers off to Halifax—was the most remarkable personality in the political life of Nova Scotia in his time, editor of the *Novascotian* (1828–41), and author of patriotic and narrative poems and of several volumes of travel sketches remarkable for their humour and shrewd observations. In the columns of the *Novascotian* in 1835–36 appeared the first Canadian literary work to gain international notice, *The Clockmaker, or the Sayings and Doings of Samuel Slick of Slickville.* The author, Thomas Chandler Haliburton (*q.v.*), member of the assembly and judge, was motivated in his public life by the pro-British, anti-American and antidemocratic prejudices of the Tory loyalist families. His fellow Nova Scotians, most of them the descendants of New Englanders, seemed to him to have acquired most of the faults and few of the dubious virtues of the republican Yankees. In *The Clockmaker,* Yankee shrewdness, energy and salesmanship make an easy victim of Nova Scotian gullibility and laziness, and Haliburton joins in the laughter. The sayings and doings of Sam Slick and the vivid little pictures of frontier life make this book a minor classic, in spite of its formless and sometimes repetitious arrangement.

These earliest writers all lived in the maritime provinces which had attracted a large part of the better educated loyalists of the northern Atlantic seaboard; the loyalists who settled in Quebec and along the St. Lawrence and Niagara frontiers were of humbler stock, mostly farmers, and literary activity began later than down east. The first name in this region is John Richardson, a native of Queenston, whose background and military adventures were almost as romantic as his novels. His best book, *Wacousta* (1832), a story of the days of Pontiac's descent in 1763 on Michilimackinac and Detroit, draws on the experiences of Richardson's grandparents who included Scottish Jacobite exiles and an Indian grandmother who had witnessed the siege of Detroit. Richardson is best in graphic descriptions of scene and episode; his faults are stilted dialogue and frequent lapses into melodrama. Of the early immigrants to the Canadas (Quebec and Ontario) from Britain the most literary were two sisters, Catherine Parr Traill (1802–99) and Susanna Moodie (1803–85). Although they published novels, poems and stories for children, they are remembered mainly for their autobiographical volumes: *The Backwoods of Canada* (1836) by Mrs. Traill and *Roughing It in the Bush* (1852) by Mrs. Moodie, accurate and spirited social records of pioneer life. About contemporary with these two gentlewomen were two immigrant poets of the working class: Alexander McLachlan (1818–96), a tailor turned farmer, whose verses are compounded of memories of poverty and social inequality in Scotland and love for the new country where "Jack's as good's his master," and Charles Heavysege (1816–76), a Montreal cabinetmaker, whose dramatic poems *Saul* (1857), *Count Filippo* (1860) and *Jephthah's Daughter* (1865), though often commonplace or pompous in language, are bold in design and in their implied moral and religious skepticism.

From Federation to the 1920s.—In 1867 the separate colonies of British North America joined in a federal union to form the Dominion of Canada—except Prince Edward Island and the western territories (which joined within six years) and Newfoundland (which stayed out until 1949). A growing sense of national identity preceded the federal union and was cultivated by its accomplishment. The most national-minded poet in the decade before federation was Charles Sangster (1822–93), once regarded as the unofficial laureate of the Canadas but now remembered, if at all, for a few lines in his memorial verses on Gen. Sir Isaac Brock and for some description in "The St. Lawrence and the Saguenay" (1856). In the two decades after federation Charles Mair (1838–1927), who spent most of his life in the west, found themes for poetry on the new frontier and also in Canadian history, as in his verse drama *Tecumseh* (1886). Historical romance, always a popular form in Canada, is best represented in this period by *The Golden Dog* (1877) by William Kirby. Superficially, it is a costume romance of the struggle between the forces of honesty and corruption in New France; but Kirby's romantic Toryism informs the plot, characterization and description, giving the novel more depth and consistency than is found in any earlier Canadian example.

Meanwhile, a considerable number of semiliterary periodicals had appeared in Canada, the most notable being the *Literary Garland* (1838–51), the *Canadian Monthly* (1872–78) and the *Nation* (1874–76), the organ of the "Canada First" group. A little later (1883–96) appeared the best of these periodicals, *The Week*, founded by Goldwin Smith.

The first editor of *The Week* was Charles G. D. Roberts who, with Bliss Carman, Archibald Lampman and Duncan Campbell Scott (*qq.v.*) wrote the best poetry composed in Canada before the 1920s. Of these, Roberts and Carman had much in common. They were first cousins, brought up in New Brunswick, educated at the same school and at the provincial university, steeped in the poetry of English romanticism and in the transcendentalism of their distant kinsman Ralph Waldo Emerson; and both were to spend many years outside Canada. Roberts is most memorable as a regional poet but he also expresses the nationalistic optimism of the end of the century. He is best in his *Songs of the Common Day* (1893) and similar poems where he renders the appearances of the rural scene in the St. John valley and by the wide tidal flats of Tantramar and gives to field and barn or to the lonely wood chopper at his work a representative human significance. His religious and philosophic poetry seems less authentic, a pale reflection of romantic pantheism and transcendentalism. In the case of Carman these romantic and transcendental feelings are pervasive in his regional description and the outlines of objects are often blurred by the soft haze of the poet's mood. At his best in this manner in a few stanzas or brief poems, he is very fine; more often his pseudo-Keatsian beauties and languors are oversentimental and cloying. Carman was a popular poet, even outside Canada, in part because he represented two thriving literary cults at the end of the 19th century, the cults of pagan aestheticism and of bohemian vagabondage, both having their North American temples in Greenwich Village, New York city. The other two poets of this so-called Confederation group, Lampman and Scott, were friends living in Ottawa as members of the civil service. Lampman learned to describe the countryside in the Ottawa region with affection and exact truthfulness; but the commercial and political life of the capital he regarded with distaste and foreboding. Both his poetry of natural description and of social comment are the expressions of a lonely and sensitive mind. Scott was also, in his way, an isolated and slightly austere figure but of a more vigorous cast of mind. Like the others he was a regionalist, but of the remote and vast northern wilderness where the Indian lived, a region and a people that Scott knew intimately during his long career in the department of Indian affairs. Scott's narrative and descriptive poetry is commonly a poetry of conflict of man against man or of the charged energies of nature against man, but the potentially realistic violence of the themes is subdued and often given suggestions of strangeness and fantasy.

During the years 1900–20 three of these poets were living and publishing, but the most characteristic writing of the period was more popular. This was the first age of the best seller; regional idylls and the tales of the frontier were popular types. The romances of Ralph Connor (*q.v.*) and the Yukon ballads of Robert W. Service (*q.v.*) sold by the millions. Tom MacInnes (1867–1951), who began as another rhymer of the gold rush, for 40 years chanted the joys of bohemian vagabondage, more plausibly than Carman, in ballade and villanelle. At the other extreme, Marjorie Pickthall (1883–1922), a much finer artist who also preferred exotic verse forms, combined religious feeling with end-of-the-century aestheticism in her beautiful but often cloying historical idylls. The comic-sentimental dialect poems of rural Quebec by William H. Drummond (*q.v.*), beginning with *The Habitant* (1897), and the feminine romances of Lucy M. Montgomery (1874–1942), author of *Anne of Green Gables* (1908) and numerous sequels, were very popular. The best book of the period, *Sunshine Sketches of a Little Town* (1912) by Stephen Leacock (*q.v.*), is predominantly a regional idyll, though the sentiment is laced with ironic satire and the author's affection for an Ontario town does not diminish his comic sense of the pettiness of its life. In the best of his other humorous volumes, in *Literary Lapses* (1910) and *Arcadian Adventures With the Idle Rich* (1914), beyond the fun and sheer nonsense one discerns the ambivalent attitude of the genial satirist.

Literature After 1920.—World War I had little immediate and direct influence on Canadian writing, but it fostered the growing nationalism and eventually an interest in Canadian cultural arts. The founding of the *Canadian Forum* (1920) which championed the painters of the Group of Seven, the little theatre movement and the new poets, and offered criticism of politics, society and the arts, was one sign of the times. The first of the new poets was E. J. Pratt (*q.v.*), who lived in Newfoundland until he was in his 20s and kept his connections with the island during his career as a professor of English in Toronto. Pratt's love of the sea, his fascinated interest in great sea monsters, his gusto and his impulse toward sheer fantasy are evident in *The Witches' Brew* (1925) and *The Titans* (1926). Later, most of his longer poems have been narratives of heroism: *The Titanic* (1935), *Brébeuf and His Brethren* (1940), *Behind the Log* (1947)—poems displaying exact historical and technical knowledge, a sense of the latent heroism in ordinary men and an Elizabethan delight in the vigour and splendour of words. Pratt is an isolated figure in poetry, without predecessors or followers, but his example of a complete break from the tradition of the Confederation poets was soon followed in the late 1920s and early 1930s by younger men, mostly influenced to some degree by T. S. Eliot. Five of them, with Pratt, in 1936 produced an important joint volume of verse, *New Provinces*, and all later published volumes of their own. A. J. M. Smith (1902–), the critic of the group, and Leo Kennedy (1907–) show most clearly the influence of Eliot; Robert Finch (1900–) owes more to Eliot's French masters; F. R. Scott (1899–) is most effective in brief poems of social satire; much of the special quality of Abraham Klein (1909–) derives from his being a learned, sensitive Jew, steeped in the religion and history of his people and writing in Canada's most cosmopolitan city, Montreal.

Among those who began to publish during the depression of the

1930s and World War II, economics and politics were predominant concerns. They include Earle Birney (1904–), Dorothy Livesay (1909–), P. K. Page (1917–) and Louis Dudek (1918–). Of these, Birney has the widest range: social comment and satire, war poetry (and a comic novel of the war, *Turvey*), narrative and regional description especially of British Columbia. For example, *Near False Creek Mouth* (1964) is a poet's record of travel in Latin America, the Orient and around the world with sympathetic observation of the life of common people everywhere, except Canadian tourists. Louis Dudek's first volume, *East of the City* (1946), set in the industrial landscape of his native Montreal, is occasionally Marxist in social comment on the scene and modern times, but more often lyrically expressive of joy in human relations and of beauty, even in the world of urban workers. When later, like Birney, he wrote of his travels abroad, as in *En México* (1958), social comment and the sense of beauty and joy retained about the same proportions. Irving Layton (1912–), also of Montreal, is more aggressively proletarian, naturalistic and egocentric, the castigator of puritanism and intellectualism which he evidently considers the bane of Canadian society and writing. The verbal exuberance of another Montreal poet, Patrick Anderson (1915–), reminds one of Dylan Thomas. James Reaney (1926–) is also a satirist, of small town life in southern Ontario, beneath the often complex literary and archetypal allusiveness of his poems. A rather similar preoccupation with symbol and myth, Blake and Jung, informs the poetry of Jay Macpherson (1931–).

Meanwhile, after the 1920s some able writers of prose fiction appeared, though the art of the novel was never cultivated in Canada as carefully as the art of poetry. The early novels of Frederick Philip Grove (*q.v.*), from *Settlers of the Marsh* (1925) to *Fruits of the Earth* (1933), are powerful and sombre studies of pioneering on the prairies, though marred by a rather stiff formality of style. Two previous volumes of western sketches, *Over Prairie Trails* (1922) and *The Turn of the Year* (1923), are the most perfect of his writings. From *Jalna* (1927) to *Morning at Jalna* (1960), Mazo de la Roche (*q.v.*) published 16 novels about the turbulent Whiteoak family—the most massive achievement in Canadian fiction. Writers of historical fiction include Frederick Niven (1878–1944), who attempted an ambitious trilogy on the settlement of the west, and Will R. Bird (1891–) and Thomas Raddall (1903–), who wrote of 18th-century Nova Scotia. Ethel Wilson (1890–), whose novels and stories are set chiefly in Vancouver and the adjoining countryside, writes with sensitivity and technical skill about the private world of emotion and conflict. Philip Child (1898–), who began with historical romance, turned later to contemporary realism of a clearly humanistic and humanitarian tendency, as in *Day of Wrath* (1945). Morley Callaghan (1903–) has been a humanitarian realist all his career, describing with compassion the lives of the misfits, the outcasts and the morally bewildered in urban society. W. O. Mitchell (1914–), in his short stories and novel *Who Has Seen the Wind* (1947), writes of small town life on the western prairies, with special sympathy for eccentric independents. Hugh MacLennan (1907–) was a realist of regional life in *Barometer Rising* (1941) and *Each Man's Son* (1951), stories of Nova Scotia society; more ambitiously, he attempted to be the interpreter of the Canadian national character in *Two Solitudes* (1945). Canadian mores, in small cities of southern Ontario, provide comic themes for Robertson Davies (1913–), the witty and versatile author of several plays, a fictional diary and collection of table talk, and satiric novels. In the best novel of Mordecai Richler (1931–), *The Apprenticeship of Duddy Kravitz* (1959), his juvenile antihero and his Jewish world of Montreal are compounded of the farcical, the realistic and the pathetic.

Two transient novelists who lived for a time in Canada are Malcolm Lowry (1909–57), who came from Mexico and spent 5 years, chiefly in British Columbia, where he wrote his extraordinary novel *Under the Volcano* (1947); and Brian Moore (1921–), who lived more briefly in Montreal, the setting of *The Luck of Ginger Coffey* (1960).

The situation of the creative writer in Canada was considerably changed in the second half of the 20th century by three circumstances. The establishment of the Canada Council in 1957 made possible the systematic distribution of public funds for the encouragement of literature and the arts. To a greater degree than formerly the universities became patrons in their several ways. Also there was a remarkable increase in the number of literary magazines and reviews, most of them short-lived, but others more hardy, for example, *Northern Review* (1945–55), *The Fiddlehead* (1945–), *The Tamarack Review* (1956–) and *Canadian Literature* (1959–).

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(J. R. MAC.)

CANADIAN LITERATURE (FRENCH). The cultural history of Canada has been conditioned by the country's dual origin, resulting in a certain tension between French and English components, and by a sensitivity in regard to the position Canada occupies in the company of France, Great Britain, and the United States. The psychological problem is more acute in French Canada, however, and a strong urge to hold to the past long remained a prominent feature of the French-Canadian outlook; in the second half of the 20th century, however, a burst of vitality has brought a sudden orientation toward the future. All these considerations are reflected in the thought and literature of French Canada.

History and Related Fields.—Reacting to the stinging accusation of 1839 that French Canadians were a people without history or literature, François X. Garneau (*q.v.*) laid the foundation for the later blossoming of both historical studies and creative literature. His *Histoire du Canada* (1845–48) reawakened a dormant pride of nation and inspired poets, novelists, and other historians of the day. His successors have presented points of view ranging from the strictest nationalism to the broadest liberalism. The most ambitious study is Robert Rumilly's *Histoire de la province de Québec,* begun in 1940 and reaching volume 36 in 1966.

Various aspects of French-Canadian society are examined in J. C. Falardeau's *Essais sur le Québec contemporain* (1953), Philippe Garigue's *Essais sur le Canada français* (1958), and Father P. Angers' *Problèmes de culture au Canada français* (1960). Among the many theologians and philosophers who have contributed to religious thought was Msgr. Louis Adolphe Paquet (1859–1942), who published a series of social and religious studies in the first two decades of the 20th century in which he developed the theme of *la mystique nationale,* the providential mission of the French in America. This theory cast strong reflections on regional literature earlier in the 20th century. Two comprehensive views of French Canada are found in I. F. Fraser, *The Spirit of French Canada* (1939), and Mason Wade, *The French Canadians, 1760–1967* (1968).

Poetry.—The first literary movement of French Canada, the Patriotic School of 1860, was inspired by F. X. Garneau and centred around Crémazie's bookshop in Quebec city. The authors of the day were imbued with a strong nationalism to which religious fervour, often sentimental in tone, was a natural adjunct. Literary inspiration was found principally in Victor Hugo and Alphonse de Lamartine. Later in the 19th century Baudelaire, the Parnassians, and the Symbolists gradually replaced romantic models, and literary activity was oriented more around Montreal. In the 1930s Surrealist influences began to predominate; after World War II the impact of existentialism was felt, and one has the impression that poets sensed and wrote with more independence than formerly. Young poets tended to form certain loose groups, such as the "Hexagone" in Montreal, which offered stimuli to their inspiration and outlets for their production. They are often animated by a resurgence of love of their country.

Joseph Octave Crémazie (*q.v.*) was the first important poet of French Canada. His "Chant du vieux soldat canadien," "Le

Drapeau de Carillon," "Les Morts," "Le Canada," were still popular poems early in the 20th century. Louis Fréchette (*q.v.*) won success with a collection of patriotic poems in the rhetorical style of Victor Hugo entitled *La Légende d'un peuple* (1887). Other followers of Crémazie who celebrated Canadian life, its picturesque customs, and religious faith are Pamphile Lemay (1837–1918), William Chapman (1850–1917), Alfred Garneau (1836–1904), and Nérée Beauchemin (1850–1931). These poets were precursors of the *Terroir*, or regionalist, school of Quebec, who recorded the humble aspects of French-Canadian life. Blanche Lamontagne, the best-known of the group, published *Par nos champs et nos rives* (1917), *La Vieille maison* (1920), and *Ma Gaspésie* (1928). Other poets of the *Terroir* school were Albert Ferland, Englebert Gallèze (pen name of Lionel Léveillé), and Alphonse Désilets.

In 1895 Jean Charbonneau and Paul de Martigny founded the Montreal Literary School. Canadian life, Canadian landscape, and patriotism no longer inspired these poets. Symbolists and aesthetes, they wished to live in the presence of beauty. Charbonneau's *Sur la borne pensive* (1952) invites his readers into a garden of delights where life is a spectacle of Persian lilacs, pergolas, fountains, and ruined temples. These poets liked to picture their souls as beautiful things, and Émile Nelligan (1879–1941) pictured his as a transparent ship sculptured in gold and laden with treasures, "Le Vaisseau d'or." Paul Morin (1889–1960) reflects his European experience in the exotic and Parnassian poems of *Le Paon d'émail* (1911) and *Poèmes de cendre et d'or* (1922). Louis Dantin (pen name of Eugène Seers), the critical conscience of the group, contributed *Le Coffret de Crusoé* (1932). Another writer of Parnassian sonnets is Alfred DesRochers, author of *L'Offrande aux vierges folles* (1928) and *À l'ombre de l'Orford* (1929). The gusty spirit of the north country found expression in his grand "Hymne au vent du nord." Clément Marchand, poet and critic, sang of town and country in *Soirs rouges* (1939).

In 1934 Robert Charbonneau, François Hertel (pen name of Rodolphe Dubé), and St. Denys Garneau founded an important literary journal called *La Relève*. Charbonneau (1911–) subsequently made a name for himself as a novelist and editor. For Garneau (1912–43), author of *Regards et jeux dans l'espace* (1937), poetry was a means of probing the despair within himself and touching the solitude of reality; the importance of his *Journal* was only realized in the 1960s. His intense feeling and suggestive technique have exerted a strong influence on many poets who follow him. Hertel (1905–), as noted in such titles as *Axe et parrallaxes* (1941) and *Strophes et catastrophes* (1943), is a humorous man with a double vision. Torn between sensuous delights and the consciousness of sin, Hertel is the poet of religious inquietude and metaphysical rebellion (*Mes naufrages* and *Jeux de mer et de soleil*, 1951). The full spectrum of his poetry is found in *Poèmes d'hier et d'aujourd'hui* (1967).

Alain Grandbois (1900–), world traveler and exquisite poet, has a masterful grasp of cosmic images. Constellations of silence, worlds vanishing, black eyes in a dark night, ghostly, insubstantial things on a swift black river, are some of the visions he conjured up in the poems of *Les Îles de la nuit* (1944). Art of the very first order continued to appear in his subsequent works, *Rivages de l'homme* (1948) and *L'Étoile pourpre* (1957), all subsequently re-edited in *Poèmes* (1963). Jean Guy Pilon (1930–) is the founder, with Gaston Miron, of the Hexagone group in Montreal (1954). In *Les Cloîtres de l'été* (1954) he clothes passion in a spiritual veil. *La Mouette et le large* (1960) presents the eternal themes: woman, life, and death. Roland Giguère (1929–), publisher as well as poet, has produced a score of titles in which Surrealist elements are evident; they are all represented in *L'Âge de la parole* (1965). Giguère stressed the vertiginous element in the suffering of existence in a style where erotic and political themes meet in the new context of contemporary Quebec.

Rina Lasnier (1915–), a Christian poet looking for perfection, was inspired by the women of the Old Testament who anticipated the perfection of the Immaculate Virgin (*Le Chant de la montée*, 1947). *Présence de l'absence* (1956) contains one of her best poems, "Malemer"; her latest collection is entitled *L'Arbre blanc* (1966). Anne Hébert (1916–) is one of the most impressive of the now middle generation of poets. A sure poetic progress is seen between her *Songes en équilibre* (1942) and *Poèmes* (1960) which is composed of "Le Tombeau des rois" (published separately in 1953) and "Mystère de la parole." The same inspiration is seen in her volumes of poetic prose, *Le Torrent* (1950) and *Les Chambres de bois* (1958). She belongs doubly to the lineage of St. Denys Garneau, by blood relationship and by the excellence of her frugal art.

From his early collection, *Le Vierge incendié* (1948), through *Arbres* (1960), to his later work, *Pour les âmes* (1964), Paul Marie Lapointe (1929–) deepened and affirmed his incantatory art to the point where he holds a place of honour even among the generation of poets that follows him. His younger namesake, Gatien Lapointe, haunted by the flight of time, has a filial attachment to the Canadian landscape (*Ode au Saint-Laurent*, 1963, and *Le Premier mot*, 1967). Yves Préfontaine reflects a similar intense feeling for the nordic expanse of the country, stretching in time for him from *Boréal* (1957) to *Pays sans parole* (1967).

A comprehensive view of French-Canadian poetry may be had by reference to a number of documents: Laure Rièse's anthology *L'Âme de la poésie canadienne-française* (1955), Guy Sylvestre's *Anthologie de la poésie canadienne d'expression française* (2nd ed., 1958), G. R. Roy's book, *Twelve Modern French Canadian Poets* (1958), the long-playing record *Voix de 8 poètes du Canada* (1958), Guy Robert, *Témoignages de 17 poètes* (1964), and Alain Bosquet, *Anthologie de la poésie canadienne* (1966).

The Novel.—The history of fiction follows a course parallel to that of poetry. Romantic in mid-19th century, it lapsed into a long period of regionalism in which authors tended to illustrate the theses of *la mystiqué nationale*, the sanctity of the land, and the virtue in remaining faithful to soil, language, race, and religion. The social novel developed later under naturalist influences, providing an authentic picture of urban French-Canadian society.

According to its author, P. A. de Gaspé, Jr. (1814–41), *Le Chercheur de trésor* (1837) is the first Canadian novel. It is a story of adventure and black magic. The best-known 19th-century novel is *Les Anciens Canadiens* (1863), the work of P. A. de Gaspé, Sr. (1786–1871; *q.v.*); it describes seigniorial life and the tragedy of divided loyalties caused by the conquest. *Charles Guérin* (1852) by P. J. O. Chauveau and *Jean Rivard* (1862) by Antoine Gérin-Lajoie (*q.v.*) depict pioneer life, intending to show that it is the duty of young Canadians to settle in Canada and not to emigrate to the industrial cities of New England. In this sense they anticipated *Maria Chapdelaine* (1916) by Louis Hémon (*q.v.*) and the novels of pioneering in which young people choose to carve out new homes in the northern Quebec wilderness. This theme is the mainspring of the "deserter" novels of writers like Claude Henri Grignon, author of the long-popular *Un Homme et son péché* (1933) and *Le Déserteur* (1934), where the habitant who sells his farm and moves to the city is called a deserter.

The feeling for the sacred earth takes the form of Franciscan mysticism in two of the works of Léo Paul Desrosiers (1896–1967), *Sources* (1942) and *L'Ampoule d'or* (1951). Msgr. F. A. Savard (1896–) finds inspiration for his novels of national energy in the logging industry (*Menaud, maître-draveur*, 1937) and in pioneering (*L'Abatis*, 1943); *Minuit* (1948) is an idyllic picture of life in a parish isolated from the cities.

Germaine Guèvremont (1900–68) dramatized the progressive decadence of a pioneer family in her novels of peasant life (*Le Survenant*, 1945, and *Marie-Didace*, 1947), knowing how to clothe the bitter facts in a charming veil of poetry without distorting them. Ringuet (pen name of Philippe Panneton, 1895–1960) brought a clinical talent into fictional art and in *Trente arpents* (1938) viewed the migration from the farm with disarming frankness. In *Fausse Monnaie* (1947) he photographed the frustration of an insignificant life in the city for one whose heart remained in the country. The inner void assumes tragic proportions in *Le Poids du jour* (1949), where the protagonist is crushed by his environment.

Works of historical fiction exploit the natural interest in past glories. *Les Habits rouges* (1923), by Robert de Roquebrune, revives memories of the Rebellion of 1837. The same author's *Testament de mon enfance* (1952) pictured a golden age, a deightful civilization which flowered in the 1890s. Léo Paul Desrosiers went back to the early days of the colony for *Les Opiniâtres* (1941), and to the fur trade of 1800 for *Les Engagés du Grand Portage* (1939). These works on historical themes contrast with his later style as found in *Sources*, *L'Ampoule d'or*, or *Vous qui passez* (3 vol., 1958–60).

Gabrielle Roy (1909–), who caught the humour of the polyglot situation in her native Manitoba (*La Petite poule d'eau*, 1950), went east and recorded her observations of life in a workng-class district of Montreal in a widely acclaimed novel, *Bonheur d'occasion* (1945). The purity of her objective art and her ironic treatment of wartime affluence gives her work a universal appeal. She continued her skilful revelation of the frustrating insignificance of modern city living in *Alexandre Chenevert* (1954) in which a humble cashier is burdened by the consciousness of his ellowman's sufferings. *Rue Deschambault* (1955) is autobiographical fiction. While Gabrielle Roy was portraying Montreal, Roger Lemelin (1919–) was depicting life in Quebec city. The hero of his three novels, *Au pied de la pente douce* (1944), *Les Plouffe* (1948), and *Pierre le Magnifique* (1952), chafes under he limitation of his modest place in a theocratic society, torn between a desire for grandeur and a paralyzing sense of impoence.

Yves Thériault (1915–), a prolific novelist, reaches beyond his own milieu for his subjects. *Aaron* (1954) is concerned with he strain on a Jewish family in a gentile world; *Agaguk* (1958) powerfully depicts an Eskimo family faced with the white man's code of law; *Ashini* (1960) gives a lyrical picture of the Indian way of life. Thériault has examined other social phenomena also, bigotry in *Les Vendeurs du temple* (1951) and alcoholism n *Cul-de-sac* (1961). In later novels he continued to seek new milieux and exploit erotic themes more fully. Gérard Bessette 1920–) is another keen observer of French-Canadian society; *La Bagarre* (1958) deals with antagonistic social forces in a big ity, *Les Pédagogues* (1961) reveals how education functions on he local scene, and *L'Incubation* (1965) presents whimsically the tragedy of contiguous human solitudes. Lemelin's humour is inged with cynicism, but it is not as boisterous as that of Thériault n *Les Vendeurs du temple*, or that of Jean Simard in *Hôtel de la Reine* (1949), not to mention the racy quality of Rodolphe Girard's *Marie Calumet* (1904).

Certain novelists, variously feeling the impact of Mauriac, Gide, Camus, or others more distant such as Stendhal or Dostoevski, probed the depths of the individual soul. Robert Charbonneau ocated his psychological studies in a small fictional town which also provides the name of his novel *Fontile* (1945). In it and n *Ils posséderont la terre* (1941) and *Les Désirs et les jours* (1948), souls wither away just when they should have been maturing. André Giroux (1916–) chose two extreme situations for his penetrating studies, a *crime passionnel* in *Au delà des visages* (1948), and a man near death from cancer in *Le Gouffre a toujours soif* (1953). Robert Elie (1915–) depicts at length the case f a manic-depressive who sees life revolving around him as in dream (*La Fin des songes*, 1950), and he examines an unmotivated murder in *Il suffit d'un jour* (1959). Perhaps the ultimate n the theme of despair is reached by André Langevin (1927–) n *Évadé de la nuit* (1951) and in *Poussière sur la ville* (1953), ne of the most artistic novels to come out of French Canada, nd far superior in style to his later work *Le Temps des hommes* (1956).

The novels of the 1960s were born in an atmosphere owing a ood deal to the insights gained from the introspective 1950s, ut a new anguish of cosmic dimensions, stimulated by political nd spiritual turmoil, transformed the genre. Representative ames include Réal Benoît, *Quelqu'un pour m'écouter* (1964); Hubert Aquin, *Prochain épisode* (1965) and *Trou de mémoire* (1966); Jacques Godbout, *Le Couteau sur la table* (1965) and *alut Galarneau* (1968); André Major, *Le Cabochon* (1964); Jacques Renaud, *Le Cassé* (1964). The last two present adolescents as cruel and tortured souls in a hostile world. This theme is exploited prolifically by the dozen short novels of Marie Claire Blais, from *La Belle bête* in 1959 to *Manuscrits de Pauline Archange* in 1968; the shock value of Miss Blais's poetic lucubrations is eclipsed by the greater literary merit of Réjean Ducharme treating the same theme in *L'Avalée des avalés* (1966) and *Le Nez qui voque* (1967).

Drama.—The theatre is the poor relation of French-Canadian literature. After Louis Fréchette's *Véronica* (1908) there was a long void. Excellent theatrical companies were nonetheless founded, "Les Compagnons du Saint-Laurent" (1937–52), "Le Théâtre du Nouveau Monde" (1951), "La Comédie Canadienne" (1956), "L'Egrégoire" (1959), to mention a few. Gratien Gélinas (1909–) won great popular acclaim as author and principal actor of *Tit-Coq* (1950) and *Bousille et les Justes* (1960). Eloi de Grandmont presented the deserter theme in the historical tragedy *Un Fils à tuer* (1950). Robert Elie offers in symbolist form the anguish felt in longing for lost purity (*L'Etrangère*, 1954). André Laurendeau (d. 1968) gave an example of psychological drama in *Deux femmes terribles* (1961). Paul Toupin's personal interpretation of the theatre, *Théâtre* (1961), finds its oblique explanation in his biographical *Souvenirs pour demain* (1960). Marcel Dubé (1930–) is sure of a wider audience with his accessible social themes in *Le Temps des lilas* (1958), *Un Simple soldat* (1958), *Florence* (1960), *Pauvre amour* (1968). Even more popular is the appeal of certain *romans fleuves* or "soap operas" appearing on radio or television; for example, C. H. Grignon's rural drama *Un Homme et son péché*, Roger Lemelin's chronicle of the Plouffe family in Quebec city, or Robert Choquette's vision of Madame Velder's Montreal boardinghouse which reached literary maturity when the novel *Élise Velder* was published in 1958. Radio and television have, indeed, offered much scope to poets and novelists in French Canada, but especially to dramatists, and quite a number are engaged in writing specifically for this medium. Examples of their art are found in the series *Écrits du Canada français* (1958–).

Criticism.—Literary criticism appeared in 1903 with the study of the poet Émile Nelligan by Louis Dantin. Msgr. Camille Roy (1870–1943), however, made one of the first systematic studies; among the many works he published the most important is his *Manuel d'histoire de la littérature canadienne* (1918; 10th ed., 1945). The over-all presentation was brought up to date by Rev. Samuel Baillargeon's textbook *Littérature canadienne-française* (1957), which, however, was almost immediately rendered obsolete by Gérard Tougas' *Histoire de la littérature canadienne-française* (1960; 2nd ed., revised, 1964). Available literary histories are often eclectic or sketchy, as are, for example, Berthelot Brunet's *Histoire de la littérature canadienne-française* (1946), Dostaler O'Leary's *Roman canadien-français* (1954), or the *Essais critiques* (1958) published by the Académie Canadienne-Française. The presentation is thorough, on the other hand, in Jeanne Paul-Crouzet's *Poésie au Canada* (1946), Jean Béraud's *350 ans de théâtre au Canada français* (1958), and Séraphin Marion's ten-volume study of the 19th century, *Les Lettres canadiennes d'autrefois* (1939–59).

The University of Toronto Quarterly has published an excellent annual review of French-Canadian letters since 1936. Adrien Thério provides a complementary source of information with his annual *Livres et auteurs canadiens* since 1961, and Paul Wyczynski has been publishing his scholarly *Archives des lettres canadiennes* since 1961.

Other important critics may be mentioned by name rather than by their various publications: Roger Duhamel, Guy Sylvestre, David Hayne, and Jean Ethier-Blais.

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CANADIAN RIVER. Rising in the mountains of northeastern New Mexico and flowing southward across Las Vegas plains, the Canadian river cuts a gorge nearly 1,500 ft. deep in the

Canadian escarpment before turning eastward. It continues its course through the Panhandle of Texas in a deep, narrow valley cut into reddish sandstones, the walls of which are known locally as "the breaks." Continuing eastward through Oklahoma, the Canadian joins the Arkansas at the western edge of the Boston mountains. During dry seasons, usually late summer and early fall, little or no flow exists, but spring snow melt or summer thunderstorms may raise the level to raging flood proportions. A crest of 24 ft. was recorded near Amarillo, Tex., in May 1914. Through most of its 906-mi. course, the Canadian is a braided stream with an interlacing system of channels.

The main tributary of the Canadian is the North Canadian with a drainage area of 14,290 sq.mi. It enters the Canadian below Eufaula, Okla. Its flow is partly controlled through Lake Overholser and Lake Hefner, storage reservoirs which supply domestic water for Oklahoma City. Other tributaries include Mora river and Ute creek (N.M.) and Mustang creek (Tex.).

Control works on the Canadian include Conchas dam and reservoir which irrigates about 33,000 ac. near Tucumcari, N.M. Above Conchas dam the Canadian irrigates about 57,000 ac. The total drainage area of the main Canadian is about 47,576 sq.mi.

"The breaks" and other deeply eroded indentations into the Llano Estacado (*q.v.*) and the high plains caused by the Canadian and its system occur in a semiarid climate where shrubs and low grasses predominate. Because of the rugged terrain and many deep box canyons, this area was a favourite hiding place for bandits and rustlers. The name may have come from early French traders and hunters from Canada who followed it west into Spanish territory. The southern route for early U.S. immigrants to California lay along the south bank to Santa Fe. (C. N. C.)

CANAKKALE, a town in Turkey and capital of an *il* (province) of the same name which includes the peninsula of Gallipoli and the island of Imroz (*qq.v.*), the ancient Troad and adjoining islands. Pop. (1965) 22,789. The town lies at the mouth of the Koca river (anc. Rhodius) and at the narrowest part of the Dardanelles (*q.v.*) strait which is there only one mile wide. The pottery trade, from which the town derived its name (*canak* means "pot" in Turkish), has declined, but the town has become one of the chief centres of the fish canning industry in Turkey. Because of its location, controlling the Dardanelles, it has always been of great importance strategically. The site of ancient Troy, near Hisarlik on the Aegean coast, is about 20 mi. S.W. from the town.

The *il* of Canakkale (area 3,759 sq.mi.) had a population of 350,317 at the 1965 census. Its eastern and southern parts are both mountainous and forested. Mt. Ida (Turkish Kaz Dagi) in the southeast reaches 5,797 ft. The climate is Mediterranean, with warm summers and relatively mild winters. Cereals, cheese and valonia are the chief products of the *il*.

(N. Tu.; S. Er.; E. Tu.)

CANAL: *see* Water Transport, Inland.

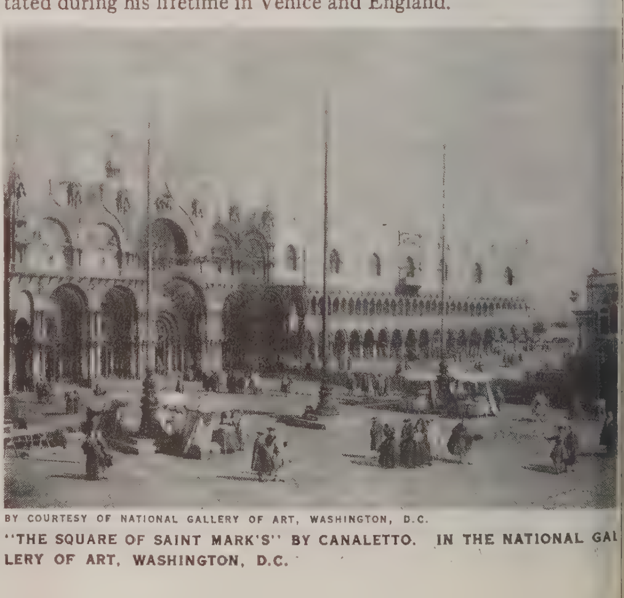
CANALEJAS Y MÉNDEZ, JOSÉ (1854–1912), Spanish statesman who was prime minister from 1910 to 1912, was born at El Ferrol on July 31, 1854. He graduated from Madrid university in 1872, took two doctorates the following year, and then worked for the railway company of which his father was a director. Beginning his political career in 1881, when he was elected to the *Cortes* for Soria, he gained rapid promotion: undersecretary in the prime minister's department in 1883, successively minister of public works and of justice in 1888, and minister of finance in 1894. Canalejas stood on the extreme left wing of the Spanish Liberal party and believed strongly in imposing restrictions upon the religious orders and in suppressing the latifundia. His ministry, which succeeded Segismundo Moret's government in Feb. 1910, undertook a great deal of social reform, but was especially concerned with three problems: Morocco, the religious orders and industrial unrest (*see* Spain: *History*). Canalejas displayed great energy in dealing with the series of strikes and civil and military disturbances which occurred during 1910–12, but his firmness meant forfeiting the support of the moderate republican left, and led to his assassination in Madrid on Nov. 12, 1912.

See José Francos Rodríguez, *La Vida de Canalejas* (1918); Duque de Canalejas, *Reflexiones sobre la vida de mi padre* (1928).

CANALETTO, the name commonly given to the Venetian painter and etcher Antonio Canal (1697–1768) and sometimes applied to Bernardo Bellotto (*q.v.*), his nephew and pupil.

Antonio Canal or Canale was born at Venice on Oct. 18, 1697 and received his early training there in the studio of his father Bernardo, a painter of theatrical scenery in the style of the Bibienas. About 1719 he abandoned this career and, probably at the suggestion of the view painter Luca Carlevaris, went to Rome where he came under the influence of the Dutch painters of classical ruins and perhaps of Giovanni Pannini. On his return in 172 he adopted a career of a painter of views of Venice for foreign visitors, a course in which his early training in architectural draftsmanship stood him in good stead. At first he may have collaborated with Carlevaris, but was already working independently by 1722 when he received his earliest commission from an Englishman. Thereafter English visitors to Venice were to play a predominating role among his patrons, many of his commission coming through Joseph Smith, merchant, art collector and later British consul at Venice, whose own magnificent collection o Canaletto's work was purchased for the British crown in 1763. In 1741–43 Canaletto painted a series of large views of Rome and may even have revisited the city. The outbreak of the War of the Austrian Succession perhaps deprived him of his English patrons and induced him to visit England in 1746. His scenes of London of the country houses of his patrons and of provincial cities brough him success as great as had his Venetian work, and except for tw short visits to Venice he resided in England more or less continuously until 1755. He was elected a member of the Venetia academy in 1763. He died in Venice on June 20, 1768.

Canaletto's early style is broad and impressionistic, but unde the pressure of prodigious success he adopted an increasingly lucid linear and firm manner suited to the demands of his clients fo accurate views of the city and more readily taught to assistants toward the end of his life, marked mannerisms tended to displace accurate observations of nature. Among his contemporaries h was renowned for his masterly use of the camera obscura in preparing his drawings. In addition to view painting he executed many *capricii* in which real buildings from different sites wer combined in an imaginary setting; he was a skilled draftsman an produced many drawings for engravers, his last important commission in 1763 being for drawings for a set of engravings of the principal ceremonial functions performed by the doge. Abou 1742 he executed a series of etchings of great brilliancy. They show the same command of luminosity and aerial perspective seen in his paintings. He etched 31 plates. Except for his nephew Bellotto the names of none of his many pupils are known. It i possible, however, that Francesco Guardi (*q.v.*) worked in Canaletto's studio briefly between 1755 and 1765. He was widely imitated during his lifetime in Venice and England.



BY COURTESY OF NATIONAL GALLERY OF ART, WASHINGTON, D.C.

"THE SQUARE OF SAINT MARK'S" BY CANALETTO. IN THE NATIONAL GALLERY OF ART, WASHINGTON, D.C.

See W. S. Constable, *Canaletto: Giovanni Antonio Canal, 1697–1768*, 2 vol. (1962) with full bibliography. (F. J. B. W.; X.)

CAÑAR, a province of highland Ecuador, bounded on the north by the provinces of Guayas and Chimborazo, east by Oriente, south and southwest by Azuay. Area 1,614 sq.mi.; pop. (1962) 112,733.

Cañar includes a part of the high cordillera, a part of the basin of Cuenca on the east and the valley of the Naranjal river on the northwest. The higher slopes of the mountains are used for the pasture of sheep. Around the capital, Azogues, the farms provide pasture for cattle and produce maize, wheat, barley, potatoes and fruit.

In the deeply cut valley of the Naranjal river there are plantations of sugar cane and coffee. There are small deposits of coal and ores of gold, silver, copper and mercury, none of much importance. Around Cuenca householders weave panama hats. (P. E. J.)

CANARIS, WILHELM (1887–1945), German admiral remembered for his ambiguous role as head of military intelligence under the Nazi regime, was born at Aplerbeck, in Westphalia, on Jan. 1, 1887, the son of an industrialist. He served at sea and in naval intelligence in Madrid during World War I. A member of the military tribunal that sentenced the murderers of Rosa Luxemburg in 1919, he is alleged to have assisted the subsequent escape of one of the condemned officers. In Jan. 1935 he was appointed head of the *Abwehr* (the military intelligence branch of the high command of the German armed forces). In this position he played an important part in organizing German aid to Spain during the civil war, but he had little sympathy for the Nazi regime, which he considered destructive of traditional conservative values and dangerous to Germany by its foreign ambitions.

Canaris participated in the resistance to Hitler from 1938 to 1944, but his exact role is difficult to determine. He enlisted some of the conspirators into the *Abwehr* (although it was his subordinate, Gen. Hans Oster, who sponsored them) and enabled them to work under its cover, but while he shielded and encouraged others he lacked enthusiasm for the cause or the power of decisive action. His task was made more difficult by the fact that the rival security office, the *Reichssicherheitshauptamt*, a department of the SS (*Schutzstaffel*) under Heinrich Himmler and Ernst Kaltenbrunner, sought to gain control over the *Abwehr* in order to extend the empire of the SS within the regime. He thus found himself carrying on genuine and active (though not always successful) intelligence work against the Allies; defending his own organization against his Nazi rivals; and at the same time shielding conspirators against the regime that employed him. Investigations by the SS into the *Abwehr* inevitably uncovered evidence of treason; but Himmler made no use of such knowledge when, in Feb. 1944, he persuaded Hitler to disband the *Abwehr*, on grounds of inefficiency, and to place it under his control. Canaris was transferred to the economic staff of the armed forces, where he remained until after the abortive plot of July 20, 1944, against Hitler. He was then arrested. He was executed at Flossenbürg concentration camp on April 9, 1945. (W. Kp.)

CANARY, a finch (*q.v.*) best known as the yellow cage bird, descended from the wild canary *Serinus canarius canarius* of the Canary Islands, the Azores and Madeira. The serin, *S. c. serinus*, of Europe is a close relative.

The wild canary is about five inches long and is a streaked, greenish-brown bird with conspicuous yellow on the head, breast and rump in the male. It lives in small flocks, has an undulating flight, perches in trees, hops on the ground and eats seeds. The birds live in pairs; the female builds a cup-shaped nest in a tree or bush and lays three to six pale blue, brownish spotted eggs.

As a cage bird, the canary was introduced into Europe in the 16th century and quickly became popular and much changed under domestication. The common household canary is clear yellow, green, cinnamon or mottled in colour. Among the fancy breeds are some with pure white, orange or spangled plumage. Others have crests or caps of long, flat feathers, or frilled or recurved plumage. There are breeds of large size, up to eight inches long; and those that, when excited, adopt grotesque poses with the neck held at a strange angle; and those like the rollers that are bred for the sweetness of their song.

JOHN MARKHAM

WILD CANARY (SERINUS CANARIUS CANARIUS)

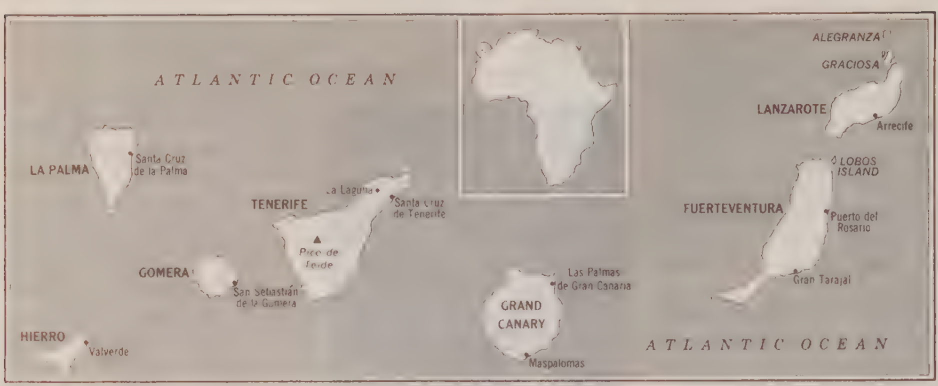
Canaries do well in cages that are about 12 in. in each dimension. They do not need space to fly, but need round perches to hop on for exercise. The bottom of the cage should be covered with clean sand that is changed frequently for cleanliness; the sand also supplies grit for the bird's gizzard. Canaries are hardy birds, but they need sunshine and fresh air, and protection against drafts and too-high temperatures. Canaries may catch cold if subjected to too much heat, for instance when they are placed too close to a radiator. Their food consists chiefly of small seeds, such as those of millet, rape, canary, poppy, etc.; these should be given in moderate amounts only, for overfeeding is the commonest cause of illness. They should be fed fresh green food such as chickweed or lettuce and the surplus removed before it wilts. Clean drinking water is essential, and also water in a shallow dish for frequent bathing. When the birds are molting, they are voiceless; at that time a diet supplement, or "voice restorer," is advisable. The supplement usually includes egg cake or zwieback, poppy and flaxseed, and cayenne pepper; the pepper intensifies the yellow of the growing feathers.

To breed canaries, a pair is placed together in a cage in early spring. The cage is about 15 in. high, 10 in. deep and 24 in. long; all sides are covered except for the wire front. Nest receptacles and soft materials for building the nest are provided, and supplementary "egg food" of grated hard-boiled egg and bread is given. The female builds, lays and incubates, being fed by the male during this time. The young hatch in 13 days, are fed by both parents, and leave the nest in about 3 weeks. About a week later they learn to feed themselves, and then are separated from the parents. The female may quickly start another family. The young are gradually changed to the adult diet. When the adults begin to molt in midsummer, they are separated until molting is concluded. (A. L. Rd.)

CANARY ISLANDS (Islas Canarias), a Spanish archipelago in the Atlantic Ocean, between 27°49′ and 29°27′ N and 13°20′ and 18°12′ W. The minimum distance from the northwest African mainland is 67 mi. (108 km.) between Fuerteventura and Cape Juby. Area about 2,896 sq.mi. (7,500 sq.km.).

Physical Geography.—Physically the Canaries fall into two groups. The western group includes Tenerife, Grand Canary, Palma, Gomera, and Ferro (*qq.v.;* Hierro), and consists of mountain peaks, isolated and rising directly from a deep ocean floor. The eastern group comprises Lanzarote (*q.v.*), Fuerteventura, and six islets, surmounting a single submarine plateau less than 4,500 ft. deep. After the researches of Christian Leopold von Buch (*q.v.*) in the early 19th century, the Canary Islands, which are geologically associated with Madeira and the Azores, became classical ground to the student of volcanism. They are merely cones of ejection, formed by volcanic eruptions during and after the Tertiary Age. The lavas consist chiefly of basalts and trachytes.

Climate.—The Canaries are situated most of the year within the northeast trade wind and at the eastern edge of a vast subtropical anticyclone. The trade wind blows strongly and steadily all the summer but in winter may be interrupted by winds from between southeast and west which occasionally bring hot dusty weather, and, very rarely, locusts, from the mainland. In winter the passage of shallow depressions causes most of the archipelago's scanty rainfall. The climate is warm and dry. On the lower parts, February, the coolest month, has a mean temperature of about 60° to 64° F and August, the hottest month, of 74° to 76° F ex-



REPRODUCED FROM "MADEIRA AND THE CANARY ISLANDS—A CONCISE GUIDE FOR THE VISITOR

CANARY ISLANDS, OFF COAST OF CAPE JUBY, AFRICA, SHOWING MAJOR TOWNS

cept in the eastern islands, which can be very hot. Sunshine is abundant at all seasons and rainfall, except on more exposed parts of some of the western islands, small and variable. The more populous districts have mean annual rainfalls of between 5 and 15 in., with about 50 to 60 rain days, but most of this falls in a few short, heavy storms in winter. The lower, eastern islands experience long periods of drought. Snow does not fall below about 3,000 ft. and is unusual below 5,000 ft. The Pico de Teide on Tenerife is often snow-clad above 8,000 ft. from December to March. This grand peak was the scene of a remarkable step in the progress of meteorology when in August 1856 Charles Piazzi Smyth made two ascents that demonstrated the layering of the atmosphere in trade-wind areas.

Animal Life.—There were probably no indigenous mammals on the Canaries at the time of their discovery by Europeans. The dog, swine, goat, and sheep found there by the Spaniards had probably been introduced by earlier invading peoples from Africa. The ferret, rabbit, cat, rat, mouse, and bat and various domestic animals have become naturalized. The ornithology is more interesting. About 220 species have been recorded, and of these 75 breed locally and more than 40 are peculiar to this archipelago. Notable native birds include a large blue chaffinch, the houbara bustard, the black oyster catcher, the black-breasted sand grouse, the Canary chat, the greenish-brown wild canary (*Serinus canarius canarius*), and the trumpeter bullfinch. There are no snakes but several species of lizard thrive.

Vegetation.—Of the 900 species of wild flowering plants found in the Canaries just over 300 are indigenous. The latter show strong affinities with the vegetation of the Mediterranean region and tropical East Africa and weak affinities with the vegetation of eastern Asia and the New World. The scanty rainfall and porous volcanic surfaces cause large tracts of the drier islands to be almost barren. Yet the xerophytic plant life is of great interest, especially the cactuslike *Euphorbia,* of which about 25 species occur, and the famous dragon tree (*Dracaena draco*). The considerable height of the western islands, all of which exceed 4,000 ft., allows a wide range of subtropical and temperate plants to flourish. The following scheme for Tenerife illustrates the general zonal arrangement of vegetation, wild and cultivated, with increase of altitude: (1) From sea level to about 1,300 ft. the climate resembles that of Egypt, and the characteristic plants of arid tracts are *Euphorbia* and *Sempervivum.* The better-watered or irrigated lands yield crops such as bananas, oranges, coffee, dates, sugarcane, and tobacco. (2) From 1,300 to about 2,400 ft. the climate resembles that of southern Italy, and the chief crops are wheat, barley, maize, potatoes, and grapes. Where the rainfall suffices trees such as laurel, fig, walnut, almond, and eucalyptus thrive. (3) Between 2,400 and 4,000 ft. is the main cloud layer and the climate becomes appreciably cooler except during southerly winds. Rather open formations and, in wetter places, quite dense stands of indigenous trees occur, including *Ardisia, Ilex, Rhamnus, Olea, Myrica,* and various species of laurel. (4) From 4,000 to just about 6,000 ft., athwart the normal upper edge of the cloud layer, the Canary pine (*Pinus canariensis*) is dominant; but tree heaths are fairly common and in some localities the *faya* (a beechlike shrub), Canary laurel, and juniper. (5) Above about 6,000 ft., or above the cloud layer, the tree growth is replaced first by a narrow belt where *escobón* (*Cytisus proliferus*) and the gorselike *codeso* (*Adenocarpus viscosus*) provide important fodder supplies, and then by a wide zone where the pumice-and-lava-strewn slopes are dotted with *retama,* a dark-green broom which bears white and pink flowers. (6) Above about 10,500 ft. snow lies for many months and vegetation is almost absent.

Population and Administration.—The Guanches (*q.v.*) who occupied the islands at the time of the Spanish invasion no longer exist as a separate race. The present inhabitants, or Canarios, are slightly darker than the people of Spain but otherwise are scarcely distinguishable from them. The men are of middle height, good physique, and strong. Spanish is the only language in use and Spanish customs are stoutly maintained. Since 1900, when 80% of the Canarios could neither read nor write, education has progressed rapidly. Good schools are numerous and there is a university (founded 1701) at La Laguna, Tenerife. The staple diet of many of the poorer people is composed of fish, potatoes, and *gofio,* which usually consists of maize or wheat roasted, salted, ground, and kneaded with water or milk. Pop. (1960) 944,448.

The archipelago of the Canary Islands formed a single Spanish metropolitan province until 1927, when rivalry between the two ports, Las Palmas de Gran Canaria (*q.v.*) and Santa Cruz de Tenerife, caused it to be divided into two provinces. To the province of Las Palmas were allocated Grand Canary (Gran Canaria), Fuerteventura, and Lanzarote, together with three inhabited islets (Alegranza, Graciosa, Lobos) and several uninhabited rocky islets. Santa Cruz de Tenerife Province comprises the islands of Tenerife, Palma, Gomera, and Hierro. Appropriate civil and military provincial officials reside in both capitals. In addition, each of the seven main islands of the archipelago has its own council (*cabildo insular*) under a deputy civil governor. Roman Catholicism is the official religion, and ecclesiastical law is the same as in other Spanish provinces. La Laguna and Las Palmas are episcopal sees in the archbishopric of Seville.

Area, Population, and Major Cities of the Chief Canary Islands

Island	Area (sq. mi.)	Population (1960)	Major city
Gran Canaria	592	400,837	Las Palmas
Lanzarote	307	34,818	Arrecife
Fuerteventura . . .	668	18,138	Puerto del Rosario
Tenerife	795	387,767	Santa Cruz
Palma.	281	67,141	Santa Cruz
Gomera	146	27,790	San Sebastián
Ferro Hierro . . .	107	7,957	Valverde
Total	2,896	944,448	

Economy.—Because of the mild temperatures and richness of the volcanic soils, agriculture in the Canaries is usually profitable and varied. Yet land values are extraordinarily high because the soil forms the only popular investment and relatively large areas are too dry, too rocky, too steep, or inaccessible for cultivation. Until 1853 wine, largely from vines grown on unwatered slopes, formed the staple product, and exports of it often exceeded £500,000 annually. In that year a grape disease caused by phylloxera (a plant louse) attacked the vineyards, and viticulture was soon largely replaced by cochineal production.

The cochineal insect, introduced in 1825, throve on a local cactus and yielded annual exports worth £750,000 by 1869. The boom imparted a lasting benefit to Canarian agriculture, as landowners undertook elaborate terracing and in places even broke up lava streams to expose the ancient soil buried beneath. The cochineal industry declined (because of competition from synthetic dyes) in the late 19th century in favour of the cultivation of sugarcane and later of bananas, tomatoes, potatoes, and various other vegetables and fruits. In the 1960s the banana, which occupied about 20,000 ac. (8,000 ha.) of the lower areas, was the main cash crop. Fishing, especially of tunny, hake, sardine, and mackerel, is important locally.

The Canaries lie athwart trade routes from Europe to South Africa and to Central and South America. The chief ports are Las Palmas de Gran Canaria and Santa Cruz de Tenerife (*q.v.*), which together are entered annually by about 8,000 vessels totaling 10,000,000 tons. The islands are interconnected by steamship services. The two capital cities are linked by airlines with Madrid and West Africa and maintain air services between each other and to the islands of Fuerteventura, Lanzarote, and Palma. The islands enjoy a popular reputation as a winter resort.

History.—The Romans learned of the Canaries through Juba, king of Mauretania, whose account of an expedition to the islands, made about 40 B.C., was preserved by Plutarch and the elder Pliny. The latter mentions "Canaria, so called from the multitude of dogs [*canes*] of great size." Ferro, then the most westerly place known, was chosen in about A.D. 150 by Ptolemy for the prime meridian of longitude, and until the late 18th century some navigators continued to reckon from this line. In 999 the Arabs landed and traded on Grand Canary. During the 13th and 14th centuries Genoese, Majorcan, Portuguese, and French navigators visited the islands. In 1402 Gadifer de la Salle and Jean de Béthencourt (*q.v.*) sailed from La Rochelle and soon occupied Lanzarote. Béthencourt went to Cadiz for reinforcements and returned in 1404 with the title of king, which he had secured from Henry III of Castile. Thereupon Gadifer, feeling slighted, departed. Béthencourt completed the conquest of Fuerteventura and Ferro and in December 1406 returned to Europe, leaving his nephew Maciot in charge of the islands.

Eight years of misrule followed before Queen Catherine of Castile intervened. Between 1420 and 1479 a force sent by Prince Henry of Portugal subdued Gomera. In 1479 the treaty of Alcáçovas recognized Spanish sovereignty. The bitter conquest of the three more populous islands then began. In 1483 the few hundred surviving Guanche warriors on Grand Canary surrendered; Palma was finally conquered in 1491 and Tenerife in 1496. The islands were used by Columbus and became an indispensable Spanish base on sea routes to America.

In 1833–34 the islands were linked by submarine cable to Europe and America. In 1936 Gen. Francisco Franco used the Canaries as the first base of the nationalist revolution, going from there to Spanish Morocco.

The tourist industry and the number of hotels grew rapidly in the 1960s. Each year more than 200,000 foreign visitors came by air and 330,000 by sea.

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(R. P. BE.)

CANASTA, a card game of the rummy (*q.v.*) family and itself the progenitor of a large group of games including notably samba, Bolivia, Cuban canasta, Italian canasta and others. The name canasta, which is the Spanish word for "basket," probably derives from the tray placed in the centre of the table to hold the undealt cards and discards. The basic form of canasta originated in Uruguay in the late 1940s, probably about 1947. By 1948 it was the most popular game in the fashionable clubs of Argentina and in 1949 it was introduced in the U.S., where it had a vogue comparable only to those of mah-jongg in 1923–24 and contract bridge in 1930–32. By the end of 1951 the number of canasta players in the U.S. and Canada was estimated at more than 30,000,000, and for the first time since 1931 contract bridge had dropped from first place among the most popular games. Between 1949 and the end of 1952 canasta accounted for the sale of more than 5,000,000 books and about $300,000,000 worth of playing cards, other equipment and accessories. Contract bridge soon regained first place among card games in the U.S. but canasta in its various forms continued to be much played. In Europe canasta never had more than moderate success.

The Game: Four-Hand Canasta.—This has usually been the most popular form of the game. The four players form two partnerships, partners facing each other across the table. A 108-card pack is used, two standard 52-card packs plus four jokers. All jokers and deuces are wild; *i.e.*, may represent any card. Eleven cards are dealt to each player, the undealt portion of the pack is placed on the table as the stock and the top card of the stock is turned up to start the discard pile. The player at the dealer's left has the first turn. Each player in turn must draw, may meld and must discard one card face up on the discard pile. The melds of partners are combined.

In drawing, a player may take the top card of the stock or—if he is able to use it immediately in a meld—the top card of the discard pile, in which case he takes also the entire discard pile. A meld consists of three or more cards of the same rank (sequences may not be melded), including at least two natural cards and not more than three wild cards. A meld of seven or more cards of the same rank is called a canasta and is a mixed canasta if it includes one or more wild cards and a natural or pure canasta if it contains no wild card. Having drawn and melded if he wishes, the player discards one card.

A player may add a card or cards to his side's previous meld of the same rank and a canasta may be completed in this way. The discard pile is said to be "frozen" for a side that has not melded and for both sides if it includes a red three or any wild card. When the discard pile is frozen, a player may take it only if he has in his hand a natural pair matching the top discard. The "official" laws of the game, made first (1950) by the Regency club of New York city and later (1951) revised by an international committee of U.S. and Argentine authorities, permit a player to take the discard pile for a new meld if he can match its top card with one natural card and one wild card, or to add the top discard to a previous meld; but players in both North and South America have generally disregarded this provision and demand a natural matching pair to take the discard pile at any time. It is customary also to rule that no card may be added to a completed canasta.

Each card has a value in points: 50 for a joker, 20 for a deuce or ace, 10 for a card from king to eight, and 5 for a card from seven to three. A side's first meld in each deal must have a value of 15 if the side's score at the beginning of the deal was minus; 50 if its score was less than 1,500; 90 if its score was at least 1,500; and 120 if its score was at least 3,000. When a side's score at the end of a hand is 5,000 or more, the game ends. The side with the higher score wins the game.

A hand ends when a player goes out (melds his last card). A player may not go out unless his side has completed at least one canasta. At the end of a hand, each side scores the point value of each card it has melded, plus 300 for each mixed canasta, plus 500 for each natural canasta, plus 100 for going out, less the point value of all unmelded cards in the partners' hands.

Three-spots have special values and functions. Each player, at his first turn, must remove from his hand any red threes and lay them face upon the table, drawing from the stock to restore his hand. Thereafter, when a player draws a red three, he must immediately face it and draw a replacement card from the stock. At the end of a hand a side scores 100 for each red three it has obtained (800 for all four of them), provided it has made any meld; if it has not melded, these scores are charged against it. A black three when discarded stops the next opponent from taking the discard pile. Black threes may be melded only in the turn in which one goes out.

The object of the game is to score points by making as many melds, especially canastas, as possible. It is losing play to meld one's cards too rapidly or to go out too soon.

Two-Hand Canasta.—Canasta for two players differs only slightly from the above. Fifteen cards are dealt to each player. A player draws two cards from the stock but discards only one. To go out, a player must complete two canastas.

Three-Pack Canasta.—For three or six players (the latter in two partnerships of three each, or three partnerships of two each), three regular packs plus six jokers are used and 15 cards are dealt to each player. Other rules are as in four-hand canasta.

Samba.—Three 52-card packs plus six jokers are used. A sequence of three or more cards in the same suit may be melded and a seven-card sequence, or samba, ranks as a canasta (for the purpose of going out) and scores a bonus of 1,500 points. The top discard may never be taken without a natural matching pair. No meld may contain more than two wild cards. In each turn a player draws two cards from the stock (unless he takes the discard pile) and discards only one card. The discard pile may never be taken to add its top card to a sequence, and no wild card may be melded with a sequence. Game is 10,000, and the initial meld requirement for a side with 7,000 or more is 150.

Bolivia.—Three or more wild cards may be melded, the same as natural cards, and a canasta of wild cards pays a bonus of 2,500. Game is 15,000. A black three left in the hand when a player goes out counts 100 against the holder.

Other Variations.—There are many other variations of canasta, most of them permitting the melding of sequences or wild cards and paying special bonuses for designated melds.

See Oswald Jacoby, *Complete Canasta* (1951); Ottilie Reilly, *Bolivia* (1954), *Brazilian Canasta* (1956). (O. Jy.; A. H. Md.)

CANBERRA, the national capital of the commonwealth of Australia, lies in the Australian Capital Territory (*q.v.*), 190 mi. S.W. of Sydney by road, 418 mi. N.E. of Melbourne, 760 mi. E. of Adelaide and about 70 mi. from the Pacific coast. Pop. (1966) 92,308.

Like Washington, D.C., and certain other federal cities, Canberra was deliberately chosen and planned as a capital, on a site formerly little occupied. The area was first entered by white men in 1820; it was reported as being "perfectly sound, well watered, with extensive meadows of rich land on either side of the rivers" and having plentiful building materials. A small permanent settlement was made, probably in 1824, when stockmen squatted at "Canberry," or "Canbury," as it was called, which gradually expanded; in 1845 part of the church of St. John the Baptist was completed and in 1863 a post office established. By the end of the century the district had taken on the characteristics of a "contented, rather conservative world of great stations and prosperous, hard-working farmers . . . where life had changed little since the days of the pioneer settlers." (L. F. Fitzhardinge in *Canberra, a Nation's Capital*, ed. by H. L. White, Angus & Robertson, Sydney, N.S.W., 1954.)

As the demand for federation grew, suggestions were invited in 1899 for a site for the national capital. The commonwealth of Australia was inaugurated in 1901 and the Commonwealth Constitution act of 1900 provided for the establishment of a capital in the state of New South Wales, but not within 100 mi. of Sydney. After two royal commissions and much public debate, the commonwealth parliament in 1908 selected the Yass-Canberra district and in the following year the site for the new city was determined. On Jan. 1, 1911, an area of approximately 900 sq.mi. was transferred from New South Wales to the commonwealth, which then launched a world-wide competition for a design for the capital. The first prize was awarded to Walter B. Griffin (1876–1937) of Chicago, Ill. Construction was begun in 1913 but was delayed by World War I; from 1915 to 1920 Griffin was in charge of constructional work on the city.

After the war work was accelerated by the Federal Capital commission which assumed control over all constructional and administrative activities in the territory on Jan. 1, 1925. On May 9, 1927, the duke of York (later King George VI) opened the new parliament house and the transfer began of the central staffs of the administrative departments from Melbourne (hitherto the temporary seat of government of the commonwealth). Attractive houses, schools and other buildings for this garden city were built in the suburbs. In 1930 the Canberra University college was opened and in 1936 a wing of the National library. The depression and World War II curtailed progress, but the Australian war memorial and the patent office were opened in 1941 and an extensive new hospital in 1943. After World War II a great surge in the development of Canberra took place. More than 8,000 houses and flats were built, as well as administrative offices, extensive buildings for the Australian National university (founded in 1946), shops, schools and community facilities.

A resumption of transfers of central staffs from Melbourne began in 1959 with the movement of several hundred officers of the defense group. Further transfers were planned, with the object of making Canberra the headquarters of the whole commonwealth public service. This objective became the task of the National Capital Development commission, set up in 1958. Proposals of its five-year planning report were endorsed by the government; these included the erection of offices for the whole defense group and the construction of a system of ornamental lakes across the centre of the city. This feature, an important element of Griffin's plan, was aimed at unifying the city in a striking fashion.

Canberra has also developed as a centre of learning and research. In addition to the university, which provides for undergraduate studies as well as four schools devoted solely to postgraduate research in the fields of medical science, Pacific studies, physical and social sciences, there are such institutions as the Forestry and Timber bureau, Australian Institute of Anatomy, Mount Stromlo observatory, Bureau of Agricultural Economics, National library, and several establishments of the Commonwealth Scientific and Industrial Research organization.

A short branch line links Canberra with the New South Wales railway system at Queanbeyan, eight miles distant. Road transport accounts for an important proportion of the inward movement of goods. Daily air services link the city with Sydney and Melbourne and through them with the other state capitals.

CANCELLI, in architecture, screens or parapets, similar to those used by the Romans to divide off the judges' space in a basilica. From their resemblance to such Roman screens the enclosures of the choir and chancel of a church are also known as cancelli. *See* Basilica; Chancel; Choir.

CANCER ("The Crab"), in astronomy, the fourth sign of the zodiac, denoted by the symbol ♋. The constellation contains a large loose cluster of stars known as Praesepe, or the Beehive *See* Constellation.

CANCER, an abnormal and unrestrained new growth in cells and tissues that produces deleterious and often fatal effects. The basic cause of cancer is unknown. Cancer occurs in many different plants and animals, but this article deals primarily with cancer in man. Cells and tissues are said to be cancerous when for no known reason, they grow more rapidly than normal, assume abnormal shapes and sizes and cease functioning in a normal manner. The ultimate involvement of a vital organ by cancer, either primary or metastatic, may lead to the death of the patient Cancer, in contrast to benign neoplasms (tumours), tends to spread into contiguous tissues and also to metastasize. In metastasis, cancerous cells break off from the original lesion and are carried in the blood or lymph systems to distant part of the body where they set up new lesions. Cancer is said to be malignant because of its tendency to cause death if not treated Benign tumours usually do not cause death, although they may i they interfere with a normal body function by virtue of their location or size. (*See* Tumour: *True Tumours.*)

In general, cancer cells divide at a higher rate than do normal cells, but this is not always true; for example, in the organization of the callus in a fractured bone and in the relining of the uteru by endometrium after menstruation the normal cells divide at a higher rate than do cancer cells. It is true, also, that some malignant tumours have intermittent growth and latent periods The distinction between the growth of cancerous and normal tissues is not so much the rapidity of cell division in the former a it is the partial or complete loss of growth restraint in cancer cell and their failure to differentiate into a useful, limited tissue of th type that characterizes the functional equilibrium of growth normal tissue.

Cancer may not be so autonomous as once believed. The lesions probably are influenced by the host's susceptibility and immunity. Certain cancers of the breast and prostate, for example, are considered dependent on specific hormones for their existence; other cancers are dependent on the presence of specific viruses.

GENERAL

Classification.—There are two types of cancer according to the simplest method of classification—that of calling the cancer a carcinoma or sarcoma depending on whether the cancer originated in epithelial or nonepithelial tissue. The latter term refers chiefly to the structural framework of the body, including muscle, fat, connective tissue, bone cartilage, tendon, etc. It follows, therefore, that as many varieties of cancer exist as there are organs and tissues within the body. Each type and subtype of cancer has its own histological appearance and can be identified by microscopic study; the behaviour or natural history of each type has been well determined so that the pathologist can predict the manner of its growth.

Cancers also may be classified according to the stage of the disease; for example: (1) early, or localized, when still confined to the tissue of origin (frequently curable); (2) metastatic, or spread to regional lymph nodes, or invading contiguous structures (sometimes curable); (3) widely disseminated throughout the body (usually incurable).

Cancers also can be classified into one of four grades on the basis of their degree of malignancy, as determined by microscopic examination. Grade one cancers (barely malignant) tend to differentiate toward and resemble the cells of the tissue of origin, whereas grade four cancers (highly malignant) are composed of cells extremely active in cell division. The other two grades represent intermediate degrees of differentiation and reproduction. It follows that grade four cancers as a rule grow more rapidly, metastasize earlier and more widely, pursue a more rapid course and have a lower rate of curability than the other three grades.

Prefixes are generally added to the basic designations of carcinoma and sarcoma to indicate the tissue of origin. Thus a sarcoma originating in bone and tending to reproduce osseous tissue is called osteogenic sarcoma; other examples of the use of prefixes include: liposarcoma primary in fat, rhabdomyosarcoma primary in skeletal muscle, fibrosarcoma primary in fibrous or connective tissue and synovial sarcoma primary in the synovial linings of bursa and joint. The word "primary" indicates the cancer originated in the tissue rather than having been established as a secondary site through metastasis from another lesion. The prefix "adeno-" connotes the persistence of ductal or glandular elements in the epithelial tumour, as in thyroid adenocarcinoma, gastric adenocarcinoma and uterine adenocarcinoma. Cancers of the pavement cell epithelium of the skin and of certain mucous membranes, such as cancers in the tongue, lip, larynx, urinary bladder, uterine cervix or penis, may be termed epidermoid or squamous cell carcinomas.

Distribution and Occurrence.—Cancer is widespread throughout the vegetable and animal kingdoms. Plant cancers occur in clover, sunflowers and other common plants. Malignant neoplasms in animals include cancer of the breast in dogs, melanoma of the anus in gray horses and epithelioma of the eyelids in cattle. Cancer occurs with great frequency in mice, and these rodents are used extensively for experimentation with transplantable cancer.

It is difficult to evaluate the relative influence, if any, of racial predisposition and environmental factors on the variation in racial distribution of human cancer. Cancers of the nasopharynx are notoriously frequent in the Chinese. Cancer of the liver occurs many times more frequently in Malay groups and west African Bantu than in Caucasian peoples. Kaposi's hemorrhagic sarcoma of the skin occurs almost exclusively in Chinese, Jews and Bantu peoples in the Mediterranean basin. Cancer of the breast is seldom seen in women who nurse their children. Malignant melanoma (black cancer of the skin), which develops from pre-existing moles, only rarely occurs in Negroes. Cancer of the stomach develops twice as frequently in the Japanese and Icelanders as in other peoples and occurs on an average of ten years earlier in Japanese and Negroes than in Caucasian people. Cancer of the uterine cervix is extremely rare in Jewish women. Cancer of the penis is infrequent in peoples who practise circumcision in childhood.

Until the 1950s it had been commonly assumed that the preponderance of certain cancers among specific peoples was due to racial transmission, implying a genetic background. Epidemiological surveys, however, have revealed extrinsic causes instead; for example, the frequency of stomach cancer in Iceland may be due to cancer-inducing hydrocarbons in the smoke that Icelanders employ to cure fish and meats. The cancer of the liver so common among the Bantu may be partly attributable to their severe nutritional deficiencies; the incidence of the disease drops sharply when the Bantu start eating nutritionally adequate diets.

Cancer occurs at a slightly greater frequency in women than in men because of the great susceptibility of the uterus and functional breast to this disease. Incidence differences between the sexes for certain cancers of the regional types cannot be explained. For example, 60% of the cases of cancer of the stomach occur in males. Kaposi's hemorrhagic sarcoma of the skin of the extremities occurs almost exclusively in males; cancers in the mucous membrane lining of the mouth, pharynx and larynx occur three to eight times more frequently in males than in females.

Cancer occurs at different rates in different age groups. In general it is pre-eminently a disease of middle and old age but it may occur in any age group. Certain varieties, such as glioma of the eye, embryonal adenosarcoma of the kidney and neuroblastoma, are found more frequently in children than in any other age group, although children in the 5–14 age group have greater freedom from malignant tumours than any other age group. Cancer of the testicle, commonly known as teratoma, is a disease of young males, usually those under 30 years of age. Malignant tumours of epithelial structure are uncommon in adults under the age of 30, extremely rare in patients under 20 but increase in frequency after 30. Carcinomas of the breast and uterus have their greatest incidence in women between the ages of 45 to 65 and decrease in relative frequency after 65. Exceptions to the rule of unequal age distribution are connective tissue sarcomas, which occur at the same rate in all decades of life.

Effect of Heredity.—It has been possible through selective breeding, particularly inbreeding, to develop strains of mice in which cancer of different histological and regional types appear consistently in each generation. In humans, similar genetic tendencies are usually dissipated through marriage; a child may inherit the type of skin or the type of breast in which cancer is most prone to occur rather than inheriting the disease itself.

As a rule, two factors must be present for human cancer to develop: (1) the genetic background or susceptibility, which is not the same for every variety of cancer; and (2) an inciting or causal factor that precipitates the onset of the cancer in the predisposed tissue. Occasionally, through chance breeding in which the genetic factors are magnified, the hereditary tendency becomes manifest. For example, mothers, daughters and granddaughters in certain families acquire cancer of the breast, while in other families cancer of the stomach is a common ailment. This familial distribution has occurred too frequently to be considered coincidental. This conclusion has been supported by reports of cancers of similar type and regional distribution in identical twins.

Certain benign tumours are inherited, such as tumours of peripheral nerves, cartilaginous tumours (enchondromas), pigmented moles of the skin and polyps of the colon; some of these may eventually become malignant. Glioma of the eye in childhood is definitely inherited. Xeroderma pigmentosum is an inherited skin condition in which all protective resistance to the irritating action of actinic rays is lacking. For some unexplained reason, in this disease those portions of the skin exposed to sunlight, notably that on the hands and face, inevitably develop multiple lethal cancers; the only way for people with this condition to avoid cancer is to avoid sunlight or other radiation that includes rays beyond the violet end of the spectrum.

A genetic transmission theory based on the study of cancers in laboratory animals (mice, rabbits, fowls) gained credence in the early 1960s; this theory contended that the supposed heredity factor of cancer is not transmitted by the genes but by a parasitic virus present in the intracellular material of the egg or sperm that unite to begin the formation of the new individual.

Relation of Trauma to Cancer.—The origin of a cancer lesion can seldom be attributed to a single blow or trauma, even though this possible origin is a controversial medicolegal subject. In view of the thousands of serious injuries that occur in both war and peacetime and the rarity with which cancer follows such injuries, it is illogical to assume that a single trauma plays an important role in causing cancer. Before a single injury is accepted as the immediate cause of cancer, certain postulates should be fulfilled, namely, definite evidence of the injury, identical sites of the injury and the cancer that develops later, a logical time interval between the date of injury and the appearance of the cancer, the absence of a pre-existing tumour at the site and, finally, a type of malignant tumour consistent with this mode of origin, such as a sarcoma of the structural framework; *e.g.*, fibrosarcoma of connective tissue, liposarcoma and malignant synovioma arising from tendon sheaths. An injury such as an extensive laceration or burn may result in a scar that in future years becomes cancerous. But the mechanism of the genesis of cancer under these circumstances is different from its reputed onset immediately following a single injury.

Trauma does play a part in the development of some cancers of stratified epithelium in the skin or mucous membranes of the oral cavity and esophagus. But here the injury consists of a repetition of small traumas in the form of a chronic irritation, sometimes occurring daily for many years. Common examples are irritation of the tongue or mucosa of the cheek by ill-fitting dental plates, pressure of hot pipestems on the lip and daily irritation of the esophagus from swallowing hot soups or other liquids. A classic example of cancer that arises from chronic irritation is that which occurs in the cheeks of Hindus who are addicted to chewing a mixture of areca nut, betel nut and lime.

Occupational Cancers.—Occupational cancers can be definitely traced to the patient's external environment. In the early 1960s many inorganic and organic compounds had been recognized as carcinogenic agents, *i.e.*, capable of causing cancers. The amount of an agent required to produce cancer may be so minute that it causes no apparent irritation at the time of exposure; but continued exposure gradually produces tissue changes that ultimately become cancerous. The precancerous change may be so permanent that a malignant tumour will develop many years after an occupation has been abandoned.

Examples of workers in whom cancer may develop if their occupational environment is not controlled properly include the following: roentgenologists and X-ray technicians; dentists who use X-rays without shielding themselves completely; orthopedic surgeons who overuse fluoroscopy for setting fractures; radium technicians. All of these persons, as a result of chronic overexposure to radiant energy, may develop radiation dermatitis and ultimately X-ray or radium cancer. Workers in the dyestuffs industry who are exposed to aniline, benzidine or beta-naphthylamine may later develop papillomas and even cancers of the urinary bladder; cancers of the respiratory tract occur in workers who inhale chrome salts, asbestos dust and nickel carbonyl. Leukemia, a malignant tumour of the tissues that form white blood cells, sometimes develops in workers who have been exposed to benzene. Workers exposed to coal tar, crude mineral oils, crude paraffins, pitch and arsenical compounds may develop multiple cancers of the skin, chiefly of the hands, arms and scrotum. Workers who prior to the mid-1920s painted radium numerals on watches and ingested the radioactive substance by moistening the brush tip on their tongues later developed bone sarcoma; this and similar hazardous practices were halted after the danger was discovered. (*See* CARCINOGENIC CHEMICALS.)

Precancerous Conditions.—Certain diseases have been recognized as potentially dangerous because they occasionally are followed by cancer. Malignant tumours do not develop inevitably but occur with such frequency that the term precancerous has been applied to these conditions.

An example is the presence of gallstones; the incidence of cancer in gall bladders is approximately 5% of the general population. But 98% of the persons who develop cancer of the gall bladder have or have had gallstones, which is a strong indication that the chronic irritation of the stones is a causative factor of the cancer.

Leukoplakia, another example, is a disease in which thick, white patches appear on the mucous membrane of the tongue, lip, cheek, floor of the mouth, palate, tonsil or other mucosa-lined organs such as the male and the female genitals and the esophagus. Cancer of the type known as epidermoid or squamous cell carcinoma develops with some frequency in these locations, probably because of pre-existing leukoplakia.

Syphilis of the tongue sometimes predisposes to the development of lingual cancer; in fact, 25% of all patients who have cancer within the oral cavity have had syphilis, which is a higher incidence by far than in the general population.

The neck of the womb (cervix uteri) may subsequently become cancerous if badly scarred, eroded or chronically infected, as sometimes occurs sequential to childbirth.

Certain benign tumours are precancerous in varying percentages; examples are benign adenomas of the thyroid gland, polyps of the colon, papillomas of the urinary bladder and the common pigmented mole of the skin.

Radiation dermatitis caused by overexposure of the skin to X-rays, as when improper dosages are used to treat acne or excess hair on the face, also may be precancerous.

Keratoses, which are warty overgrowths of the skin occurring in elderly persons or persons with oily skin, may degenerate over joints so that scar cancers develop. The scarred skin lacks the oil glands and elastic tissue that normally protect the skin against irritation. The early grafting of new skin in burns lessens the incidence of scar cancers later. Certain types of mastitis, when accompanied by overgrowth of the ductal elements, may, under certain conditions, become cancerous.

Incidence.—Statistics on the incidence of cancer by countries must be based on the number of cancer deaths recorded, inasmuch as there is no national census of the number of cases or the number of cures. The significance attached to any figures must take into account the age composition of the population of each country, since cancer is predominantly a disease of middle and old age. According to the U.S. Department of Health, Education, and Welfare, cancer deaths in the United States in 1963, in both sexes and all sites, totaled 285,362, including: digestive organs 92,914; female breast, 25,139; respiratory tract (male), 39,817; genital organs (male) 16,409, (female) 23,574; urinary organs, 13,582. This was 16.3% of all causes of death in the U.S., being exceeded only by heart disease (*Vital Statistics*, 1965). Statistics compiled by the American Cancer Society showed the cancer death rates per 100,000 population in representative countries in 1962–63 to be as follows: Austria, males 190, females 130; Denmark, males 163, females 140; England and Wales, males 178, females 113; Finland, males 188, females 106; West Germany, males 168, females 127; Italy, males 143, females 100; Japan, males 137, females 95; Scotland, males 199, females 126; Sweden, males 131, females 108; U.S., males 138, females 103.

The American Cancer Society estimated annual deaths in the U.S. in the late 1960s as follows: males, total 177,500; stomach 9,800; colon 16,300; pancreas 10,400; lung 49,400; prostate 16,900; females, total 147,500; stomach 6,500; colon 18,800; pancreas 7,700; lung 9,800; breast 29,200; uterine cervix 9,700; in both sexes, leukemia 14,600; lymphomas 17,350. Uterine cancer, formerly the chief cause of cancer death in women, had declined 50% in a generation. Deaths from lung cancer in men had increased more than 15 times in 35 years and were mounting, though less so, in women. The mortality rate for cancer of the breast, a leading cause of cancer death in women, remained unchanged as it had for many years.

IDENTIFICATION OF CANCER

Diagnosis.—At least 50% of all cancers are visible on inspection or can be reached for palpation by an examining finger; at least 25% more can be seen with special examining instruments that are inserted within the orifices of the body.

The first of three steps in diagnosis is a careful elicitation of the history of the patient's complaints relating to abnormalities in the functioning of a specific organ. The symptom complex elaborated by most cancers is sufficiently characteristic to arouse the physician's suspicion when recited by the patient.

The second step is a careful physical examination that leads in most cases to the discovery of the malignant tumour and a recognition of its extent and character. By using special hollow instruments that are electrically illuminated and equipped with magnifying lenses, the examining physician is able to inspect the interior of such organs as the larynx, lungs, esophagus, stomach, lower colon, rectum and urinary bladder. This procedure is referred to generally as endoscopy and specifically, as they relate to the organs just listed, as laryngoscopy, bronchoscopy, esophagoscopy, gastroscopy, proctoscopy and cystoscopy. X-ray study, with or without the utilization of contrasting media, is important in the diagnosis of cancers within the nasal sinuses, lungs, esophagus, stomach, colon, intestines, kidneys, bladder, bone and brain. Chemical tests for cancer were generally discarded soon after being proposed, but a few for special types of cancers are valid, such as those for an increased acid phosphatase content of the blood in patients with cancer of the prostate and a quantitative increase of albumoses in the blood and urine of patients with myeloma of the bone.

The final step in establishing the diagnosis is the biopsy, in which a portion of the suspected cancerous tissue is removed for microscopic study and identification. The microscopic characteristics of various cancers are so definite and well known that this method serves as an accurate check on the diagnosis and usually enables the examiner to identify the tissue or organ of origin. Specimens for biopsy are removed by forceps or electric snare, or a plug of tissue is obtained by syringe aspiration, or cells may be obtained from body fluids, such as uterine, vaginal, gastric, bronchial or urinary secretions.

Symptoms and Course of Certain Common Cancers.—*Cancer of the skin* may appear as a progressively enlarging ulcer with hard, elevated margins and no tendency to heal spontaneously. Pain is conspicuously absent in many cases until the disease becomes advanced. It appears in other forms as a horny overgrowth of skin or as a fissure that degenerates in a scar. Between 75% and 95% of the cases can be cured. Half of the cases of malignant melanoma develop from pre-existing pigmented moles and the other half from apparently intact skin. It is the most malignant of all accessible cancers and soon metastasizes through both lymphatic and blood vessels to lymph nodes and internal organs. The cure rate is seldom higher than 70% of cases treated, depending on the presence or absence of metastases.

Oral Cavity.—Cancers of the lower lip develop as fissures, elevated plaques of keratosis or hard ulcers situated on the vermilion border, usually of the lower lip. At least 90% of these cancers are cured if treated before metastases develop.

Cancer of the tongue appears as a fissure, chronic ulcer or indurated segment of the tongue, commonly on the lateral or posterior margins. It is one of the few cancers that is painful in its early stages and consequently is recognized early because of its tenderness and interference with the mobility of the tongue. Extension of the cancer to the lymph nodes in the neck occurs relatively early because of the high grade of malignancy of this type of cancer and the rich lymph drainage of the tongue. The cure rate is seldom above 22% to 30% of patients treated.

Cancer of the larynx may be detected early by an investigation of persistent hoarseness or changes in the voice. The development of stridor (difficult breathing) is an indication of an advanced stage of the disease. The prognosis of cancer of the larynx is good following radiological treatment or surgical removal of the larynx.

Cancer of the thyroid gland requires surgical removal of the gland and of the lymph nodes on the same side of the neck as the cancerous lesion. All nodular goitres, as distinguished from smooth enlargements and those associated with the toxic symptoms of hyperthyroidism, require immediate surgical removal because these nodules, even though painless, inconspicuous and without symptoms, are found on subsequent microscopic study to be cancerous in 8% to 20% of cases.

Cancer of the neck is usually secondary to a primary cancer in the mouth, pharynx, larynx, hypopharynx, chest or abdomen; less frequently, the primary site is within the structures of the neck. The appearance of a lump in the neck, if the thyroid gland is excluded from consideration, should arouse suspicion of a possible undetected and asymptomatic cancer within the mouth or adjacent structures, and it calls for careful investigation to discover the site of origin. When found, it requires treatment of the primary cancer and of the metastatic cancer within the cervical lymph nodes by radical surgical excision with or without irradiation by X-rays and radium.

Cancer of the lung was apparently increasing in frequency in the mid-1960s, partly because of improvements in diagnosis and partly because of an increment in occurrence of the disease. Its presence is heralded by the onset of a cough that persists and may not be productive until later when expectoration of blood occurs. Its true character can be identified by X-ray study supplemented by bronchoscopic visualization and biopsy. The removal of the entire lung with dissection of those lymph nodes in the mediastinum that drain the lung offers opportunities for cure that formerly did not exist.

Cancer of the esophagus causes progressively increasing difficulty in swallowing, chiefly of coarse or solid foods. The patient voluntarily ingests a diet that is soft and liquid; diagnosis can be established by X-ray study, esophagoscopy and biopsy. The esophagus may be removed partially or completely; it can be replaced partially or completely by a joining together (anastomosis) in the chest of the remaining sections or by elevating the stomach and joining a remaining section to it or by interposing a section of colon between the remnants of the esophagus at the base of the neck.

Cancers of the stomach develop insidiously and are difficult to diagnose because of the absence of specific symptoms. Gradual onset of indigestion in a person of previously good health with symptoms occasionally suggesting peptic ulcer, associated with an unexplained loss of weight, anemia, loss of appetite and, in the advanced stages, vomiting and the presence of a mass that can be felt in the abdomen, are common diagnostic features of the disease. The diagnosis is confirmed by X-ray study and gastroscopic visualization. Because of improved, more radical surgical technique, 60% of cancers of the stomach became resectable and of this group 35% of the patients were cured.

Cancers of the pancreas are seldom diagnosed early because of the absence of localized signs and symptoms. A radical operation was designed for successful treatment, but the end results were bad because of the delayed diagnosis. The presence of unexplained deep abdominal pain with backache, occasional diarrhea and later development of jaundice with the absence of gallstones are suspicious symptoms that indicate the possible presence of this disease.

Cancers of the rectum often are erroneously diagnosed as hemorrhoids in the early stages because of the frequent first symptom of repeated small hemorrhages with bowel movements. The usual indications of a rectal tumour are an incomplete sense of relief after defecation associated with some tenesmus or spasm, increased frequency of bowel movements, the passage of a mucous discharge with or without the stools and a change in the shape of the feces. Approximately 80% of the rectal cancers are resectable by radical operation, and about 50% of the operations produce permanent cures.

Cancer of the breast appears initially as a small, painless lump that grows in size; it subsequently may adhere to the skin, causing dimpling and later ulceration; the nipple sometimes becomes inverted. All lumps in the breast should be suspected of being cancerous until proved noncancerous. Although the disease develops more frequently in women of middle age than in any other age group, 17% of the cases occur in women under 40 years. One per cent of all breast cancer occurs in men, chiefly those of middle and old age. Cancer of the breast metastasizes or spreads most frequently to the lymph nodes in the armpit on the corresponding side of the body and sometimes to a chain of lymph nodes beneath the junction of the sternum and ribs; until it spreads beyond these nodes it is still operable and curable. In 78% of patients with cancer confined to the breast, a cure is obtained by removing the breast, muscles of the chest wall and the regional lymph nodes (radical mastectomy); 42% of patients who have cancer of the breast with metastases to the regional lymph nodes and without evidence of dissemination elsewhere are cured by the radical operation.

Cancer of the breast may spread by lymph and blood vessels to other organs, such as the lungs, the brain or the bony skeleton, under which circumstances X-ray treatment and hormone therapy are excellent palliative measures.

(*See* MAMMARY GLAND: *Cancer.*)

Uterine Cancer.—Cancer of the neck (cervix) of the uterus develops most frequently in women 30 to 50 years of age but may occur before 30 or after 50. Women who develop cancer of the uterine cervix often have sustained injury to the cervix during childbirth. The onset of the disease is heralded by excessive uterine bleeding either at the time of menstruation or in the intermenstrual phase or on sexual intercourse. The discharge may be brown and foul as well as bloody; actual hemorrhages may occur.

Cancer of the interior of the body of the uterus (endometrial cancer) is relatively more frequent in women who have not borne children; it occurs in a slightly older age group, usually postmenopausal. It is more difficult to diagnose than the cervical type since it is not visible. A diagnostic curettage of the uterus (obtaining a biopsy specimen with a scraping tool) may be done or secretions from the uterus may be studied for identification of cancer cells. By the proper application of X-ray and radium therapy or radical surgical excision, the curability of cancers of the uterus varies from 30% to 75%.

Cancers of the urinary bladder and kidney produce an initial symptom of hematuria (blood in the urine) that may be accompanied by frequent urination and pain. The exact location of the cancer may be determined by combined X-ray study and cystoscopic visualization of the urinary bladder. Cancers of the kidney may grow as silent tumours and may not be suspected until metastatic focuses appear in distant parts, such as the bones, lungs or brain.

Cancer of the prostate in elderly men may provoke no symptoms other than occasional difficulty in micturition. Sometimes the first indication of the presence of this cancer is backache, which is caused by metastases of the prostatic cancer throughout the bones of the pelvis and vertebral column. Surgical treatment is employed only for the relief of obstruction to the urinary outflow and in rare cases for the extirpation of early cancers. The majority of prostatic cancers are in an advanced stage when diagnosed and are treated palliatively by a combination of castration and the administration of female sex hormones or their synthetic chemical equivalents.

Cancer of the bone may occur in any age group, including children and young adolescents. The presence of pain and disability in an extremity, when associated with an enlargement of a bone, is a significant sign of an early bone sarcoma. Amputation, if performed early, may permit a curability in 10% to 15% of these patients.

TREATMENT

The therapy of cancer properly begins with prophylaxis. The recognition and discontinuance of cancer-inducing habits, the removal of environmental hazards and occupational predispositions to cancer, the treatment of precancerous diseases and the removal of benign tumours known to undergo malignant transformation are effective steps in prevention.

Surgical Excision.—This is the most generally applicable method of treatment. Cures are most readily obtained when the cancer is still confined to the organ or tissue in which it develops and before it becomes generally distributed throughout the body. The application of surgical excision is limited by the degree of usefulness of the organ that must be sacrificed.

Commonly employed operations for cancer are those for the removal of a segment of the lip, followed by plastic repair; the excision of a segment of the tongue, and a wide removal of skin with replacement by grafts. Hollow organs such as the esophagus, stomach and colon may be resected segmentally with anastomosis to restore the continuity of the intestinal canal. Cancer in one member of paired organs such as the eyes, testes, lungs or kidneys may be cured by removal of the diseased organ without interfering appreciably with the function of the patient. Internal organs, such as the larynx, esophagus, stomach, colon, rectum, pancreas and urinary bladder, may be totally removed for extensive cancers; the patient is able to lead a near-normal life by employing medications or devices that substitute for the removed organ.

Skin cancers, such as epitheliomas and melanomas on the hands and feet or other portions of the upper and lower extremities, may spread or metastasize to the lymph nodes in the armpit and groin, necessitating radical surgical dissections and in some instances complete amputation of the extremities. Malignant tumours that occur frequently in the bone and soft tissues of the upper and lower extremities may in some instances be removed segmentally, followed by grafting of bone and skin to preserve the arms and legs. In the majority of cases, however, amputation of the arm or leg to include the shoulder or hip joint may be necessary. Cancers that metastasize or spread via lymph vessels may require removal of the original site of the cancer together with regional lymph nodes secondarily involved; this is a well-recognized plan of surgical treatment and was first employed for cancer of the breast in which the breast was removed together with the lymph nodes in the corresponding axilla (armpit). For cancers involving the medial and central segments of the breast, this operation has been extended by some surgeons to include a segment of the breast bone and the cartilaginous ribs, which incorporate a chain of lymph nodes often involved by the cancer.

In the 1950s cancerous lobes of the liver were removed successfully for the first time. Surgeons equipped with exact knowledge of the complex extrahepatic vascular and biliary systems by the late 1960s were able to remove 80% or more of the human liver containing either primary or metastatic cancers. The patient can survive if only 20 to 25% of the liver remains inasmuch as the liver has an amazing capability for regeneration. The possibilities for the saving of lives by these procedures are most promising. Total pelvic exenteration proved its worth in salvaging patients with otherwise hopeless cancers implicating multiple pelvic viscera.

Extensive cancers may necessitate the total surgical removal in continuity of tongue, hemimandible, hypopharynx, larynx, and cervical nodes in a single operative session and with preservation of life.

Experimental removal of the entire liver, an entire lung, and both kidneys (for bilateral malignant tumours) has been done with replacement by homologous organ grafts from other humans. With increasing knowledge of factors responsible for host rejection by the recipient, these transplantations may ultimately succeed. Most of the technical, physiologic, and immunologic problems had been studied in dogs prior to application in the human. It must be accepted that, at the present and for some time to come, these heroic procedures must be performed under academic auspices because of the complexity of the problems involved, the number of highly competent specialists in the various fields of medicine working simultaneously for the single patient and the expense of the procedure to the institution rather than to the patient.

X-Ray and Radium Therapy.—The use of X-rays and radium (gamma) rays, at first empirical, became relatively standardized and most accurate in application. An immense body of knowledge accumulated concerning the radiation sensitivity of various cancers, and the dosages of radiant energy necessary to destroy or sterilize various cancers became well known. Cancers vary greatly in their known response to irradiation and, because of this variable response, both X-ray and radium therapy are not universally suit able for the treatment of all malignant tumours. In some cancers either X-ray or radium therapy produces better results than surgical excision; in other instances, surgery and irradiation may be equally suitable, and the choice of treatment will depend on the experience and training of the therapist. In other instances, surgical treatment alone should be employed, and in some rare cases radiation therapy is used in conjunction with surgical excision either as a preoperative or postoperative supplement.

Examples of malignant tumours that are very responsive to irradiation are those originating in lymphoid tissue, such as lymphosarcomas, leukemia and Hodgkin's disease, and carcinomas of the palate, tonsil, base of the tongue and the larynx exclusive of vocal cords. X-rays of variable penetrating ability are employed, depending on the depth to which the X-rays must be delivered for absorption. Radiant energy must be absorbed before it can destroy human tissue, including cancer cells; cells through which the rays pass without being absorbed are not affected. Superficial cancers such as those in the skin may be treated with X-rays generated at low voltages of 50,000 to 120,000 v., whereas cancers in deep sites such as those in the uterus, esophagus and pancreas may be treated with X-rays generated at 1,000,000 v. The higher the voltage the greater is the penetration of the X-rays. The physical factors, such as filtration, intervening distance, milliamperage and voltage, are combined with spacing the treatments at proper intervals in order to allow maximum recuperation of normal tissues and maximum destruction of cancerous tissue.

Later innovations in X-ray therapy were the use of an X-ray bath (teleroentgen therapy), in which a patient with generalized radiosensitive cancer is placed in a special room with the X-ray beam emerging from the ceiling so that the entire body is irradiated at low intensity. Another mechanism employed in selected cases is a rotating chair or table in which the body of the patient rotates within the beam of X-rays so that the normal tissues are circumferentially and intermittently irradiated although the beam constantly impinges on cancers situated within the interior of the body. A beam of electrons emerging from an apparatus termed a betatron also has been used for treating deeply situated cancers. When properly controlled, an electron beam delivers a greater dose of radiant energy to the cancer than to the skin and normal tissues it traverses in reaching its objective.

Radium salts and their radiation equivalents, radon gas and radioactive cobalt, may be employed in several ways. Large quantities (4 to 2,000 g.) in a single applicator may be applied at a relatively great distance from the skin to treat deeply situated cancers. Plaques containing smaller amounts of radium are suitable for contact or short-distance radium therapy of superficial cancers involving the skin or mucous membranes of the mouth and nasal passages. Capsules containing radium may be inserted into cavities such as the uterus, esophagus and nasopharynx for the delivery of intracavitary irradiation. Radium salts or radon gas may be imprisoned in needles of variable lengths or in minute seeds for interstitial insertion. The radium or radon container is made of a heavy metal, such as platinum, gold, lead or mercury, to filter out the less-penetrating, caustic beta rays so that only the therapeutic gamma rays emerge. In some instances, a combination of X-ray and radium therapy is required for the successful treatment of cancer, notably in cancers of the uterine cervix.

(*See* RADIOLOGY: *Therapeutic Radiology.*)

Hormonal Treatment.—Certain cancers that originate in organs susceptible to influence by hormones may be temporarily controlled by withholding or administering certain hormones. Cancer of the prostate gland, even when widely disseminated to bone, may be controlled for one or more years either by castration or by administration of the female sex hormones (estrogens) or their chemical analogues such as stilbestrol. Cancer of the breast, when metastatic to bone, may be controlled with healing of the bone lesions, relief of pain and prolongation of life either by removal of the ovaries, by administration of testosterone (a male sex hormone), by removal of both adrenal glands or by hypophysectomy (removal of the pituitary gland). This radical ablative hormonal surgery is usually reserved for breast cancers that seem to require the presence of certain hormones for their continued growth.

Radioactive Isotopes.—Certain elements, when bombarded by neutrons or other nuclear particles from a nuclear accelerator, start to disintegrate and in the process become radioactive. This radioactivity can be used to treat several kinds of cancer.

Radioactive phosphorus, for example, has been employed as a palliative measure in the treatment of malignant tumours of the lymphoid system; the phosphorus, when ingested, is concentrated within the tumour itself because cancerous lymphoid tissue absorbs two and one-half times as much phosphorus as does normal tissue.

Radioactive iodine, when administered to patients with certain types of thyroid cancer, will be selectively absorbed and concentrated within the cancerous thyroid cells; radioactive iodine destroys not only the lesion of origin in the thyroid but also the metastatic focuses in bone or lung.

Radioactive gold, radioactive yttrium, radioactive chromium orthophosphate and other isotopes have been introduced into the pleural (chest) and peritoneal (abdominal) cavities to dry up accumulations of cancerous fluids. Radioactive isotopes, *e.g.*, radioactive cobalt-60 and radioactive iridium, may also be used as radiation sources in surface application for superficial cancers and interstitially applied for deep invasive cancers.

Radioactive yttrium in ceramic microspheres 60 microns in diameter has been injected intravenously so that it is carried to the lungs, where it becomes inseparably incarcerated in the capillary bed and then emits irradiation in the treatment of metastases.

Chemical and Biological Agents.—The majority of the first chemical and biological agents recommended for treatment of cancer, such as colloidal lead, Coley's toxin, etc., were largely abandoned as ineffective. Chemotherapy in cancer treatment became more effective because of the use of toxic radicals in conjunction with chemical substances, *e.g.*, nucleic acid, that are required by the cancerous cell for its metabolism and division; when the cancer cell ingests or absorbs these compounds, it tends to be injured or killed.

One group of cancerostatic or cancerocidal compounds consists of the so-called alkylating agents. These compounds are highly reactive chemically because their end groups consist of alkyl derivatives; *i.e.*, such groups as methyl ($—CH_3$), which are derived from the saturated series of hydrocarbons, such as methane (CH_4). The alkylating agents include mechlorethamine hydrochloride (nitrogen mustard), chlorambucil, triethylene-melamine (TEM) and thio-tepa (N,N′,N″-triethylenethiophosphoramide). They exert their antineoplastic effect by combining chemically with nucleic acids, thereby altering the function of these essential cellular components.

Another group useful in the chemotherapy of cancer consists of the antimetabolites (*q.v.*), examples of which are the folic acid antagonists, such as methotrexate, which interfere with the biosynthesis of nucleic acids, and certain purines, notably mercaptopurine, which also interfere with the synthesis of nucleic acids. Although these drugs are somewhat toxic, their continued use in cancer chemotherapy contributed greatly to the knowledge of fundamental cellular enzymatic reactions.

Urethane, a chemical closely akin to amino acids, was used in the treatment of myeloma, a malignant tumour of bone, although in the mid-1960s its mechanism of action was not known. In general, the tumours most susceptible to chemotherapy are those of the lymphoid system.

Perfusion and Infusion Therapy.—In the case of malignant tumours largely confined to an upper or lower extremity and of an extent unsuitable for surgical extirpation (for example, certain melanomas, epitheliomas, Kaposi's sarcomas), a continuous perfusion of the leg or arm may be done by an arrangement in which the entire circulation is controlled by an extracorporeal oxygenating pump connected in circuit with the chief afferent artery and the chief efferent vein. The chemotherapeutic agent, such as phenylalanine mustard for melanoma, is continuously circulated through the involved limb, which is temporarily excluded by tourniquets from the body proper, thereby increasing the effect on the cancer and protecting the patient from dangerous toxic action. Because cancers are supplied with blood through the arterial system, certain organs, such as the liver and brain, may be given palliative chemotherapy by protracted arterial perfusion with selected chemicals.

Cannulation of peripheral lymphatic vessels and pressure infusion of chemical agents and radioisotopes have been demonstrated to be effective for such neoplasms as malignant lymphomas and metastatic testicular cancers.

CANCER CONTROL

Great Britain, France, the Scandinavian countries and the United States early recognized the national need and opportunities for cancer control. These countries established disciplines for the special education of medical and nonmedical people, built institutions for the diagnosis and treatment of cancer and founded special societies and institutes for the organization and pursuit of cancer research. The movement spread throughout the world until many countries, including Canada, Mexico, India, Cuba, Peru, Venezuela, Chile, Argentina, Colombia, Brazil and Italy, operated cancer-control programs and special hospitals for the study and treatment of this disease.

The program for cancer control has involved several efforts, including the following:

1. Informing the public through private physicians and nurses, radio and television, and newspapers and magazines. The efforts, sponsored by lay cancer organizations, often included instructions to biology students in high schools and colleges.
2. Improved education of the medical profession through undergraduate instruction, postgraduate courses, special fellowships in cancer and allied diseases, and journals devoted largely to the subjects of cancer and cancer control.
3. Earlier diagnosis of cancer and allied diseases through the establishment of cancer-prevention and cancer-detection clinics, the organization of tumour-diagnostic groups in general hospitals, the enacting of laws by states and nations making cancer a reportable disease, and the increased availability of diagnostic aids such as endoscopic facilities, radiographic apparatus and competent pathologists. Cancer was reportable by law or by state health-department regulation in 30 of the 50 states.

See CANCER RESEARCH; PATHOLOGY: *Tumours;* LYMPH AND LYMPHATIC SYSTEM: *Diseases of the Lymphatic System;* TOBACCO: *Tobacco and Disease; see* also references under "Cancer" in the Index.

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CANCER RESEARCH. Cancer is the generic term applied to a great host of diseases in man and animals, which, although different in their detailed manifestations, have a common basis and expression in the defectively controlled growth of one or other of the multitudinous types of living cell from which the body is constructed. From its origin in the fertilized egg by cell division, the body normally develops with utmost regulation and precision. At an early stage, the rapidly dividing cells differentiate one from another, that is, acquire individual properties of both structure and function, leading to the establishment of specialized tissues and organs in perfect integration. While at first the rate of growth is in general high, it gradually relents in the course of organogenesis and slowly declines in the adult organism. Even in the adult, however, very many cell types—as of the skin, the mucous membranes of the intestinal tract and the bone marrow—continuously multiply, so as exactly to repair an equal loss or wastage. Rapid cell growth also ensues in more abnormal situations, for example in the healing of wounds, or in the process of compensatory hypertrophy designed to offset the loss of parts of such organs as the kidneys or liver. In these cases, cell division comes to an end when repair or restoration has been completed, and all these mechanisms have the effect of ensuring the integrity of the body as a whole and the mutual and optimal functioning of all its parts. Considering the astronomical numbers of cells involved, and the high order of complexity, the system is one of great stability and freedom from error.

On occasions, however, one or a few individual cells, either spontaneously or from the action of known causes such as are considered below, escape from normal regulation and, as cancer cells, embark on a course of unlimited division that has no relation to the physiological needs of the body but on the contrary leads to the development of rapidly growing tumour masses, which either directly or by spreading by metastasis to other organs interfere with structure and function and result in the death of the host.

In the space of this article it is clearly not possible to give a comprehensive account of every aspect of so formidable a problem. It is proposed, however, to outline briefly the historica development of the subject and to deal in turn with the propertie of the cancer cell, the experimental reproduction of the disease by chemical, physical and viral agents, theories as to the mechanisms of carcinogenic action, treatment especially by chemotherapeutic means and, finally, the support and organization of cancer research.

THE DEVELOPMENT OF RESEARCH TECHNIQUES

Observational.—Many classical observations of the features of cancer had of course been made throughout the whole of the history of medicine, but most notably in the 17th and 18th centuries, slowly accumulating to increase knowledge in terms of medicine, surgery and morbid anatomy. The origins of cancer research proper are, however, to be found in the historical development of the microscope, with which its own development is largely conterminous. This gradually led to the emergence of the cel theory. Although the theory had many precursors, it is remarkable that it only became finally established and accepted in the early part of the 19th century. Great developments immediately resulted, especially from Rudolf Virchow's application of the cel theory to pathology (*Die Cellularpathologie,* 1858), whereby h inaugurated several decades of investigation of the microscopi structure of cancer in man and animals, first in the medical school of Germany and then the world over.

From this epoch of morphological description there gradually emerged certain key principles. First it became clear that th cancer cell is indeed a derivative of the normal, and second, tha it is possible to classify tumour types not only according to th tissues from which they arise (*e.g.,* such major groups as th sarcomas, carcinomas and endotheliomas derived from the connective, epithelial and endothelial tissues respectively) but als according to the extent to which individual tumours, over a wid and continuous spectrum of possibilities, lose the microscopi and other characteristics of their parent cell—that is, undergo process of dedifferentiation. In general although not absolutel so, the extent of dedifferentiation is reflected in enhanced growt rate, autonomy and invasiveness and can proceed to extremes of virulent anaplasia in which the cell no longer retains any recognizable traits that might serve to reveal its origin. The earlier pathologists were impressed by the remarkable similarities between cancer cells and embryonic cells and it appears that malignant transformation may well involve an essentially regressive change, a more or less pronounced simplification, or atavistic reversion to a less specialized function.

This conclusion, reached solely on the basis of microscopic observation, is one that is substantiated by the whole of modern research.

Many other essential facts have been, and continue to be, uncovered by the methods of clinical observation and recording, quite apart from experiment. The most central, and perhaps the oldest, is that the incidence of cancer for the most part increases steadily with age, and this relationship between cancer genesis and the aging process in cells and tissues is certainly of profound significance.

Demography and Statistics.—Again, major contributions have sprung from the fields of demography and geographical pathology. Pronounced differences in the incidence of cancer at different geographic sites have long been known, as between the communities of North and South America, Europe, Africa and Asia, examples being the high rates of cancer of the liver in West Africa, Uganda, Portuguese East Africa, South Africa, Indonesia, Japan and Thailand (in contrast with western Europe and the United States), of neural and retinal tumours in African children, of cancer of the stomach in Japan, Norway and Iceland, of oral cancer in India, of multicentric tumours of the jaw in Uganda, of cancer of the penis in Jamaica and Paraguay, of nasopharyngeal cancer in China, Thailand, Malaya and Formosa and of cancer of the esophagus in almost epidemic proportions in the Transkei area of South Africa. Other disparities are the relatively lower incidence of leukemia and cancer of the blood-forming organs in Uganda and South Africa than in the United States, the infrequency of intracranial growths in African children, the marked differences throughout the world in the rates of occurrence of cancer of the uterus, the low incidence of cancer of the prostate in Japan and of cancer of the breast in Japan and in parts of Africa and in Deccanese Hindu women in India in contrast with the Parsees. It is evident that such variations are not merely of fascinating interest in their own right but also provide invaluable leads toward the understanding of both causation and prevention.

The power of the statistical method is also seen in its revelation of the close association between the incidence of cancer of the lung and tobacco smoking (and especially the cigarette habit). Finally, it is essential to the study of secular changes in the incidence of and mortality from particular forms of the disease. From evidence mainly in the United States and the United Kingdom, no very significant change appears to have occurred, over some decades, in mortality from cancer of the breast, prostate, intestine, esophagus and larynx. Types of cancer with an increasing trend in mortality include cancer of the lung, certain leukemias and related conditions and cancer of the ovary, bladder, pancreas and kidney; while sites for which mortality from cancer is decreasing are the stomach, tongue, lip, skin, rectum, uterus and liver. Obvious factors that may underlie all such trends are changes in classification, in accuracy of diagnosis and in efficiency of recording. Yet some of the trends, and outstandingly the increase in mortality from lung cancer and the decline in that from cancer of the stomach, are real and fundamental.

Experimental Method.—Immense as have been the advances in knowledge from observation and statistical analysis, cancer research, from the nature of the problem, is also heavily dependent upon the experimental method. Although this had early beginnings, its application on any scale dates only from the turn of the 19th century, when specialized research centres were established, particularly in the United Kingdom, the United States, Europe and Japan. Within 15 years, marked advances had taken place in understanding of the biological characteristics of the cancer cell (including its capacity to propagate indefinitely on grafting from one animal host to another in succession), the role of heredity had been defined and success had been attained in the artificial induction of cancer by ionizing radiations, by coal tar and by a virus.

The spread of cancer by metastasis arises from the dissemination of tumour cells from the primary growth, which then give rise to secondary growths in the organs in which they settle. Similarly, the artificial transfer of a tumour fragment to a fresh host can result in the continued proliferation of the neoplasm by cellular multiplication, a process that may then be extended indefinitely in serial transplantation. This capacity is the outstanding attribute of the cancer cell and the artificial propagation of animal tumours by such means in a variety of species, but especially the mouse, rat, rabbit, guinea pig and hamster, also affords a great wealth of material essential to research. The growth potential is also preserved—perhaps permanently—in cells carried into the frozen state by suitable techniques, as can be demonstrated when they are restored to normal temperatures and reimplanted, after periods certainly up to many years. During the course of transplantation, in most cases the cancer cell breeds true and may remain remarkably stable in its properties. In other cases these properties may alter, either gradually or by a stepwise progression, a process usually involving further dedifferentiation and loss of function, with increased ease of transplantability and rapidity of growth. The first transplantation of a primary tumour to fresh hosts will on occasion only succeed when these are blood relations of the donor. But generally the conditions for success become less rigorous on repeated transfer, whereafter the tumour can be propagated in animals of the same species. In the overwhelming majority of instances, however, the limits of transplantability are the limits of species—or of hybridization between species where this is feasible—and are frequently even more closely restricted to a particular subline or strain. Where a tumour graft fails to be accepted (apart from accidental reasons), it does so from an immune reaction on the part of the host, which rejects it as foreign tissue; and when it is tolerated, it is then able to elicit from the tissues of the host the blood vessels and connective scaffolding on which its further growth depends.

Transplantation immunity is therefore directed against tumour grafts different in their genetical and immunological constitution from the tissues of the host, and they obey the laws that govern the transplantation of tissues of whatever kind. The capacity to develop such immunity does, however, vary with age and with transplantation site and can be diminished by various procedures. Thus, tumours of the mouse can be grown for short periods in the infant rat before immune responsiveness has wholly matured. Second, tumours of foreign species (including man) may persist or undergo varying degrees of growth when implanted in such sites as the cheek pouch of the golden hamster or the anterior chamber of the rabbit eye—sites in which the foreign graft appears to be shielded from the immune reaction that would otherwise destroy it. Last, successful transplantation to an alien host may be achieved by prior treatment of the host with various vital dyestuffs (*e.g.*, trypan blue), or other particulate material, both of which are taken up by the cells of the so-called reticulo-endothelial system on which transplantation immunity largely relies and lead to its temporary suspension; successful transplantation also may be achieved through a somewhat similar abrogation of immunity from the administration of cortisone, or following exposure to X-rays. Such technical modifications of the immune response permit the growth of tumours in circumstances in which it would not normally occur and are the basis of many experimental procedures invaluable for further research.

The propagation of tumours, so far considered, is dependent upon the transfer, from donor to host, of intact and living cancer cells. But a great revolution in cancer research occurred around 1910, with the discovery by Peyton Rous, at the Rockefeller Institute for Medical Research in New York, that certain fowl sarcomas could be transmitted not only by grafting tumour cells but also by injection of a submicroscopic agent extractable from them—the birth of the virus theory of cancer causation. The Rous and related agents are highly specific and immediate in their action, at once transforming the homologous normal cells of the fresh host into the replica of the tumour cells from which they were derived. Since that time, many other so-called oncogenic (tumour-causing) viruses have been revealed. In numerous ways heterogeneous in their properties and hence, perhaps, in their modes of action, it is, nevertheless, of much interest and significance that certain of them are also capable of transcending the species barrier and of inducing tumours in species alien to those from which they were derived.

The Study of Heredity.—A further early result of modern cancer research lay in the recognition of the importance, in the genesis of the disease, of hereditary constitution. As early as 1907 E. E. Tyzzer showed that the progeny of mice with mammary or lung cancer were more liable to develop these diseases than were the progeny of noncancerous animals. Similar conclusions were reached by Maud Slye (between 1913 and 1941) respecting other types of cancer in the mouse. The procedure of selective breeding was later developed by such pioneers as C. C. Little at the Roscoe B. Jackson Memorial laboratory at Bar Harbor, Me., and L. C. Strong. Selective breeding utilizes the principle that continued inbreeding of brother to sister, or of offspring to parents, reduces the extent of variation in inheritance and increases the genetical uniformity of the resulting animals in succeeding generations. Thus from the selective breeding of the cancerous progeny of cancer-bearing mice can be evolved strains with a high natural incidence of cancer of the type shown by their ancestors. Contrariwise, by selection of the noncancerous progeny of noncancerous parents in successive generations, strains may be established with very low rates in their natural liability. It is patent that when selective inbreeding is utilized in experimental animals such as the mouse, heredity can be demonstrated as a powerful influence in cancer causation. However, since human society is based upon the deliberate exclusion of close inbreeding and since human breeding is to all intents random and nonselective, the hereditary factor is of little practical importance in man, unless in very exceptional circumstances.

THE STUDY OF THE CAUSES OF CANCER

For obvious reasons, a great part of cancer research is devoted to the study of causation. Here the experimental method is of paramount importance because it allows not only the artificial reproduction of the disease by a wide range of carcinogenic agents but also the investigation of their diverse mechanisms of action. When it becomes possible in chemical terms to elucidate the means by which carcinogens effect malignant transformation, this knowledge will have its corollary in a correspondingly precise understanding, on a biomolecular level, of the essential differences between normal and cancer cells and may also have its implications for rational treatment and control.

Physical Carcinogenesis.—*Ionizing Radiation.*—Known carcinogens fall into three major classes—physical, chemical and viral. Of the first, by far the most important are various electromagnetic and corpuscular radiations, and radiation as a carcinogenic agent can be considered as comprising ultraviolet, roentgen and gamma, alpha and beta radiation and protons and neutrons. For ionizing radiations, recognition of their carcinogenic hazard gradually developed in the early part of the 20th century, that is, not long after the discovery of roentgen rays (X-rays) and radium —partly from the experiences of the radiologist martyrs as a result of inadequate protection but also to some extent from experiment. Evidence in man has also accrued from such examples as the risk of bone sarcoma following the use of radium paints in industry, the sequelae to the use of a colloidal suspension of thorium dioxide in medical diagnosis, the occurrence of neoplasia in children treated with X-rays in infancy for enlargement of the thymus gland, the appearance of leukemia in a proportion of cases of ankylosing spondylitis treated with X-rays and the increased incidence of leukemia, and of other cancers, in the survivors of exposure to high levels of instantaneous radiation from the atomic explosions at Nagasaki and Hiroshima. Experimentally of great importance are the high-energy radiations associated with the uranium chain reaction and the range of radioactive elements and isotopes—especially including radiophosphorus, plutonium, radioactive strontium and iodine—made possible by the development of atomic physics. It is clear that this development, by rendering available radioactive isotopes in variety and abundance, has not merely stimulated the growth of radiobiology but has also added to the scientific and practical problems that the potential carcinogenicity of such substances creates.

Chemical Carcinogenesis.—As in the case of ionizing radiation, clinical observation played an essential part in the gradual development of knowledge of chemical carcinogenesis. The occurrence of cancer of the skin in chimney sweeps had been recognized by Percivall Pott as long ago as 1775 as attributable to soot. In the second half of the 19th century many other examples came to light of cancer as an industrial hazard—especially skin tumours among the workers in the German tar and paraffin industry, "paraffin cancer" found in workers in the Scottish oil shale deposits and the so-called "mule spinners' cancer" affecting workers in the Lancashire cotton-spinning industry and caused by contamination of the skin with lubricating oil.

These and many other similar observations indicated the presence of cancer-producing substances in soot, coal tar, pitch and mineral oil and provided the stimulus toward the artificial reproduction of the disease by chemical means under experimental conditions. This was first attained by K. Yamagiwa and K. Ichikawa in 1915 by protracted application of coal tar to the skin of the rabbit ear, an achievement that in turn inaugurated the search for the agent responsible. In the 1920s the work of B. Bloch and W. Dreyfus in Zürich and of E. L. Kennaway in London together indicated that this agent probably belonged to the class of cyclic hydrocarbons; and the following years in quick succession, from the contributions of E. L. Kennaway, J. W. Cook W. V. Mayneord, I. Hieger and others, saw the discovery of the first pure chemical compound with pronounced carcinogenic properties (1,2,5,6-dibenzanthracene), recognition of the main carcinogen in coal tar and pitch (3,4-benzpyrene) and the production by synthesis of various series of carcinogenic polycyclic aromatic hydrocarbons. These advances were not merely of utmost importance in themselves but had immediate and lasting repercussions on every aspect of experimental cancer research throughout the world.

Carcinogenicity is not, however, restricted to the polynuclear aromatic hydrocarbons. Another occupational hazard had long been known in the incidence of cancer of the bladder in workers in the dyestuffs industry in England, Europe and Japan, from exposure to the intermediates alpha- and beta-naphthylamine and benzidine, and these substances were the forerunners of what wa to prove a large class of carcinogenic amines. Further, the propensity to evoke cancer of the liver is a feature of many dyestuff allied to aminoazobenzene. Of special interest are various associations between carcinogenesis and endocrine physiology, arising from the discovery by A. Lacassagne in 1932 that injection o the female sex hormones (estrogens) can produce cancer of th breast in male mice. The appearance of breast cancer in mic is known to be determined by a number of predisposing and conditioning factors. Also, the carcinogenic action of the estrogens is mainly confined to tissues that are highly responsive t the physiological action of the estrogens. Nevertheless, Lacassagne's experiment was the first in which cancer was produced by a naturally occurring compound and led to many other studies including those of the induction of pituitary, mammary, uterine testicular, adrenal, subcutaneous, leukotic and osseous tumours in mice and other species by both natural and synthetic estrogens Among other types of chemical carcinogenesis may be listed th action of urethan in increasing the incidence of adenoma of th lung in mice; the induction of liver tumours by carbon tetrachloride, tannic acid and alkaloids derived from the plant genu *Senecio*, the appearance of sarcomas following implantation o many polymers and plastics; the production of a variety of proliferations of the reticulo-endothelial system after prolonge administration of such azo dyes as trypan blue or Evans blue, an the role of metals, metalloids or metal-containing substances (*e.g* arsenic, chromates, nickel carbonyl, asbestos, beryllium, selenium cobalt and metal-dextrans) in producing cancer, whether under occupational conditions or by experiment. Last but highly important is an extensive class of so-called alkylating carcinogens (*e.g.*, nitrogen mustards, bisepoxides, polyethylenimines) which because of their chemical simplicity and reactivity are specially advantageous in studying the mechanism of their action.

The Oncogenic Viruses.—Added to the growing knowledge of physical and chemical carcinogenesis, the mid-20th century also saw the beginnings of a revolution in opinion as to the causative role of oncogenic viruses. Much earlier, the discovery of the Rous sarcoma virus had been followed by recognition of similar agents recoverable from many avian leukemias. Later, J. J. Bittner demonstrated the contributory part in the etiology of breast cancer in mice of the so-called milk factor, a viral agent present in the tissues of certain strains of high susceptibility and transferred by the milk to suckling mice in which it can then determine an incidence of mammary cancer to which they would not otherwise be liable. In another direction, R. E. Shope described a virus capable of inducing, in the skin of the rabbit, rapidly growing papillomas, a proportion of which then transform into highly malignant cancers. By administration of extracts of mouse leukemic tissue to day-old mice of strains not otherwise susceptible, L. Gross was able to generate a high incidence of leukemia and to demonstrate leukemogenic viruses in the mammal—a key discovery that led, through the application of similar methods by Sarah Stewart, and later by many others, to recognition of the polyoma (Stewart-Eddy) virus, capable of growth and enhancement in tissue culture and of evoking a wide range of tumours not only in the mouse but in other species. Apart from the unique biological properties of the polyoma viruses, remarkable advances were made by electron microscopy regarding their morphology and nucleic acid structure.

Mechanisms of Carcinogenesis.—A central problem concerns the mechanisms by which malignant transformation is effected and, in particular, what part (if any) is played in natural causation by processes of infection. It is clear that cancer can be induced by a great range of agents and from their diversity it is certain these must operate by different biochemical routes. It is, however, not improbable that these routes lead to a key alteration similar in principle in the different cases, notwithstanding the great diversities between the carcinogens themselves and even between many of the oncogenic viruses. The possibility of an eventual synthetic understanding is also seen in the fact that many physical, chemical and even viral carcinogens are capable of inducing chemical and biological mutation, of which carcinogenesis may be a specialized case. It is often said that the cancer cell has acquired the property of unlimited growth; but, as was earliest pointed out by J. A. Murray, this cannot be so since the same potentiality is inherent in the normal cell. Many studies, especially of such chemical carcinogens as the polycyclic hydrocarbons, the azo dyestuffs and the alkylating agents, strongly suggest an interference with protein synthesis, leading perhaps to the deletion of specific enzymes, either directly by chemical combination with protein or indirectly by damage to the chemical integrity of the nucleic acid structures, upon which both cellular heredity and protein synthesis depend. Hence it may well be that the action of all carcinogens, including the oncogenic viruses, is to deprive the cell, by various degrees of specificity of action, of growth-regulatory systems dependent upon the protein-nucleic acid association, and in this way to liberate permanently the growth potential all along present but normally controlled.

RESEARCH ORGANIZATION AND SUPPORT

In many countries cancer research is supported from both governmental and private sources. Examples of the former can be taken in the Medical Research council of Great Britain, the department of health, education and welfare of the United States government and the French Centre National de la Recherche Scientifique. Examples of private support sources are seen in the British Empire Cancer campaign, the Imperial Cancer Research fund, the American Cancer society and the Damon Runyon Memorial Fund for Cancer Research; and a specially valuable function is performed by those—such as the Lady Tata Memorial fund (for research in leukemia) and the Jane Coffin Childs Memorial Fund for Medical Research and the Anna Fuller fund (both of New Haven, Conn.)—that distribute their help on an international scale.

In research itself, apart from its support, most countries have their scientific societies designed to bring together workers in the field, outstanding being the American Association for Cancer Research. On the international plane, it is a function of the Union Internationale contre le Cancer (founded in 1933) to organize a series of international cancer congresses, at four-year intervals, and to sponsor occasional international symposia. The Union was a founder member of the Council for International Organizations of Medical Sciences (C.I.O.M.S.) and is affiliated to the World Health organization.

See Cancer; Medical Research.

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CANDELABRUM, in architecture, is a decorative motif derived from the pedestal or shaft used to support a lamp or candle. The Romans, developing Hellenistic precedents, made candelabra of great decorative richness. Two Roman types are found: the simpler, consisting of a slender shaft, often fluted, supported on a spreading base of animals' feet and acanthus scrolls, and carrying a flat shelf with vaselike moldings. The multitude of such candelabra found in Pompeii proves them to have been a common form of household decoration. The more monumental type, either of marble or bronze, used in public buildings, had for the base a pedestal resembling a little altar which carried a heavy shaft, frequently decorated with row on row of acanthus leaves. The lavishness of such examples made a great impression on Renaissance artists, and the general form known as the candelabrum shaft was widely used in the late 15th century, especially for the centre of pilasters.

For candelabrum in the sense of a large branched candlestick, *see* Candlestick.

CANDIA (Erákleion): *see* Iraklion (Heraklion).

CANDLE, a cylinder of wax, tallow or similar material surrounding and saturating a fibrous wick.

Early Forms.—Candles were known to the peoples of the ancient world. Depicted in relief on ancient Egyptian tombs at Thebes are cone-shaped candles held aloft in dishlike holders. Dish-shaped candlesticks with a central socket, similar in design to the modern candlestick, were found at Crete and date from the first Minoan civilization, about 3000 B.C. The Romans had candles and tapers of tallow and wax, and a fragment of candle dating from the 1st century A.D. was found at Vaison, near Avignon, in France.

During the middle ages in Europe the familiar means of lighting of the poor was the rushlight, consisting of a reed stripped to the pith and dipped in oil. Both tallow and wax candles were commonly known, however, although wax candles were so costly that only the wealthy could afford them. Tallow candles were called "dips." Tallow was rendered from beef or mutton suet; strands of yarn were then dipped in the melted fat and allowed to cool. The dipping and cooling processes were repeated alternately until the candle reached a desired thickness. Wax candles were made by repeatedly pouring melted beeswax over a suspended wick and removing any unevenness in the finished candle by rolling it over a hard surface.

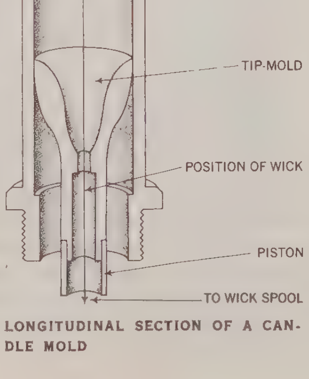
Candlemaking was exclusively a domestic pursuit for many years, but with the growth of medieval town life it became a specialized craft. In Paris in the 13th century members of a guild of tallow chandlers went from house to house making candles. A distinction was drawn between the making of tallow candles and the making of wax candles, as evidenced by the establishment in Paris of two separate guilds, the tallow chandlers and the wax chandlers. In London, also, two separate livery companies were incorporated. An interesting familiar feature of the middle ages was the tallow candle set in a lantern. It should be noted that candlemaking as a domestic art was never entirely lost. In some localities throughout the medieval period and on into much more modern times candles were still made in the home kitchen.

The candle mold did not appear until the 15th century. Its invention, attributed to the sieur de Brez of Paris, was of importance only to tallow chandling, since beeswax candles could not be molded satisfactorily.

Emergence of Modern Processes.—Few improvements in candlemaking were introduced until the 19th century, when chemistry exerted its impact on the industry. In the second decade of the century, a French chemist, M. E. Chevreul, proved that fats were composed of fatty acids and glycerin. He succeeded in separating these components by saturating fat with alkali and treating the resultant soap with sulfuric acid. The liquid oleic acid was expressed by pressure, leaving the solid combined palmitic and stearic acids, the stock of the superior stearin candle.

From this beginning, new processes for producing pure candle stock appeared in rapid succession. Fats were decomposed by treating them with concentrated sulfuric acid, by subjecting a mixture of fat and water to high temperatures under pressure in an autoclave or digester, and by distillation with superheated steam, a method that permitted recovery of pure glycerin. From these innovations developed the modern method of decomposing fats by hydrolysis; *i.e.,* breakdown through the addition of water. In this process, a mixture of fat and lime water (calcium hydroxide) is heated to a high temperature under pressure in a sealed, copper-lined steel digester, the material being agitated by a spirally turning paddle or by pumping. The products are lime soap, which is resolved into fatty acids, water and lime sulfate by treatment with dilute sulfuric acid and steam, and "sweet water," from which glycerin is recovered by purification with steam.

In addition to stearin, other important candle stocks were produced during the 19th century. Spermaceti, derived from the oil in the head cavity of the sperm whale, made a candle of superior illuminating power. Its tendency to brittleness was corrected by the addition of beeswax. The spermaceti candle, made to exact specifications, was established in England in 1860 as the standard of photometric measure. Another bright-burning candle was made of ceresin, a wax obtained from the distillation of ozocerite, or earth wax.



LONGITUDINAL SECTION OF A CANDLE MOLD

The successful production of paraffin wax in 1850 was a development of first importance. By 1855 paraffin wax was being profitably produced in England, on the continent and to some extent in the United States by distillation of coal and oil shales. Discovery of petroleum in the United States in 1859 made possible the economical production of paraffin by redistilling the abundant residue left from the initial refining of crude petroleum. Purification of the resultant material yielded white, or bluish-white, translucent paraffin wax. Its single disadvantage of a low-melting point was overcome by combining it with stearic acid, and this composite material soon accounted for most of the candle production.

The plaited cotton wick, pickled in a dilute solution of a mineral salt such as borax, potassium nitrate or ammonium chloride, was introduced by W. Cambacérès in 1825. Impregnation of the wick with a mineral salt causes it to curve when burning, thus facilitating oxidation. It also causes the ash to vitrify, eliminating the need for snuffing, or cutting away, the charred wick ends. Modern wicking is plaited by machines.

Production by Machine.—The modern candle-molding machine evolved from Joseph Morgan's machine of 1834, the first that permitted continuous wicking and ejection of molded candles by movable pistons. Molds of the modern machine are made of high-grade tin and are finely finished inside to give polish to the candles. The molds are arranged in parallel rows in a metal tank equipped for alternate heating and cooling. The amount of heat applied and the rate of cooling are carefully controlled to suit particular candle stocks. The upper, or butt, ends of the molds open into horizontal channels from which melted candle stock drains into the molds, which are preheated. The lower, or tip, ends of the molds are closed by inverted conical tip-molds, each of which is carried at the top of a hollow piston attached to a common bed. The tip-mold also serves to form the tapered end of the candle. After the filled molds have been cooled, the pistons are raised to eject the candles upward into a rack or clamp at the top of the machine. Spools of wicking are carried at the bottom of the machine, one for each mold; the wicking is threaded through the piston, entering a perforation in the tip-mold and passing up through the candle mold. As a charge of candles is ejected into the clamp the wicking is drawn up in preparation for the next charge. When a second charge of candles is ready for ejection, the wicks of the first are cut and the candles removed from the clamp. Such a machine can produce up to 500 candles at a single charge and can complete three charges an hour.

For certain specialized purposes, tallow "dips" are still made commercially. Beeswax candles continue to be made by basting a suspended wick with the melted wax, while tapers are made by drawing long strands of wicking through a bath of molten wax.

Nonlighting Uses.—Candles have been turned to interesting uses other than lighting. A millennium ago a candle marked off in 12 equal divisions was burned to time the passing of a day. Alfred the Great devised a thin horn shield that protected the time-candle's flame against disturbances by currents of air. In 17th-century England bidding at auctions opened with the lighting of an inch-high candle and closed when the candle guttered out.

Candles have exerted a perennial aesthetic and spiritual appeal. Through the centuries they have been lighted as sacramentals in Roman Catholic churches, and the lighting of candles has also been a part of Jewish religious and historic ceremonies. Where candles no longer fill the need for illumination, they are prized for the soft charm of their light. There is also a thriving interest in candlemaking as a creative art.

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CANDLEMAS, the church festival on Feb. 2 which commemorates the occasion when the Virgin Mary, in obedience to Jewish law, went to Jerusalem both to be purified 40 days afte giving birth to a son and to present Jesus to God as her first-born (Luke ii, 22–38). The festival is also known in the west as the Purification of the Virgin Mary and as the Presentation of the Child Jesus. In the Greek church it is called *Hypapante* ("meeting") because of their meeting in the Temple with the aged Simeon, who said the *Nunc dimittis* and prophesied to the Virgin Mary. The earliest reference to the festival comes from Jerusalem, where in the late 4th century the western pilgrim Etheria attended its celebration on Feb. 14, 40 days after Epiphany (then kept there as the nativity of Christ; *see* CHRISTMAS). It soon spread to other cities of the Byzantine empire, and in 542 Justinian I decreed that its date should be moved back to Feb. 2 (*i.e.*, 40 days after Christmas). By the middle of the 5th century the custom of keeping the festival with lighted candles had been introduced by a Jerusalem abbess; hence the name Candlemas. The festival is first heard of in the west when Pope Sergius I (687–701) instituted the procession for it in Rome. In the east it is primarily a festival of Christ, in the west of the Virgin Mary. (J. E. BH.)

CANDLE POWER (LUMINOUS INTENSITY), a term now technically obsolescent but still in commercial use, dating back to the candlelight era, when a standard candle was made of spermaceti wax and of such dimensions and wick length as to consume 120 gr. per hour. Later a specially made pentane lamp (Harcourt) was the standard candle for Great Britain and the United States; Germany meanwhile adopted the Hefner amyl-acetate lamp. In 1909 the international candle was defined in terms of groups of specially made and precisely operated carbon filament lamps kept at national standardization laboratories.

In 1939 the Commission Internationale de l'Eclairage in sessions at Scheveningen, Neth., recommended a new standard candle, to be of the luminous intensity per square centimetre of its surface equal to one-sixtieth of that of a black body (*q.v.*) (perfect) radiator held at the freezing point of pure platinum (1,773° C.). This was the accepted definition of the standard candle, also known as the candela or new candle (*see* PHYSICAL UNITS).

The term candle power obviously referred intuitively to the rate of flow (flux) of luminous energy, as judged by the eye, from some source of light in comparison with that of a candle. The unit of flux is the lumen. This is defined as the rate of luminous output of energy, the flux, radially streaming outward through a unit of solid angle (steradian) from the standard candle located at the apex of this angle.

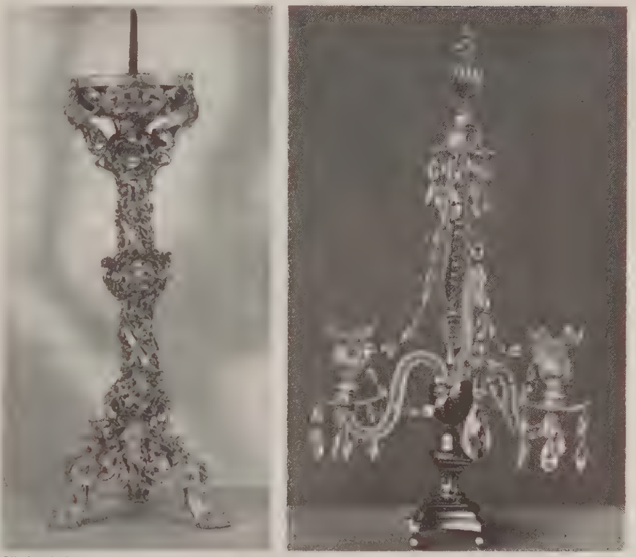
Thus in modern terms a standard candle's power sends a luminous intensity of 4π lumens out through any spherical surface centred on the candle.

For more technical details, *see* LIGHTING; PHOTOMETRY. (H. B. LM.)

CANDLER, ASA GRIGGS (1851–1929), U.S. manufacturer of soft drinks, was born on a farm near Villa Rica, Ga., Dec. 30, 1851. He studied medicine, became a pharmacist and developed a prosperous wholesale drug business. In 1887 he purchased the formula for Coca-Cola, a soft drink, from a business associate. He improved the process of manufacture and developed Coca-Cola into one of the most prosperous businesses in the southern region of the United States. He sold the business in 1919 for $25,000,000. Emory university in Atlanta, Ga., received many gifts from him and he constructed a teaching hospital adjacent to its medical school. He died March 12, 1929, in Atlanta, Ga. (H. J. SG.)

CANDLESTICK, a receptacle for holding a candle (*q.v.*). Candlesticks may range in size and complexity from the medieval block of wood holding an iron spike on which the candle was impaled, to the huge bronze altar candlesticks of the Italian Renaissance. In the most restricted sense, "candlestick" means a utensil for holding one candle, "candelabrum" a large, standing, branched candlestick for holding several candles; "candlestick" commonly is used in both senses. "Chandelier" is a branched candlestick (or lampstand) suspended from the ceiling.

Ancient Times.—In its earliest form, the candle was a torch made of slips of bark, vine tendrils or wood dipped in wax or tallow, tied together and held in the hand by the lower end. Candles of this type frequently figured on classical painted vases; subsequently a cup or discus was attached to the base to catch the dripping wax or tallow. The rushlight that was still used in 19th-century Europe was of similar construction.



BY COURTESY OF VICTORIA AND ALBERT MUSEUM

(LEFT) ENGLISH GILT BRONZE ALTAR CANDLESTICK, INSCRIBED AS HAVING BEEN GIVEN TO THE ABBEY OF ST. PETER, GLOUCESTER, BY THE ABBOT PETER, EARLY 12TH CENTURY; (RIGHT) ENGLISH CANDELABRA WITH BRISTOL GLASS STANDS MOUNTED IN GILT BRONZE, ABOUT 1800. BOTH IN THE VICTORIA AND ALBERT MUSEUM

Little is known of domestic candlesticks before the middle ages, but a number of references to ecclesiastical candlesticks are to be found in the Old Testament. Moses was commanded to make for the tabernacle a candlestick of hammered gold which was to weigh a talent and consist of a base with a shaft from which six arms sprang, supporting seven candles on the arms and central shaft. When Solomon built his temple, he placed in it ten golden candlesticks, five on each side of the Holy Place. After the period of captivity in Babylon the golden candlestick was again placed in the temple, as it had been formerly in the tabernacle by Moses, but on the destruction of Jerusalem it was carried with other spoils to Rome; representations of it can be seen on the Arch of Titus in Rome and in the catacombs.

Middle Ages.—The simplest form of domestic candlestick was a block of wood into the top of which an iron spike was driven vertically. The lower end of the candle was then impaled on this spike and the upper end lighted. This type of candlestick survived in rural areas into the early 19th century. It is found in various sizes. The earliest form had only a single spike, but subsequently the stem was wrought into two spikes, or a circular tray was attached to the top, on the upper side of which several spikes might be fixed. Candlesticks of this construction with several tiers of trays or rings for spikes (usually known as prickets) may be seen in use before shrines in Roman Catholic churches. The socket was introduced as an alternative to the pricket during the middle ages, but it did not replace it, and late medieval candlesticks are found with both prickets and sockets on one stem.

The bronze founders of Germany, the Low Countries and elsewhere produced splendid cast bronze candlesticks for both ecclesiastical and secular purposes from the 10th century onward. The most striking is the so-called Gloucester candlestick (in the Victoria and Albert museum, London), which is generally accepted as an English work dating from the early 12th century. The whole surface is pierced and modeled with nude human figures fighting dragons among foliate scrolls. There are also early bronze altar candlesticks in the Magdalenenkirche at Hildesheim and the Münsterkirche at Essen, dating from the late 10th and early 11th centuries, respectively, but the most impressive examples are of later date. The most important is the Trivulzio candlestick in Milan cathedral. Six metres in height, it was executed about 1200, but its place of manufacture is conjectural, suggestions varying between England, Lorraine and Milan itself. It is composed of floral scrolls inhabited by realistically modeled human beings and monsters. Incomplete candlesticks of similar type survive at Reims (in the museum) and Prague (in the cathedral). Alongside these huge paschal candlesticks, which usually had seven branches, smaller domestic ones were made, some of highly imaginative form. The German and Mosan bronze founders were fond of a type in which a pricket was attached to the back of a dragon or birdlike monster.

While the candlesticks from northern Europe were superbly modeled in the form of fantastic figures or animals, the enameling workshops of Limoges in central France produced altar candlesticks of various sizes in which the ornament was carried out in opaque champlevé enamel against a gilt copper ground. The Limoges workshops also specialized in small traveling candlesticks with folding legs; the secular nature of this type is shown by the shields of arms of noble French families with which they were usually enriched. Judging by surviving examples, candles were more popular than lamps during the middle ages.

The substitute in northern Europe for the hanging oil lamp used in eastern Europe was the chandelier. Hanging candleholders made of wood or iron of simple shape were used in Anglo-Saxon churches before the Conquest. In the 12th and 13th centuries huge coronas, openwork hoops of iron or bronze, supported numerous prickets for candles. Those made for royal palaces were of gold or silver, sometimes even set with jewels. Only in the cathedrals have such large Romanesque chandeliers survived, the most important being that in Aachen cathedral made for the emperor Frederick Barbarossa in 1168. A peculiar form of hanging chandelier for ecclesiastical purposes, produced in Spain, is known as a polycandelon; it consisted of a flat circular plate of bronze, the edge pierced with circular holes for the insertion of candles and the central area pierced with Christian symbols. Surviving examples date from the 8th to the 10th century.

The development of the brass-founding industry in the Meuse valley in and around Dinant, Belg., led to an important production there in the later middle ages of large altar candlesticks and smaller domestic ones of standardized form with circular molded stems and large spreading bases, often supported on three lion feet. Brass was also found to be a suitable material for the production of chandeliers, and a number of 15th-century examples survive, mostly in churches; among them is a 12-light chandelier arranged in two tiers in the Berkeley chapel at Bristol cathedral. These 15th- and 16th-century brass chandeliers were usually surmounted by a figure of the Virgin Mary, a saint or an angel, though some of the more magnificent examples, such as may be seen in Flemish 15th-century paintings, were enriched with much elaborate Gothic crocketing and tracery.

Candlesticks of silver gilt, enriched with enamel, decorated the altars of the great churches and rich chapels of the nobility in the later middle ages, but there is now little to show of such treasures. The treasury of Aachen cathedral includes silver altar candlesticks of the late 14th century, while a set of 15th-century Spanish altar plate in the British museum includes a pair of silver candlesticks enriched with translucent enamel. In England Henry VI owned a splendid pair of gold candlesticks set with 4 sapphires, 4 rubies, 4 emeralds and 24 pearls. Subsequently, in the 16th century, Henry VIII had a set of four golden candlesticks with his initials enameled on them in red and weighing 126 oz. The inventory of the plate of Queen Elizabeth I includes 148 candlesticks and chandeliers of silver or silver gilt, a great many of which were what would now be called candelabra. The houses of the wealthy must have contained a great quantity of candlesticks; the household inventory of Sir Thomas Ramsey, a former lord mayor of London, who died in 1590, included 58 brass candlesticks.

Instead of the elaborate chandelier with as many as 12 lights, a candlebeam was sometimes used. This was composed of two or three crossed beams of carved and gilded wood, fitted with sockets and drip pans. Chandelier and candlebeam alike were suspended by two or more chains to a rope passing over a pulley, so that the whole fitting could be lowered as required for snuffing. In the larger houses the candlebeam was supplemented by wall lights or sconces of silver or brass fitted with reflectors behind the candles. These are described as plate candlesticks in the inventories of the time.

While the brass candlesticks were mostly imported into England, there was a considerable production of pewter ones, but the earliest-known English example, the Grainger candlestick (in the Victoria and Albert museum), dates from the beginning of the 17th century. The ordinary table candlestick of the 16th century had a high circular foot with its upper rim encircled by a deep molding to form a drip pan. The stem was of circular section and of cylindrical or baluster form. In Germany more ambitious types were made with the stem formed as a warrior or woodwose whose extended arms held the prickets or sockets.

Renaissance.—The Italian bronze founders produced superbly modeled candlesticks from small table examples to huge altar candlesticks with angel supporters of almost life size. The most magnificent examples were made of rock crystal mounted in precious metal enriched with translucent enamels; among these is the set of altar cross and pair of candlesticks (in the Victoria and Albert museum) with rock crystal panels mounted in enameled silver gilt, made in the mid-16th century by Valerio Belli. A late-16th-century silver pair in the Vatican was made by the goldsmith Antonio Gentili. A fine bronze candelabrum in the Church of S. Antonio, Padua, Italy, is about 11 ft. 6 in. high with many grotesques, garlands, figures and panels modeled in relief.

Renaissance artists pressed a great variety of materials into use for the production of candlesticks, including Limoges enamels, pottery such as Saint-Porchaire ware, amber and damascened iron. Among the more fantastic forms were the chandeliers called *Leuchterweibchen* made in German-speaking areas. A figure of a woman or a monster was carved in wood and painted in naturalistic colours and to the back was fixed a large pair of antlers to which in turn were attached prickets or sockets for candles. A design by Albrecht Dürer for a lustre of this type exists, and examples still survive in German castles and city council chambers. At the other end of the scale are the simple table candlesticks made in England from common earthenware covered with a greenish glaze. A few of these (in the Guildhall museum, London) were excavated in London; with their bell-shaped base surmounted by a wide drip pan, short stem and long, outward-tapering socket, they show English folk art at its best.

17th Century.—The few examples of English candlesticks of pre-Restoration date that have survived present considerable variety of form. The earliest, which probably dates from about 1600, is of crystal and silver gilt, with two sockets attached to a crystal crossbeam supported on a stem decorated with figures of eagles and satyrs. Other examples are less ambitious: a pair of 1618 have solid sockets and grease pans, but stems and triangular bases of wire, supported on three feet resembling pepper pots. A pair in the Fairfax inventory of 1624 described as "wyer silver candlesticks" were doubtless of this type. Fewer candlesticks were imported from the Low Countries in the 17th century, and one of the two main types in use in England at that time was of local origin. It had a trumpet base, hollow stem decorated with "sausage" turning and a wide drip pan set about a third of the way up from base to socket. The other type, which was much produced in the Netherlands, had a baluster stem of excellent proportions and form, spreading base and wide drip pan halfway between top and base.

The production of brass chandeliers, which became so important in the Netherlands during the 18th century, was started in the 17th. These had a boldly shaped baluster stem terminating beneath in a large burnished reflecting sphere; from the stem sprang a number of S-shaped branches ending in sockets. As a rule the chandelier was suspended from a chain, but in English churches it was sometimes attached to a wrought-iron suspension rod, which was lavishly ornamented with flowers, leaves and scrollwork, and enriched with painted colours and gilding. Simpler chandeliers were also made by village blacksmiths; these had a central sphere of wood from which sprang curved iron rods ending in prickets.

In accordance with the baroque style of the 17th century, silver candlesticks were made with stems boldly modeled with human or animal figures. Very few of these survived, as they consumed a great deal of precious metal and were broken up for its sake when they ceased to be fashionable. The fashion for this type of figure ornament was widely spread in Europe and the few examples surviving are of German, English or Dutch origin.

Wall sconces were greatly favoured and were provided with reflector plates of great size, embossed with profuse ornament in high relief. The long dining halls of 17th-century houses had space for numbers of these sconces, and some of the German princely collections include large sets of them. The royal plate at Windsor castle, Berkshire, includes some very handsome sconces with elaborately embossed reflectors made for Charles II. It was soon realized that mirror plate made an even more effective reflector for candlelight than polished silver, and from the late 17th century it became usual to set the back of sconces with looking glasses, which were known as mirror sconces.

While in France the splendid silver furnishings of Louis XIV's palaces had to be sacrificed to contribute bullion to pay for his wars of conquest, much silver furniture survived in England, including several huge chandeliers made entirely of silver. The finest of these, made during the reign of William III for Hampton Court palace, Middlesex, is still in position there; others are found at Chatsworth in Derbyshire and Drumlanrig in Scotland. At the same time chandeliers of carved and gilded wood were made; one of those made for the Queen's gallery at Kensington palace during the reign of William III and now in the Victoria and Albert museum has 12 branches in two tiers of carved and gilded wood and is surmounted by a royal crown.

18th Century.—The 18th century was the great age of candlelight, and the salons of the nobility and gentry were lighted by many hundreds of candles from chandeliers, candelabra and wall sconces. In England silver and glass were used in the homes of the wealthy, while brass chandeliers were hung in churches and council chambers, these last being manufactured in England instead of being imported. As the century advanced, chandeliers became more massive in form and more elaborate in ornament. The earliest English glass chandeliers date from the 1720s and were of plain design with a heavy ball at the base of the shaft, like the contemporary brass chandeliers. Later they were decorated with numbers of pendants and the surface was given life by cutting. Another decisive change came in the 1770s when the ball was replaced by an urn form. At the same time pear drops were hung from the branches and glass spires set in the upper tiers in place of candles. The chandelier eventually became even more elaborate, icicles being suspended around the shaft and long cascades of pear drops suspended from the lustres.

In Europe rock crystal was used instead of glass on the finer chandeliers, but in the course of the 18th century the production of glass ones was greatly expanded in Venice and in Bohemia. The Venetian chandeliers were made of varicoloured glass with floral ornament and achieved a particularly decorative effect. Such was their popularity that the mid-18th-century design has been produced in Murano, Italy, ever since and can be purchased new in most European capitals. Magnificent porcelain chandeliers were produced at the larger European factories but, because of their extreme fragility, few have survived.

In 18th-century France some of the finest chandeliers were made of gilt bronze (ormolu). The richest and most splendid, dating from the mid-18th century, were cast and chased in bronze to highly rococo designs. Corresponding to the big chandeliers were candelabra and single candlesticks, which, designed by artists such as Juste Meissonier, rank as works of sculpture rather than as domestic accessories.

In the 18th century wall lights became more elaborate. Though the same materials—carved wood, silver gilt, bronze or brass—were used, they were made with many more candle sockets arranged in tiers or, in the case of those of the rococo period, growing asymmetrically out of a central stem. The reflector plate, which had played so important a part in the design of the 17th-century wall light, was abandoned in the course of the following century, the effect being gained by massing lights rather than by reflection. The girandole was a particularly ornamental type of wall light made of gilt bronze or carved wood and having usually two branches. The great engravers and gilders of mid-18th-century Paris executed superb examples in gilt bronze.

Table candlesticks were made in great variety of design and material. The great houses contained many dozens of pairs of silver candlesticks, and consequently the candlestick is almost the commonest surviving article of English 18th-century plate. The rapid change of fashion in the 18th century from the plain Queen Anne style to the elaborate late baroque of early Georgian and subsequently to the rococo, neoclassical and regency or empire styles ensured variety in production. A similar evolution of design took place throughout Europe. Because of the greater wealth of the 18th century, the brass candlestick did not play so important a part, but toward the end of the century very elegant designs were executed in Sheffield plate at Matthew Boulton's works in Birmingham as well as in Sheffield itself.

19th Century.—The design of the candlestick in the early 19th century was influenced by the introduction of the tall glass open shade which kept the flame from flickering. The candlesticks were made of brass or bronze and decorated with Egyptian or classical motifs. An attractive type had a circle of branches below the nozzle from which were suspended cut-glass icicles. In large candelabra, figures of Atlas or of Egyptian slaves were popular, the latter especially in France. (J. F. H.)

In the latter part of the century, with the advent of the more convenient and efficient methods of gas and electric lighting, the real need for candlesticks diminished rapidly, although in remote districts their use continued in spite of the greater efficiency of acetylene, paraffin and other portable lamps. For use when moving about or going to bed, a candlestick was far lighter and simpler to use than these lamps, and the chamber type, with saucer-shaped base and small looped handle, continued to be manufactured in various metals, pottery or even kitchenware enamel. Designs retreated from decorative to purely utilitarian levels as candlesticks were relegated to humbler use.

20th Century.—A revival of purely decorative types of table candlestick or candleholder occurred in the middle decades of the 20th century, stimulated by fashions for candlelit dinner tables. Scandinavian designs popularized candlesticks of glass, both heavy polished glass and lighter blown or molded types. Wrought iron, copper and brass were used for designs in Italy, Spain, Yugoslavia and farther north, in some cases reverting to the spike or pricket method of fixing candles in position. Silver, pewter and wood also were employed.

Altar candlesticks continue to be used in churches, and although traditional "church plate" types persist widely, many individual designs have been commissioned in the modern style. Silver, gilt and, to a lesser extent, brass still remain favourite materials, but aluminum, stainless steel, enamel inlays and some forms of plastic have all been used successfully in both old and new churches. In general these designs are simple, based on pure or adapted geometric shapes that exploit the quality of the material. In contrast, the large bronze many-branched candelabra presented to Westminster abbey in 1939 and 1942 were designed by Benno Elkan with an elaborate symbolism and detail that owes much to historical sources. (E. C. D.)

CANDLISH, ROBERT SMITH (1806–1873), early leader of the Free Church of Scotland (*q.v.*), was born at Edinburgh on March 23, 1806, and spent his early years in Glasgow, where he graduated in 1823. In 1834 he was appointed minister of the important parish of St. George's, Edinburgh, and there he came to be regarded as one of the ablest preachers in Scotland. His first assembly speech, delivered in 1839, placed him at once among the leaders of the "nonintrusion" party, and his part in settling the problems created by the Disruption of 1843 was inferior only to that of Thomas Chalmers (*q.v.*). After Chalmers' death in 1847 Candlish was the most prominent leader in the Free Church. In 1862 he succeeded William Cunningham as the principal of New college, Edinburgh, while retaining his position at St. George's. His writings had a considerable influence on theological thought in Scotland and beyond. He died in Edinburgh on Oct. 19, 1873.

See W. Wilson, *Memorials of R. S. Candlish, D.D.* (1880).

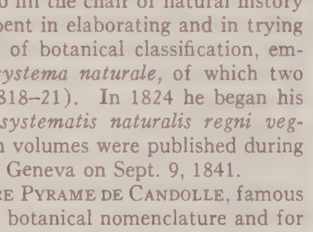
CANDOLLE, (AUGUSTIN) PYRAME DE (1778–1841), Swiss botanist who played a prominent part in the establishment of a natural system of classification of flowering plants, was born at Geneva on Feb. 4, 1778. He studied at Geneva and settled in Paris in 1796. His *Plantarum succulentarum historia,* four volumes (1799–1829) and *Astragalogia* (1802), a work on the pea family, introduced him to the notice of G. Cuvier and to J. B. Lamarck, who confided to him the publication of the third edition of the *Flore française* (1805–15). The *Principes élémentaires de botanique,* printed as the introduction to this work, contained the first exposition of his principle of classification according to the natural as opposed to the Linnean or artificial method. In 1804 he published his *Essai sur les propriétés médicales des plantes,* etc., and soon after, in 1806, his *Synopsis plantarum in flora Gallica descriptarum.* At the desire of the French government he spent the summers of the following six years in making a botanical and agricultural survey of the whole kingdom, the results of which were published in 1813. He lectured on botany at Montpellier (1808–16) until he returned to Geneva to fill the chair of natural history there. The rest of his life was spent in elaborating and in trying to complete his "natural" system of botanical classification, embodied in his *Regni vegetabilis systema naturale,* of which two volumes only were completed (1818–21). In 1824 he began his most famous work, *Prodromus systematis naturalis regni vegetabilis* (1824–73), of which seven volumes were published during his lifetime. De Candolle died at Geneva on Sept. 9, 1841.

His son, Alphonse Louis Pierre Pyrame de Candolle, famous for his formulation of the laws of botanical nomenclature and for his studies on the origin of cultivated plants, was born at Paris on Oct. 27, 1806. He succeeded to his father's chair at Geneva in 1842, and published the remaining nine volumes of the *Prodromus,* one of them in collaboration with his own son, (Anne) Casimir Pyrame de Candolle (1836–1918). Among numerous botanical works, Alphonse de Candolle published *Géographie botanique raisonnée* (1855); *Lois de la nomenclature botanique* (1867); *Origine des plantes cultivées* (1833; 2nd ed., *Origin of Cultivated Plants,* 1886). He died at Geneva on April 4, 1893.

See A. de Candolle, *Mémoires et souvenirs d'Augustin Pyrame de Candolle* (1862); A. Engler, *Alphonse de Candolle* (1893).

CANDY: *see* Confectionery Manufacture.

CANDYTUFT, the name for any small annual or perennial herb of the genus *Iberis* belonging to the family Cruciferae and native to southern Europe (*Iberis* from Iberia, the old name for Spain) and western Asia. Of the approximately 30 species several are shrubby or evergreen garden perennials. The two outer petals of the flowers, which grow in round or elongated heads, are longer than the two inner ones. Their colours range from white to dark purple or red and some are fragrant.



BY COURTESY OF BURPEE SEEDS

CANDYTUFT (IBERIS SEMPERVIRENS)

The cultivated species are easily grown if they have plenty of sun and space. The commonest border kinds are: *I. amara* (rocket candytuft), an annual with white, scented flowers; *I. umbellata* (globe candytuft), an annual with unscented flowers in a variety of colours from purple to white; and *I. sempervirens,* an evergreen shrubby plant with white flowers, much used for edges and in rock gardens. *I. amara* is sometimes found in chalky cornfields in England.

CANE. Cane perhaps most generally refers to sugar cane, *Saccharum officinarum,* of the grass family. The related *Sorghum* cane is widely cultivated in warmer parts of the temperate zone to yield a sweet sorgo sirup, and selected varieties have been an important feed grain in drier climates. Cane also signifies the jointed, pithy stems of a number of other tall grasses such as *Phragmites* and bamboo, colonies of which may be termed cane brake. Stems of several oriental palms are especially well known as rattan or rotan canes, a significant commercial export from the eastern tropics. In horticulture slender tough stems of almost any shrub may be termed canes, such as those of the raspberry and rose.

Sugar cane is probably native to the far east, but has been introduced throughout the tropics. It has become a mainstay in the agricultural economy of several Caribbean countries and Brazil In the mid-1960s world production of cane sugar exceeded 36,000,000 tons. The spent canes, bagasse, are used as fuel for boilers and in making fibreboard.

Sugar cane is typically propagated by planting sections of stems Modern machines have been used for planting and cutting. Often the plants are set afire to eliminate foliage on mature canes, facilitating harvest by cutting machines. Juice extracted from cut canes is concentrated to molasses by boiling, from which the suga crystals are centrifuged out prior to refining (*see* Sugar: *Suga Cane*).

Bamboo, *Arundinaria,* canes have been used, like rattan, for construction in the orient; for the familiar fishing poles, porch furniture and plant supports; and (split) for weaving and binding Bamboos are the largest members of the grass family, some species attaining heights of more than 100 ft. Bamboo cane has neve attained the importance in the western world that it has in th orient (*see* also Bamboo).

Rattan cane comes from the long trailing stems of climbing palms, especially species of *Daemonorops* and *Calamus,* exceedingly strong, tough and elastic. There are reports of stems reaching 600 ft., clinging to supporting jungle vegetation by hooklike spines on the petioles of the pinnate leaves. Canes are hand pulle from their lofty perches for harvest.

Stem sections have been used for walking canes (Malacca walking sticks), handles, in furniture and for basketry. Split, the are often woven into seats and backs, wickerwork, for garde type furniture.

Rattan is an important commercial item of Indonesia, exports from there reaching about 30,000 metric tons yearly. Rattan can also finds native use for construction and binding. Plastics have supplanted canes for many industrial uses. (R. W. Sy.)

CANEA (Gr. Khania), capital of Crete (since 1841) and o the *nomos* (prefecture) of Khania. The successor of the classical city Cydonia, it occupies the coast round the Bay of Canea (Kolpos Khanion) and the isthmus between that and Suda bay (Kolpos Soudhas). Pop. (1961) 38,467. The town returns five members to the assembly in Athens and is the seat of the governo general. As a port it has been largely superseded by Suda bay an Iraklion (Candia). It still exports, however, about a quarter o Crete's oil and wine and most of the island's citrus fruits. It i connected with Iraklion by a daily bus service and with Piraeus by regular boat services.

The Venetians fortified the town (which they named Canea) an built numerous churches, but the medieval buildings sufferec severe damage during the German attack in 1941. The harbou and galley sheds, however, though originally far less inspiring than those of Iraklion, are now in much better condition. A Turkish bathhouse near the harbour is now an archaeological museum. Canea is the seat of a suffragan of the metropolitan o Iraklion and also has a Roman Catholic convent and a Jewis synagogue.

The city was captured from the Venetians by the Turks in 1646 After numerous revolutions the treaty of Khalepa (a suburb o Canea) was signed in 1878, granting various privileges to th Cretans. After the rebellion of 1897 Canea was occupied by detachments from the protecting powers. Eleutherios Venizelos wa born at Mournies, a neighbouring village, and made Canea hi headquarters during his rebellion in 1909. In 1941 the city wa used first by the British and later by the Germans as their headquarters in Crete.

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CANELONES, a department bordering Montevideo in southern Uruguay established in 1816; area 1,835 sq.mi., pop. (1963

255,326. The Montevideo market is the key to Canelones' flourishing economy. Its truck gardens, dairy and poultry farms, vineyards and cattle butchers supply products to the capital. Canelones' beach resorts Atlántida and La Floresta, part of its 40-mi. coastline, and the racetrack at Las Piedras attract visitors from Montevideo. Proximity to the capital city has raised land values and encouraged land subdivision in Canelones, and loss of land fertility has been an indirect result. The departmental capital, Canelones (pop. [1963] 14,028), is an agricultural trading centre with a flour milling industry. (M. I. V.)

CANIS MAJOR (the Greater Dog), in astronomy, a constellation southeast of Orion. It is situated across the Milky Way from Canis Minor, the Lesser Dog. The two Dogs are represented in old celestial picture books (*see* CONSTELLATION) as accompanying Orion in his conflict with Taurus. Some diversion of their interest is suggested, however, by the presence of Lepus, the Hare, immediately south of Orion.

Canis Major presents no distinctive geometrical figure; it consists of the brilliant Sirius (*q.v.*) and other stars generally to the south of it. Sirius, the Dog star, the brightest star in the heavens, appears in the south in the early evenings of late winter for observers in middle northern latitudes. It is situated nearly on the extension to the southeast of the line of the three stars of Orion's belt. Sirius occupies one vertex of a large equilateral triangle, of which the other two vertexes are marked by Procyon, the Little Dog star, and the red star Betelgeuse in Orion. For observers as far south as St. Louis, Mo., Sirius comes up high enough in the south so that Canopus, in Carina, the second in brightness of all the stars, can be seen near the horizon below Sirius.

The Epsilon star of Canis Major ranks last in the list of 22 stars brighter than visual magnitude 15. Beta Canis Majoris, west of Sirius, gives its name to a class of variable stars that pulsate in periods of only a few hours. (R. H. BR.)

CANKAR, IVAN (1876–1918), an outstanding Slovene writer and patriot, was born at Vrhnika, May 10, 1876. After a childhood spent in poverty he went to Vienna to study engineering, but soon abandoned this to earn his living by his writings, which defended the oppressed and made satirical attacks upon those who exploited them. He returned to Slovenia in 1907. Cankar was a prolific writer of short stories, novels, articles, drama and verse; he was also a political speaker and was imprisoned for criticism of the Austrian regime. In spite of its tendentious nature his work has great artistic value and reveals an original style—simple, yet eloquent, subtle and melodious. He died at Ljubljana on Dec. 11, 1918.

Cankar's collected works were edited by Izidor Cankar in 20 volumes (1925–36). His *Hlapec Jernej in njegova pravica* was translated as *The Bailiff Yerney and His Rights* (1930). (V. J.)

CANNABIS, an ancient intoxicating drug originally obtained from the flowering tops of the hemp plant (*Cannabis sativa*), which grows in mild climates in many parts of the world, is mentioned in a Chinese herbal dating to about 2700 B.C. The crude drug can be obtained from the leaves, flowers, seeds, and stems of hemp, the female plant yielding more resin and therefore more active principle than the male. One of the least understood of all natural drugs, cannabis is known under many aliases. The term marihuana (marijuana) is often used to refer to any part of the hemp plant or to its extract. Among other names for the crude drug are hashish, charas, dagga, bhang, ganja, kef, and, in the Western Hemisphere, as argot for marihuana, pot, tea, grass, weed, and Mary Jane. The dried, crushed product, which varies in strength depending on where and how it is grown, prepared for use, or stored, is usually smoked in cigarettes or pipes, but it can also be sniffed or taken in food. The drug has long been used as a sedative or analgesic, but it has no known use in modern medicine and is no longer an official drug. Its wide use as an intoxicant throughout the world has raised various medical and social questions, many of which are under continuing scientific investigation. (*See* also HEMP.)

The more immediate effects of cannabis can be reddening of the eyes, moderately rapid heartbeat, tightness of the chest (if the drug is smoked), thirst, food craving, drowsiness, unsteadiness, muscular incoordination, and disruption of the perception of time and space. The effects vary, depending on the strength and amount of the drug consumed, the setting in which it is consumed, and the experience of the user. Psychological effects tend to predominate, the common experience being a mild euphoria, with heightened suggestibility, some distortion of vision, and faulty judgment. Acute intoxication may induce visual hallucinations, pronounced anxiety, depression, extreme variations of mood, paranoid reactions, and transient psychoses lasting from four to six hours. Chronic use does not establish physical dependence, nor does the regular user suffer extreme physical discomfort upon withdrawal such as that associated with opiate use. Much research is being directed to identifying long-term physical effects on the body and to clarifying the effectiveness of the drug as a reality-distorting agent producing psychological dependence.

International trade in cannabis was first brought under control in the International Opium Convention of 1925, largely at the instance of the governments of South Africa and Egypt. Information subsequently collected by the League of Nations Advisory Committee on Illicit Traffic showed that the drug was widely consumed in the Middle East, Africa, and the Indian subcontinent, where certain preparations were traditionally used for religious as well as social purposes. During the 1930s abuse of cannabis became evident in North America, and federal legislation to control this was passed in 1937, an action extended to the synthetic in 1968. After World War II the United Nations Commission on Narcotic Drugs initiated a number of surveys that showed the use of the drug to be widespread in the Middle East and some parts of Africa and South America and to be increasing in Europe and North America. In 1954 and 1957 the World Health Organization affirmed its view that cannabis does not possess any therapeutic value, and in 1965 a WHO publication declared that "the harm to society derived from abuse of cannabis consists of the impairment of the individual's social functions and his enhanced proneness to asocial and anti-social behaviour." In 1961 a Plenipotentiary Conference, convened at New York to adopt the Single Convention on Narcotic Drugs, approved the inclusion in the treaty of provisions to strengthen control of production of cannabis and trade in cannabis preparations, to bring to an end within 25 years the nonmedical use of cannabis in countries where this had been traditional. and to permit the absolute banning of the drug (except for research) where this seemed to the government concerned desirable because of the risk to public health. In the convention cannabis is cited (along with heroin) as a drug particularly liable to abuse and having no irreplaceable therapeutic advantages. By the late 1960s most countries had enforced restrictions on the traffic and use of cannabis and imposed generally severe penalties for illegal possession, sale, or supply. Also, reports received by the United Nations showed that more than 350,000 kg. of cannabis were being seized annually by enforcement authorities.

In latter years controversy has arisen in some Western countries about the harmfulness of using cannabis, and such international organizations as the Narcotics Commission, WHO, the Permanent Central Narcotics Board, and Interpol have felt it necessary to reaffirm their concern about the dangers of the drug. In May 1968 the Economic and Social Council of the United Nations adopted a resolution recommending that all countries concerned should intensify enforcement, promote research, and deal effectively with publicity advocating legalization or tolerance of the nonmedical use of the drug. In 1969 WHO reported cannabis as not physically habit forming but a drug of dependence and recommended keeping it under legal control.

In the United States and elsewhere cannabis research began to accelerate in the late 1960s. The drug's active ingredient, a tetrahydrocannabinol (THC) derivative, was isolated and subsequently synthesized by R. Mechoulam and Y. Gaoni (reported in 1965). This chemical became available for research, through which scientists could more accurately measure the drug's effects and study its short- and long-term action on the body.

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CANNAE, an ancient village of Apulia in Italy, on a hill above the right bank of the Aufidus (mod. Ofanto) river, 4 mi. S.W. of its mouth and about 6 mi. downstream from Canusium (mod. Canosa di Puglia), celebrated for Hannibal's victory over the Romans there on Aug. 2, 216 B.C. Later it became a municipium, and Roman remains survive on the hill of Cannae (Monte di Canne). In the middle ages it became a bishopric, but was destroyed in 1276.

The consuls of 216 B.C., Lucius Aemilius Paulus and Gaius Terentius Varro, acting in accordance with a senatorial decree, prepared to meet Hannibal in a pitched battle (for the military situation and for a plan of the battle *see* PUNIC WARS). They advanced to Cannae with perhaps 86,000 men; this is Polybius' figure, although Livy cites another tradition of 50,000–55,000. The Carthaginians had over 40,000 infantry and about 10,000 cavalry, of which a considerable proportion comprised Celtic recruits. The battle was fought on level ground beside the Aufidus near Cannae, but the precise position is uncertain. Attempts to place it either upstream from Cannae or near the hill of Cannae should be rejected. Two main theories prevail, placing the site (1) on the left (*i.e.*, north) bank, or (2) on the right (south) bank. The latter, which on balance seems more probable, is accepted here. Reports that the Romans were hampered by the rising sun and by a southeast wind have been used to help in establishing the position of the troops, but the former is denied by Polybius and the second is not decisive, any more than are suggestions about a possible change in the course of the Aufidus. Nor does the discovery in 1937 of large-scale burials help, since the date of the numerous skeletons is now known to be medieval.

While Hannibal was encamped probably on the right bank near Cannae, the Romans camped on the other bank about three miles lower down, and then established a smaller camp as an outpost on the right bank. In order to provoke battle Hannibal then transferred camp to the left bank, but this challenge was refused, and the Romans in turn offered battle on the right bank. They faced southwest, with their right wing resting on the river, and with the sea about three miles in their rear. They placed their cavalry (about 6,000) on their wings, and massed their infantry in an exceptionally deep (and therefore narrow) formation in the centre in the hope of breaking the enemy centre by weight and push. To counter this, Hannibal relied on the elasticity of his formation. He stationed his Gallic and Spanish infantry in the centre, two groups of his African troops on their flanks, and the cavalry on the wings. But before engaging the enemy, his line adopted a crescent shape, the centre advancing with the African troops on their flanks *en échelon.* As he anticipated, his cavalry won the struggle on the wings, and some then swept round behind the enemy. Meanwhile the Roman infantry gradually forced back Hannibal's centre, and victory or defeat turned upon whether the latter held. It did: although it fell back, it did not break, and the Roman centre was gradually drawn forward into a trap. Hannibal's crescent had now become a circle: the African troops, past whom the Romans were now thrusting, turned inward against them, and the Carthaginian cavalry was in the rear. Massed together and unable properly to use their arms, the Romans were surrounded and cut to pieces. Only 14,000 men escaped, together with 10,000 who were captured. The dead included Aemilius Paulus, but his colleague survived: Varro has in fact been made the scapegoat for the defeat which the senatorial tradition attributed to the rashness of a "new man" (Varro's father had been a merchant). Much of central and southern Italy now went over to Hannibal, but Rome refused to admit final defeat, although it could not fight another pitched battle until it had eliminated the chief cause of the defeat, the rigidity of the legionary formation. Cannae is regarded by military historians as a classic example of victorious double envelopment.

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CANNAN, EDWIN (1861–1935), British economist whos chief services to economic theory were on the theory of money on questions of demography and in clarifying and modernizin the theory of supply and demand as laid down by Adam Smith He was born at Funchal, Madeira, Feb. 3, 1861. After studyin at Clifton college and Balliol college, Oxford, he became lecture in political economy in London university in 1897. From 190 until his retirement in 1926 he was professor of political economy He died at Bournemouth on April 8, 1935.

Cannan's principal works were *History of the Theories of Production and Distribution* (2nd ed., 1903); *History of Local Rate in England* (2nd ed., 1912); *Wealth* (3rd ed., 1928); *Mone* (7th ed., 1932); and the standard edition of Adam Smith.

See his *An Economist's Protest* (1928); and an introd. by H. Dalto to *London Essays in Economics in Honour of Edwin Cannan* (1927)

CANNEL COAL, formerly called candle coal because of th appearance of the flame and because it can be lighted easily, is massive, noncaking, fine-grained block coal with a conchoidal fracture found to a limited extent in Lancashire, Eng., and in Virginia West Virginia, Tennessee, Kentucky and Pennsylvania in the U.S Cannel coal is a fireplace fuel; it has little industrial use. *Se* COAL AND COAL MINING. (M. D. CR.)

CANNES, a fashionable resort and tourist centre of souther France, lies on the Mediterranean sea, 16 mi. S.W. of Nice, in th *département* of the Alpes-Maritimes. Pop. (1962) 54,967. Apar from its climate, that of the Côte d'Azur (French Riviera), th town has the advantage of being sheltered by hills. Its roadstea is a port of call for transatlantic liners and yachts. There ar beaches of fine sand and luxuriant subtropical vegetation. Th town has extended on both sides of the original village on th slopes of Mont Chevalier, where there still stand a 12th-centur tower and a chapel. On the Promenade de la Croisette, which follows the curve of the coast, are the big hotels, and the Palais de Festivals in which the annual international film festival take place. There are two casinos. The town is linked with Paris b the southeast highway, and by rail with Paris and with neighbouring countries. Most of the important airlines serve the Nice airport. The tourist industry is the principal occupation, but flower especially mimosa, are exported all over the world.

Little is known of the early history of Cannes before 1834, whe Lord Brougham decided to settle there. It was probably founde in the 8th century B.C. by Ligurian tribesmen and occupied successively by Phocians, Celts (or Gauls) and Romans. In the 4t century A.D. it came under the protection of the monks of Lérin whose abbots were lords of Cannes. In 1763 Tobias Smollet found it "a little fishing town, agreeably situated on the beach o the sea"; and Napoleon, on the first night of his return from Elb bivouacked with his little army beneath the old village. There ar numerous reminders of history in the offshore Lérins Islands "the man in the iron mask" (possibly Count Mattioli or Eustach Dauger) and Marshal Bazaine, among others, were imprisone in Ste. Marguerite; and in the smaller island of St. Honorat (*se* LÉRINS, ABBEY OF) there are a Cistercian monastery and 5th century chapel, and on a promontory a fortified tower facing t seaward.

CANNES, CONFERENCE OF (Jan. 6–13, 1922), a mee ing of the supreme council of the Allies with the primary obje of considering Anglo-French suggestions for World War I reparations, drafted at the preliminary conference of London, De 18–22, 1921 (*see* LONDON, CONFERENCES OF; REPARATIONS).

The conference opened with a criticism of the Anglo-French su gestions by the French minister of finance, who was supported by the Belgian representative. After long and complicated discussions this resulted in a modification of the London suggestions, and representatives of Germany, as well as the Reparation commission, were summoned to Cannes to make proposals on the basis of the agreement finally reached between the Allies.

But wider questions of security and reconstruction were broached by David Lloyd George in a memorandum submitted to Aristide Briand on Jan. 4, which declared that the three problems of reparations, security and reconstruction were interrelated, and that any general scheme for European reconstruction must include Russia; and in which he offered to conclude an agreement by which Great Britain would pledge itself to assist France with all its forces in the event of unprovoked German aggression upon French soil. Lloyd George warned Briand that the British empire would not be willing to incur military commitments in central and eastern Europe.

On Jan. 6 Lloyd George proposed the summoning of a general reconstruction conference to which both the U.S.S.R. and the U.S. were to be invited, and this proposal was adopted by the supreme council, together with an outline agenda. Meanwhile Briand had been making counterproposals respecting the Anglo-French pact. The guarantee must be reciprocal and supplemented by a technical military convention. This second condition would probably have proved an insuperable obstacle from the British point of view, but Briand was violently attacked in the French senate and chamber in the belief that he was giving way unduly to Lloyd George. As a consequence he resigned on Jan. 12, and therewith the conference came to a premature close. Its main results were the provision for the Genoa conference (*q.v.*) in April and the avoidance of a deadlock over reparations.

See British White Paper, *Resolutions Adopted by the Supreme Council at Cannes, Jan. 1922, as the Basis of the Genoa Conference*, Cmd. 1621 (1922); A. J. Toynbee, *Survey of International Affairs, 1920–23* (1925).

CANNIBALISM. The eating of human flesh by men is a widespread custom, going back into early human history and found among peoples on most of the continents. The term is derived from a Spanish form of Carib, a West Indies tribe who were famous cannibals; the Greek term "anthropophagy" is also used.

Many of the early accounts of cannibalism are undoubtedly exaggerated or in error, since many peoples attributed the practice to their enemies. But cannibalism is still practised in interior New Guinea and prevailed until recently in parts of west and central Africa, Melanesia (especially Fiji), Australia, among the Maori of New Zealand, in some of the islands of Polynesia, among tribes such as the Batak of Sumatra, and in various tribes of North and South America.

In some regions human flesh was looked upon as a form of food, sometimes equated with animal food as in the Melanesian pidgin term "long pig." Much of Melanesian cannibalism was apparently of this type, and Fijian chiefs sometimes kept count of the number of individuals consumed. The victorious Maori cut up the dead after a battle and used them for feasting. The Batak were reported to sell human flesh in the markets before full Dutch control.

In other cases, however, the consumption of particular portions or organs was a ritual means by which certain of the qualities of the person eaten might be obtained, or by which powers of witchcraft or sorcery might be employed. Ritual murders and cannibalism in portions of Africa are often related to the practice of sorcery. And head-hunters and others often consumed bits of the bodies or heads of deceased enemies as a means of absorbing their vitality or other qualities and reducing their powers of revenge. (*See* HEAD-HUNTING.)

In some cases a deceased individual is ritually eaten by his relatives, a form called endocannibalism. In portions of aboriginal Australia such practices occurred as an act of respect, the bones being kept for a period. In other cases ritual cannibalism occurs as a part of the drama of secret societies. In the famous Cannibal Society of the Kwakiutl, the novice who is possessed by the cannibal spirit eats the flesh of a corpse or bites a piece out of the arm of a living person before being subdued and returned to a normal state. But such dramas were carefully staged for their effect on the audience; both the Kwakiutl and their neighbours had an actual horror of eating human flesh.

In the interior of North America, where Indian tribes lived on the margins of subsistence, cannibalism was an ever-present possibility. Occasional individuals among the Ojibwa developed a psychosis involving the desire to eat human flesh, a condition greatly feared and thought to be brought about by the windigo, or cannibal giant, who was believed to reside in the woods.

Perhaps the most graphic account of cannibalism in existence is Hans Staden's 1557 account of his captivity among the Tupinamba Indians of eastern Brazil. There captives might be adopted and marry, until the day came when they were to be killed and eaten. They were fed and treated well, and even knowing their eventual fate they did not attempt to escape. On the appointed day the victim was killed with a club and the women participated in the preparation and the eating of the body.

The eating of human flesh, even where primarily for food, always involves special utensils or some ritual restrictions. There are no completely satisfactory explanations of cannibalism. Groups closely related often have radically different reactions, and a group may practise cannibalism at one period and view it with horror at another. The practices of head-hunting, human sacrifice and ritual cannibalism seem to be linked in various areas, particularly in west Africa, Indonesia and South America. Often they are interchangeable or occur in adjacent groups; and frequently they have a general relation to fertility and group welfare.

The spread of western values and controls usually results in the prohibition of such practices before they are adequately studied. In modern society cannibalism occasionally occurs as the result of extreme necessity; the case of the Donner party crossing into California in the 19th century is such an instance.

(F. R. E.)

Lower Animals.—Cannibalism, in its broadest sense the eating of animals by other members of the same species, is common at all levels among the lower animals. The only necessary condition for cannibalism to occur is that some life stage of the organism fits within the range of food material of the species. Fertilized eggs or minute free-swimming larvae, for example, may fall prey to their own parents who subsist on minute organisms filtered out of the surrounding water. One of the more spectacular cases is the praying mantis, where the female devours the male during the mating process. Any carnivorous or omnivorous form is likely to be cannibalistic unless specific behaviour patterns contrary to cannibalism have evolved within the group. In some groups of birds and mammals which have evolved to what might be termed the family level of social behaviour, adverse conditions such as starvation or illness or injury of an animal may bring about a reversion to cannibalistic habit.

Under conditions of crowding, cannibalism is sometimes a powerful force for regulating the size of a population, a force that is greater when the population is relatively dense. In the flour beetle *Tribolium* the larvae and adults cannibalize the inactive stages, the egg and pupa. In a spatially limited environment at realistic densities of adult beetles, observations have shown that egg mortality caused by cannibalism alone can exceed 96% over a period of time equal to the duration of the egg stage. In this particular organism, this is the greatest single force regulating population growth, and thereby the degree to which the population exploits the environment. There have been no convincing data involving cannibalism as an important regulating force in a natural population. Rather it would appear that the event of an animal eating another member of its own species is largely a coincidence and, under suitable circumstances, not an unexpected one. The case of cannibalism as a specific behaviour pattern is a rather rare exception. (E. R. RI.)

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CANNING, CHARLES JOHN CANNING, EARL (1812–1862), English statesman, who was governor general of India at the time of the Indian Mutiny (*q.v.*), subsequently became the first viceroy of India and played an important part in the work of conciliation and reconstruction. He was born in London on Dec. 14, 1812, the youngest son of George Canning, succeeding in 1837 to the viscountcy created for his mother after his father's death. He served under Sir Robert Peel as undersecretary for foreign affairs and as commissioner of woods and forests, and under Lord Aberdeen as a successful reforming postmaster general (1853–55). Offered the governor generalship of India by Lord Palmerston in 1855, he took office in India in Feb. 1856.

His dispatch of an expedition to the Persian gulf in 1856 secured the Persian abandonment of Herat and the friendship of Dost Mohammed, ruler of Afghanistan. This friendship, consolidated by a treaty in 1857, proved invaluable when the Mutiny broke at Meerut in May 1857, for Canning, with small British forces eccentrically disposed, had soon to contend with rebels who held much of north India.

Canning was not an obvious leader: he combined great industry with an inability to delegate responsibility, his moral integrity involved him in overnice scruple. He lacked the dash, the feeling for public relations immediately required. But his stature grew with the danger. He was prompt to gather reinforcements, including troops on their way to China, and to hurry them up-country. He grasped the overriding importance of retaking Delhi and Lucknow, of not abandoning Peshawar. Above all he had the vision to look beyond the Mutiny—whence his insistence upon "deliberate justice and calm patient reason." He was severe. He brusquely rejected amnesty proposals made by John Colvin, John Lawrence and James Outram. But while in England people were "rabid with desire of indiscriminate vengeance" and in Calcutta British civilians were clamorous for wholesale punishment and wholesale distrust of all Indians, Canning convinced Indians that his purpose was conciliation, not vengeance. To him, the first viceroy, appropriately fell the task of announcing in Nov. 1858 the queen's offer of mercy, of impartial favour to all races, of respect for religion and hereditary title.

After the Mutiny Canning presided over the reorganization of the Indian government which had now passed from the British East India company to the crown. By the Councils act of 1861 he reorganized his executive council, substituting for collective action a departmental division of responsibilities. He enlarged his legislative council, making room for Indian nonofficial members. Though he restored legislative councils to the presidencies, he retained, through his law member and council, the right to legislate for all India and passed with their aid three great codes, including the remarkable penal code. He remodeled the Indian army, strengthening the European element and taming the sepoys by division. More Sikhs, Muslims and Gurkhas were recruited, and the Hindus were divided into caste companies. He pressed forward railway development. By his successful measures in 1861 he showed the possibility of famine relief. Education he encouraged: Calcutta, Bombay and Madras universities had been founded during the Mutiny, grants-in-aid followed for private colleges. By the Bengal rent act he protected tenants against eviction or undue rent enhancements, and he intervened to prevent their exploitation by European indigo planters.

Only in Oudh, where in 1858 he had alarmed everyone by declaring all land confiscated, did he introduce a land-revenue settlement unduly favourable to landlord interests. The motive was political, a wish to win over the influential landlords, to make them what the princes had proved to be, "breakwaters against the storm," junior partners under the crown in empire.

Lady Canning died in Nov. 1861. In March 1862 Canning left India, broken by overwork and grief. He died in London on June 17, 1862.

See Sir H. S. Cunningham, *Earl Canning* (1891). (J. B. Ha.)

CANNING, GEORGE (1770–1827), British statesman, who was prime minister for a short time during 1827, is chiefly remembered for his liberal policy as foreign secretary from 1822 to 1827. He was born at London on April 11, 1770. His father, also named George, was the eldest son of a country gentleman with a large estate in County Londonderry, Ire. In May 1768, four years after being called to the bar, Canning senior married a beautiful but penniless girl, Mary Ann Costello, against the wishes of his father, who disinherited him. He died on April 11, 1771, leaving his wife and year-old son entirely destitute. The widow became an actress to support herself and her son, and became the mistress of the actor Samuel Reddish, by whom she had five children. Later (Feb. 11, 1783) she married another actor, Richard Hunn, and by him too she had five children, but this new connection did nothing to rescue her from discredit and misfortune. From this unsatisfactory environment the boy was taken by a wealthy uncle, Stratford Canning, who brought him up with his own children.

Canning was educated at Hyde Abbey school near Winchester, at Eton and at Christ Church, Oxford. After graduating (1791) he entered himself at Lincoln's Inn, but soon decided on a political career. Hitherto his views had been distinctly Whiggish, under the influence of R. B. Sheridan and Devonshire house, but in July 1792 he came under the influence of William Pitt, who undertook to find him a seat in parliament. Moreover, the progress of the French Revolution toward anarchy and violence at home and aggression abroad cured him of his leanings toward constitutional change. He was elected for the pocket borough of Newtown, Isle of Wight, in July 1793, and he quickly became recognized as one of the rising men on the government side of the house. Pitt further procured for him the undersecretaryship of state for foreign affairs in 1796. Though the work was "pretty hard and constant" he found time to contribute to the *Anti-Jacobin* (1797–98), a weekly paper started to ridicule both English and French republicans. In 1799 he left the foreign office and was appointed a commissioner of the board of control. In May 1800 he was promoted to the office of joint paymaster of the forces and made a privy councilor. A few weeks later he married Joan Scott (with a fortune of £100,000), whose sister was the wife of the duke of Portland's son Lord Titchfield. By her he had four children, including Charles John, Earl Canning, a governor general of India. Mrs. Canning (d. 1837) was created Viscountess Canning in 1828.

When Pitt resigned in 1801 Canning too went out of office. Disapproving of Pitt's support of Henry Addington (later Lord Sidmouth) he made himself independent in 1802 by giving up Wendover, for which he had sat since 1796, and buying an Irish rotten borough, Tralee, "the freest seat that the market could afford." In 1803 Pitt began to turn against Addington, and Canning could then go into open opposition without forfeiting Pitt's friendship. On the formation of Pitt's last ministry (May 1804–Jan. 1806) Canning became treasurer of the navy, but his unpopularity (his biting wit made him many enemies) kept him out of the cabinet. Much to his disgust his colleagues resigned after Pitt's death because of the insecurity of their parliamentary position, but in March 1807 the king dismissed the "ministry of all the talents" on the Catholic question, and called upon "the friends of Mr. Pitt" again to form a government. Canning became foreign secretary but his rival, Spencer Perceval, was now leader of the house of commons.

Canning's first tenure of the foreign secretaryship witnessed the seizure of the Danish fleet (his own brilliant planning), the beginning of the Peninsular War and the unfortunate expedition to the Scheldt. Holding Viscount Castlereagh, the war secretary, responsible for the disasters that overtook British arms at Corunna, Spain, and Flushing (Holland), Canning, in 1809, insisted on his dismissal. They quarreled, and fought a duel on Sept. 21, Canning being wounded in the thigh. Both had already resigned, Canning because of the nonfulfillment by the duke of Portland, the dying prime minister, of his promise that Castlereagh should be removed from the war department. Canning offered to form a government but the king called upon Perceval, and Canning remained out of office until 1816. Lord Liverpool, who succeeded to the premiership in 1812 on Perceval's assassination, tried hard to induce Canning to take office, the negotiations breaking down in July because Canning refused to allow his old rival Castlereagh (who generously offered to surrender the foreign secretaryship to him and to take the inferior office of chancellor of the exchequer) to retain the leadership of the house of commons. So Canning lost the chance of being the peacemaker of Europe in 1815, and he further damaged his reputation in 1814 by accepting what was believed to be a rich sinecure, the Lisbon embassy.

Two years later he entered the cabinet as president of the board of control, and under his direction the marquess of Hastings extirpated the Pindaris and established British supremacy in central India by defeating the Marathas. Canning, disapproving the government's proceedings against Queen Caroline, resigned in Dec. 1820. In the hope of improving his financial position, and believing that advancement at home was blocked by the king's hostility to him, he accepted the governor generalship of Bengal in March 1822, with the additional prospect of a peerage on his return, but, before his ship was ready to sail, Castlereagh committed suicide (Aug. 12), and George IV reluctantly acquiesced in Canning's succession to the "whole inheritance"—the foreign secretaryship and the "lead" of the house of commons. He was now the most important member of the government. Afraid of becoming too deeply involved in continental politics, and disliking the great despotic sovereigns who were anxious to suppress liberal movements everywhere, he cut England adrift from the so-called Holy Alliance in 1823; prevented European intervention in South America on behalf of Ferdinand VII of Spain; recognized the independence of the rebellious Spanish American colonies (and so "called the New World into existence to redress the balance of the Old"); sent an army to Portugal to meet the threat of attack by Spain; gave diplomatic support to the Greeks in their struggle for freedom; and ensured the eventual creation of an independent Greek state.

Lord Liverpool's premiership came to an end on Feb. 17, 1827. He had long since marked out Canning as his successor, but it was far from obvious that he would be the king's choice. Although since 1822 he had gained a remarkable ascendancy at Windsor by the success of his foreign policy and by a judicious attention to the royal intimates there, Canning was the leading advocate of Catholic emancipation, and George IV had been persuaded that the cause of the monarchy was linked with that of the Established Church and resistance to the Catholic claims. Peel and Wellington, the leading opponents of Catholic relief, knew that no government could be formed without Canning, and Canning refused to serve under another anti-Catholic premier. Finally, on April 10, he was authorized to reconstruct the ministry on the understanding that the royal conscience was not to be forced. Moved partly by personal animosity, partly by dislike of Canning's advocacy of Catholic emancipation, half the cabinet refused to serve under him, and, in all, more than 40 ministers and placemen resigned, but the Whigs came to his assistance, and most of the independent members of parliament supported him with their votes. His ministry, however, lasted only four months; his health broke down under the strain, and he died on Aug. 8 at Chiswick in the house of the duke of Devonshire (but not in the same room, as is sometimes stated, as that in which Fox had breathed his last, 21 years earlier).

Character and Achievements.—Canning had all the irritability of the artistic temperament which he probably owed to his mother. To some, especially to his intellectual inferiors, he seemed arrogant and contemptuous. His wit and sarcasm were remembered by all who heard or read his speeches. Wellington thought him the finest speaker he had ever heard; he was probably, indeed, not inferior to Pitt. He was the most indefatigable of men, often working from breakfast until late at night without food, and this long-continued irregularity, his friends believed, rendered an irritable temperament still more uncontrollable. The world tended to misjudge his character from his defects, and overlooked his energy, patriotism and outstanding abilities. He could never forget his ambitions, but even his enemies like Metternich, who lamented the "mischief" he did as foreign secretary, had to admit that he was a great man. It was the fashion to say of him that he was no gentleman. The hatred and malignity with which he was assailed by the Tory aristocracy in 1827 showed what mountains of prejudice still existed against a prime minister born outside the purple of the governing class. Lord Grey declared that the son of an actress was incapacitated *de facto* for the premiership. Lord Londonderry spoke of him as a charlatan parvenu, "mother Hunn's offspring." In choosing Canning as prime minister George IV found that he had to fight over again his father's battles against the pretensions of the great families to deprive the crown of its ancient and undoubted right to nominate its servants.

Contemporaries said that Canning's ministry was the most popular with the middle classes that had ever been known. As member for Liverpool (1812–22) he came fully to recognize the needs of the rising commercial and industrial interests. He and William Huskisson taught a large portion of the Tory party to take a more liberal view of many measures of domestic, colonial and foreign policy. Although the ablest and sincerest opponent of parliamentary reform, he largely contributed to the creation of that independent and liberal spirit among the younger members of the house of commons, without which the Reform bill could not have been carried without a revolution. Charles Greville thought Canning the only man capable of saving the unreformed parliament and the old order in general, but, far from recognizing him as their saviour, the Tory aristocrats hunted him to death "with their besotted and ignorant hostility." Some of his friends believed that, had he lived, he would have supported parliamentary reform in 1831, thereby taking the question out of the hands of those who were disposed to push reform as far as revolution. Lord Granville said that Canning "sought to avoid revolution, not by stubborn resistance to all movement and reformation, but by rendering the acts of the government conformable to the spirit of the times."

He put his country before personal or party interests. Nothing but a sense of public duty induced him to take the foreign secretaryship in 1822: "I take no joy, and I feel none. I have sacrificed my interests, my wishes, and I believe my happiness, but I hope I have done my duty." None of the party leaders of the time had more generous notions of the obligations that he owed to his supporters. He never thought he could do too much for his friends, but he never used his influence to secure undeserved promotion for them. They, for their part, were drawn to him by bonds of intense personal devotion, and, through his disciples, like William Huskisson and Lord Palmerston, he wielded an authority that endured beyond the grave. Like other public men of the day, he died much poorer than he would have been but for his long official career. His wife's fortune of £100,000 had shrunk to about £40,000 in 1827.

See also references under "Canning, George" in the Index volume.

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CANNING, COMMERCIAL. The history of canning goes back to 1795, when the French government offered a prize of 12,000 fr. for the discovery of a practical method of food preservation. France was in the grip of a revolution at home and at the same time was at war with several hostile European nations. Consequently, the need for adequate food supplies for its army and navy was acute. It was not until 1809 that Nicolas (François) Appert, a Parisian confectioner, succeeded in preserving certain foods in especially made glass bottles that had been kept in boiling water for varying lengths of time. Although there is one earlier reference in literature to the inadvertent preservation of food by heat sterilization (L. Spallanzani, 1765), credit for the discovery of the canning process is given to Appert. In the following year, 1810, his work was made known publicly in a treatise entitled *Art de conserver les substances animales et végétales*. The grateful government awarded Appert the prize.

The underlying principle of the various methods of food preservation is basically the same: the development of conditions within a food—temporary or sustained—that are unfavourable for the growth of spoilage organisms. Thus, for example, if a food be chilled, heated or desiccated, or if it be made excessively acid, it immediately becomes an unfavourable medium for the development of microorganisms.

In commercial canning, carefully prepared raw food is placed in a sealed container, then is subjected to definite elevated temperatures for the proper period of time and finally is cooled. Heating the contents of the can produces an unfavourable temperature environment for spoilage organisms that may be present in the food; consequently such organisms are destroyed and their growth inhibited. Reinfection of the food by spoilage organisms in the air is prevented by the permanent seal of the can. This is the basic principle of commercial canning.

It was by patient trial and error in his experiments that Appert was able to devise directions for conserving the many products listed in his treatise. He could give no logical explanations for the effects of canning. He believed, however, that the application of heat to a sealed container, together with the exclusion of air, combined to retard or eliminate the process of decomposition. Science was of little assistance, since chemistry was in its infancy and bacteriology was unknown. It was half a century later—about 1860—that the true causes of food spoilage came to be understood as a result of Pasteur's work.

Knowledge of the industry was taken to the United States from England, and by 1820 William Underwood and Thomas Kensett were engaged in the commercial production of canned foods, in Boston and New York respectively, using the Appert process. It was not until 1839, however, that tin-coated steel containers (tin cans) came into widespread use in America. Peter Durand, an Englishman, conceived and patented the idea of using tin cans instead of bottles.

In 1895 Samuel C. Prescott and William L. Underwood, working together at the Massachusetts Institute of Technology, first traced spoilage of certain lots of canned corn to imperfect sterilization (heat processing). This early work was followed by that of Harry L. Russell, Andrew Macphail, Bronson Barlow and others. Organized research into the problems of the industry was begun by the U.S. department of agriculture and several universities, followed by the inauguration of the long-range programs of the National Canners association and of the research departments of the leading can manufacturers.

The phenomenal growth of the industry in the United States and throughout the world may be attributed (aside from the scientific approach) to the development of (1) the art of container manufacture of both tin cans and glass jars and bottles; (2) the canning processes themselves; and (3) canning machinery. The United States became the greatest producer and consumer of canned foods in the world.

The modern tin can, which is 98.5% sheet steel with a thin coating of tin, is manufactured on wholly automatic lines of machinery at a rate in excess of 300 cans per minute. The improvement of the tin can as the cheapest and most serviceable container for mass production was marked by the advent of the sanitary, or open-top, can about 1905–08. This development answered many of the canner's practical problems by eliminating the use of solder in sealing the can, and a perfect closure was guaranteed by the double seamed top and bottom. Differential coated electrolytic tin plate was used beginning in 1951 to save tin and better resist interior corrosion and exterior rusting. In a typical year the industry uses about 25,000,000,000 tin cans and glass jars. Containers of aluminum and of plastic material had by 1960 been found commercially feasible for a restricted number of products.

By the 1960s the U.S. annual pack of canned goods approximated 700,000,000 cases (24 cans to the case, equivalent). The greater part was vegetables, fruits, juices and specialties; milk, meat and fish were also well represented. Annual packs of fruit, fruit juices and vegetables ran as high as 9,000,000 cases in Australia, 26,500,000 cases in Canada, 7,500,000 cases in South Africa and 42,500,000 cases (fruit and vegetables only) in the United Kingdom.

Perhaps the greatest early obstacle to volume production was the time necessary for processing the filled cans of food in boiling water. With the discovery in 1861, by Isaac Solomon of Baltimore, that calcium chloride added to boiling water raised the temperature of processing from 212° to 240° F. or higher, the time necessary to ensure relative safety in the process was reduced from 4 to 5 hours to a mere 25 to 40 minutes. Thus the average production in a first-class cannery was increased from 2,500 cans to about 20,000 cans per day. This innovation, together with the impetus given by the American Civil War requirements, brought almost immediate prosperity to the young industry. In the next decade an advance that outdated the above method was the invention in 1874 of the closed, steam-pressure retort by A. K. Shriver of Baltimore. The resultant high temperatures shortened the time necessary for processing and reduced accidents and spoilage to a new minimum.

In the meantime, hand labour in the cannery was being largely supplanted by semiautomatic and later by wholly automatic machinery, thus increasing output, reducing costs and permitting wider use of canned products. It is necessary to mention only a few machines such as the washers, graders, peelers, corn huskers and cutters, bean snippers and filling machines. After World War II electronic devices were increasingly used for regulating and controlling various operations.

Products Used in Canning.—Products available for canning include almost every fruit, vegetable, meat or marine product. In addition many specialty products are packed in smaller quantities. The location of the canneries is largely dependent on the growing areas of the product to be packed. As a great fruit-growing area, California is heavily represented. Other geographical areas are noted for a specialty; *e.g.*, Hawaii for pineapple, Alaska for salmon, etc.

In practice the relationship between grower and canner is particularly close, and the growing of crops for canning has become a highly specialized branch of agriculture. As a result of the work conducted by the federal and state departments of agriculture, state universities and by the canners themselves, great advances were made in many aspects of crop production. In order to secure uniformity in growing conditions and to ensure uniformity in the raw product, the local canner contracts with the neighbouring farmers for an acreage sufficient for the normal capacity of his cannery and either supplies or specifies the seed to be used. Planting dates may be so spread that the harvest period will be prolonged, enabling the facilities to be used more efficiently. In this way the canner is able to turn out a superior product that is grown from one type of seed, supervised during the growing period by qualified fieldmen and harvested at proper maturity. The time elapsed between picking and canning is seldom more than three or four hours.

Operations Employed in Commercial Canning.—The operations employed in commercial canning procedures depend upon the nature of the product being packed. There are, however, certain operations that are included wholly or partially in canning procedures for fruits, vegetables, milk, fish, meat or the so-called specialty or formulated products (soups, pork and beans, spaghetti etc.). These operations may be grouped as follows:

Cleaning.—All raw materials used in canning must be thoroughly cleaned. Cleaning is usually effected by automatic passage of the raw-food material through tanks of water or under high-pressure water sprays. For certain products, washing machinery of special design is used (flotation washers for whole kernel corn and peas). It is essential that only potable water be used. Some products (peas, spinach) receive a dry cleaning by subjecting them to air blasts or to a shaking that removes inedible or extraneous materials prior to water washing.

Preparatory Operations.—These operations are quite varied in character, but all aim at the removal of inedible or undesirable portions of the food and conversion of the food into the desired or necessary form for subsequent canning operations. Preparatory operations include sorting, trimming, vining (peas), husking, cutting, silking (corn), size or maturity grading (peas), sectioning (citrus fruits), slicing, dicing, peeling and coring (fruits), pitting (cherries), soaking (dry beans, cherries), straining or pureeing (infant foods), extraction (fruit and vegetable juices), homogenization (milk, some juices or pureed foods), evaporation (milk) etc. Many of these operations are performed by special machinery; in other instances hand operations are required. These operations either precede or follow other canning operations such as cleaning or blanching.

Blanching.—Some products (beets, carrots, spinach, peas) require a blanching by immersion in hot water or steam to shrink or wilt the product in order to obtain desired or legal weight in the final container and also to inactivate enzymes and thereby improve the colour and flavour of the product. Electronic heating, sometimes called dielectric heating, was used to some extent in the post-World War II period. The blanching must sometimes precede certain preparatory operations (peeling, slicing, dicing). Occasionally the necessary shrink must be obtained by a precook rather than by blanching (certain meat products). In addition to its other functions, blanching in certain products serves as an additional cleansing operation, removing objectionable flavouring materials acquired by some raw foods from inedible portions of plants (the vine flavour of peas).

Filling and Exhausting.—Automatic filling machines, which are adaptable to specific products or to types of products (solid, simisolid or liquid products) and capable of high-speed operation, are employed to place the prepared food in the can. The washed, open cans are mechanically conveyed to and from the filling machines. With some products (certain fruits, tomatoes) hand filling methods are used.

After being filled, the open cans containing the food, especially that of nonhomogeneous type, are usually thermally "exhausted" by passing them automatically through a hot-water or steam bath in an exhaust box. Thermal exhausting heats and expands the food and releases gases (carbon dioxide and oxygen) from the cells. Air is also excluded by expansion of the food; thus, after sealing, heat sterilizing and cooling the can, the contraction of the contents produces a partial vacuum in the container. Thermal exhausting may also be effected by heating the food before it is put into the cans (cream-style corn). Certain products (corn on the cob, coffee, salmon) are largely packed by the vacuum-pack method in which the cans are mechanically exhausted by specially designed vacuum-can sealing machines. These machines withdraw air and other gases from the cans by a high vacuum and seal the cans while they are still under vacuum.

Can Sealing, Closing or Double Seaming.—Special automatic sealing (closing or double seaming) machines capable of operating at various speeds (from 10 to 250 cans per minute, depending upon the can size and the nature of the product) are used to seal or close the covers on the sanitary type of can. The cans are usually mechanically conveyed to and from the sealing machine, where the covers are placed on the can automatically and the sealing operation completed. The curl on the can cover and the flange on the can body are first rolled into position and then flattened together. The thin layer of gasket material or compound originally present in the rim of the cover is dispersed between the layers of metal to ensure a hermetic seal on the container. As previously described, some vacuum closing machines of special design mechanically exhaust the can just before the double seam is formed; other special types of closing machines seal cans in an atmosphere of an inert gas such as nitrogen, carbon dioxide or helium. The vent-hole types of cans (evaporated milk, certain meat products) are sealed on special tipping machines that close the vent hole with a small drop of solder.

Heat Sterilization or Thermal Processing.—This is one of the most important operations in the canning procedure and essentially consists of subjecting the food—usually contained in the sealed can—to a known temperature long enough to destroy spoilage and pathogenic organisms that might be present in or on the raw-food material. Canners follow time and temperature processing schedules established by laboratories associated with the canning industry. The heat treatments necessary to preserve canned foods are determined by a number of factors; important among these are the acidity, as expressed by pH, of the food or food product. The "acid foods"—with pH values of 4.5 or less—may be adequately processed by subjecting them to the temperature of boiling water (212° F. or 100° C.) for the proper length of time. The "nonacid foods"—with pH values higher than 4.5—must be processed at higher temperatures. Most commercial processing temperatures for such foods fall in the range of 240° F. (116° C.) to 265° F. (130° C.). The processing temperature commonly employed, however, is 240° F. This temperature is attained by use of steam under pressure in a closed chest, or canner's "retort." Steam pressure of approximately 10 lb. corresponds to a processing temperature of 240° F.

Thermal processing equipment is of two general types: still retorts for batch operation and the so-called continuous cookers. Both types operate either at 212° F. for the acid foods or under steam pressure for the nonacid products; in either case the time of processing or "cooking" is regulated so as to subject the cans to the processing temperature for the proper length of time. Later processing installations included automatic retort controllers which regulate and record the process. In at least one U.S. state canners of nonacid products are required by law to equip their retorts in this manner. For specific products (such as evaporated milk) special processing equipment is available that either agitates or revolves the cans during the process cycle. The more acid type of foods and food products (*e.g.,* berries and citrus fruits) may be sterilized by filling them into cans at certain temperatures and inverting the containers for a short period to sterilize the can covers while sterilizing the cans. This is also the underlying principle in the flash-sterilization method for preservation of acid food juices. For public health reasons antibiotics are not used in canning although extensive investigations have indicated that certain spoilage organisms are markedly affected by some antibiotics.

Cooling, Labeling, Casing and Storage.—Following thermal processing, the sealed cans are cooled in cold water or in air.

In water cooling, the hot cans are conveyed directly from thermal processing through tanks of cold water or through cold-water sprays; cans of large diameter must be pressure cooled by water under pressure. Pressure cooling prevents outward straining or buckling of the can ends during the time the internal pressure of the cans is being reduced through loss of the heat of sterilization. Water cooling is continued until the can contents have an average temperature of about 100° F. At this temperature the food usually contains sufficient heat to dry the cans and prevent external rusting of the tin containers.

In air cooling, the cans are stacked, or ricked, in rows to permit free air circulation. Many foods cannot be cooled suitably in air.

Cans are labeled by special labeling machines and may be placed in fibre or wooden cases by hand or by special machines designed for that purpose. Frequently, cans are stored—cased or uncased—without labeling, and the labeling operation is performed just prior to shipment. Canned foods are stored in cool dry warehouses which are not subject to wide variations of temperature or humidity.

Nutritive Values of Canned Foods.—A considerable amount of investigation has been devoted to the effects of commercial canning on foods. Canning procedures have no practical effect on proteins, carbohydrates, fats, etc. When sirups or brines containing sugars are added in canning, the natural carbohydrate contents of the foods are enhanced. Many researches have also established the effect of canning on the known vitamins.

In general, vitamin A and carotene (provitamin A), if protected from atmospheric oxygen, are not materially affected by the heat treatments given canned foods. Vitamin D and riboflavin appear to be unaffected by commercial canning. The stability of vitamin B_1 is dependent not only upon the heat treatment accorded it but also upon the acidity of the food in which it is contained. For the more acid foods there is practically no loss of this vitamin during canning; in the less acid foods, which require longer processing times at higher temperatures, the degree of retention is not so great. Vitamin C, which is generally considered to be the most labile of all the vitamins, is especially subject to destruction at elevated temperatures under conditions that permit free access to atmospheric oxygen. In canning, however, the food is protected to a large degree from contact with oxygen; consequently, vitamin C is well retained in canned foods.

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(G. W. Cb.; J. K. R.)

CANNING, HOME: *see* FOOD PRESERVATION (IN THE HOME).

CANNIZZARO, STANISLAO (1826–1910), Italian chemist, was a pioneer in the development of modern atomic theory. He was born in Palermo on July 13, 1826. In 1845–46 he acted as assistant to Raffaele Piria (1813–65), known for his work on salicin and natural organic materials (*e.g.*, glucosides), who was then professor of chemistry at Pisa and subsequently occupied the same position at Turin. Cannizzaro took part in the Sicilian revolution of 1848 and was condemned to death by the Bourbons. On the collapse of the insurgents he escaped to Marseilles and reached Paris in Oct. 1849.

In Paris he worked in the laboratory of M. E. Chevreul and, in conjunction with F. S. Cloëz (1817–83), prepared cyanamide by the action of ammonia on cyanogen chloride in ethereal solution (1851). In the same year he was appointed professor of physics and chemistry at the Technical institute of Alessandria (Piedmont), where he discovered that aromatic aldehydes are decomposed by alcoholic potash into a mixture of the corresponding acid and alcohol; *e.g.*, benzaldehyde into benzoic acid and benzyl alcohol (Cannizzaro's reaction). In the autumn of 1855 he became professor of chemistry at Genoa university; six years later, after declining professorships at Pisa and Naples, he accepted the chair of inorganic and organic chemistry at Palermo. There he spent ten years, studying the aromatic compounds and continuing to work on the amines. In 1871 he was appointed to the chair of chemistry at Rome university.

Apart from his work on organic chemistry, which included also an investigation of santonin, he rendered great service to the philosophy of chemistry when in a memoir sketch of a course of chemical philosophy (1858) he insisted on the distinction, until then imperfectly realized, between molecular and atomic weights, and showed how the atomic weights of elements contained in volatile compounds can be deduced from the molecular weights of those compounds and how the atomic weights of elements of whose compounds the vapour densities are unknown can be ascertained from a knowledge of their specific heats. Copies of his pamphlet were distributed at the chemical congress held at Karlsruhe, Ger., in 1860. The significance of its contents was not realized until later, when the value of Avogadro's hypothesis in solving this problem became evident. For this achievement, of fundamental importance for the atomic theory in chemistry, Cannizzaro was awarded the Copley medal by the Royal society in 1891.

Entering the Italian senate in 1871, he became its vice-president and a member of the council of public instruction; and in other ways he rendered important services to the cause of scientific education in Italy. He died in Rome on May 10, 1910.

Cannizzaro's collected writings were published in 1925 by the Associazione Italiana di Chimica under the title, *Scritti varî e lettere*. The famous *Sketch of a Course of Chemical Philosophy* was no. 18 of the Alembic Club Reprints. For biographical details *see* W. Tilden, "Cannizzaro Memorial Lecture," *Journal of the Chemical Society* (1912); T. E. Thorpe, *Essays in Historical Chemistry*, 3rd ed. (1894); B. Vanzetti and M. Speter, essay in Günther Bugge's *Das Buch der grossen Chemiker* (1930).
(R. E. O.)

CANNOCK, an urban district of Staffordshire, Eng., in the district known as Cannock Chase, is 10 mi. S.S.E. of Stafford and 9 mi. N.N.E. of Wolverhampton by road. Pop. (1961) 42,191 The church of St. Luke is Perpendicular; it was enlarged in modern times. The famous political preacher Henry Sacheverell held his first curacy there in the 18th century.

Cannock is the centre of the Cannock Chase coal field and also has metalworking and other industries. Cannock Chase, a tract generally exceeding 500 ft. in elevation, extends on an axis from Stafford in the northwest to Lichfield in the southeast over about 56.2 sq.mi. It was a royal preserve, having been the hunting forest of the Mercian kings, and contains, in addition to the coal field, woodland and open heath land. Castle Ring, a British hill fort covering 8½ ac., is owned by the council, which also holds 24 ac. of the Hednesford hills.

CANNON, ANNIE JUMP (1863–1941), U.S. astronomer and specialist in stellar spectra, was born at Dover, Del., on Dec. 11, 1863. She graduated from Wellesley college, Wellesley Mass., in 1884, and did special work in astronomy at Radcliffe college, Cambridge, Mass. Miss Cannon was an assistant at the Harvard college observatory, Cambridge, Mass., 1897–1911, and after 1911 the curator of astronomical photographs. In 1938 she was named William Cranch Bond astronomer, a post established in honour of the founder of the college observatory.

The monumental *Henry Draper Catalogue* of stellar spectra which was published in sections between 1918–24, together with the catalogue of the *Henry Draper Extension,* comprise her principal contribution to astronomy. The importance of this work to all problems of modern stellar astronomy cannot be overemphasized. In addition to the catalogues of stellar spectra, she discovered many new variable stars and five novae.

Miss Cannon died in Cambridge, Mass., April 13, 1941.

CANNON, JAMES (1864–1944), U.S. clergyman, was born Nov. 13, 1864, in Salisbury, Md. He graduated from Randolph-Macon college, Ashland, Va., in 1884, and received his bachelor of divinity degree from Princeton Theological seminary, Princeton N.J., in 1888 and a master of arts degree from Princeton university, Princeton, N.J., the same year.

He entered the ministry of the Methodist Episcopal Church South, in 1888, was elected bishop in 1918, and retired in 1938

A fiery prohibitionist, Bishop Cannon was a foremost Anti-Saloon leaguer and head of the World League Against Alcoholism During the 1928 presidential campaign, he delivered violent tirades against the Democratic candidate, Alfred E. Smith.

In 1930 Bishop Cannon was summoned to appear before a body of high Methodists to answer charges of stock speculation in "bucket shops." The bishop admitted his "error," begged for forgiveness and was not tried. Shortly afterward, he was called to appear before a senate lobby committee to explain what he did with $48,300 given him for use in Virginia during the 1928 campaign. The bishop defied the committee and refused to answer questions. He was later acquitted in federal court of violating the Corrupt Practices act. With the repeal of prohibition his influence waned, although he continued his temperance crusade

He died in Chicago, Ill., on Sept. 6, 1944.

See Virginius Dabney, *Dry Messiah: the Life of Bishop Canno* (1949); James Cannon, Jr., *Bishop Cannon's Own Story: Life As I Have Seen It, ed. by Richard L. Watson, Jr.* (1955).
(V. Da.)

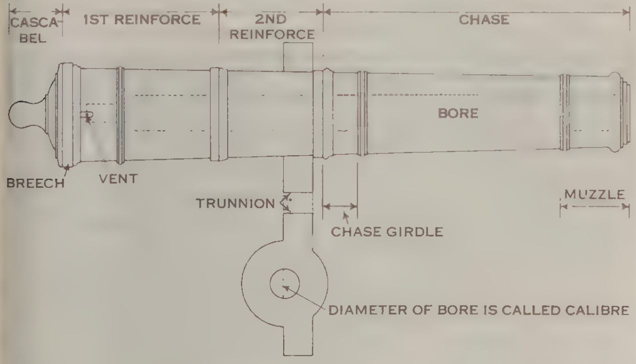
CANNON, JOSEPH GURNEY (1836–1926), U.S. politician, a member of the house of representatives for 46 years and speaker from 1903 to 1911, was born in Guilford, N.C., on May 7 1836. In 1858 he was admitted to the Illinois bar, and from 1861 to 1868 he was a state's attorney. He settled at Danville, Ill. entered politics and was elected Republican representative in congress for the periods 1873–91, 1893–1913 and 1915–23, retiring at the age of 87. On questions of national policy, Cannon usually aligned himself with the more conservative groups, and during his tenure as speaker of the house his partisan use of the powers of that office became known as "Cannonism." Rebelling against his control, the house in March 1910 passed a resolution making the speaker ineligible for membership in the committee on rules thereby curtailing his prerogatives. Cannon was, however, personally liked by the members of the house and was popularly known as "Uncle Joe" Cannon. He died at Danville, Ill., on Nov. 12, 1926.

See L. White Busbey, *Uncle Joe Cannon* (1927); E. B. Bolles *Tyrant From Illinois* (1951).

CANNON, WALTER BRADFORD (1871–1945), one of the greatest of U.S. physiologists, was born in Prairie du Chien Wis., Oct. 19, 1871, and received his medical degree from Harvard in 1900. He was George Higginson professor of physiology at Harvard from 1906 to 1942, when he retired. He died on Oct. 1, 1945.

Cannon was the first to utilize X-rays in physiological studies. These studies led to the publication of *The Mechanical Factors of Digestion* (1911). His investigations on hemorrhagic and traumatic shock during World War I were summarized in *Traumatic Shock* (1923). His work on the emergency functions of the sympathetic nervous system and on homeostasis are reported in *Bodily Changes in Pain, Hunger, Fear and Rage* (2nd ed., 1929) and in *The Wisdom of the Body* (1932). His important contributions to the knowledge of the chemical mediation of nerve impulses were published (with A. Rosenblueth) in *Autonomic Neuro-effector Systems* (1937) and *The Supersensitivity of Denervated Structures* (1949). These books, and over 200 original papers that appeared in physiological journals, bear testimony to Cannon's greatness as an investigator. Some of his nonscientific activities are narrated in his autobiographical book, *The Way of an Investigator* (1945). (A. S. R.)

CANNON, a big gun or piece of ordnance as distinguished from a musket, rifle or other small arm. The term is used loosely to include guns, howitzers and mortars. It is derived from the Latin *canna* ("cane," "reed" or "tube"), and was sometimes spelled "canon" in the 16th century. The French use the term to refer to the barrel or tube of any firearm, large or small. In U.S. army usage it may denote only the tube, breechblock and firing mechanism as distinguished from the carriage or mount. Modern cannon are complex mechanisms cast from high-grade steel and carefully machined to exacting tolerances. They characteristically have rifled bores. (*See* ARTILLERY.)



BASIC PARTS OF A CANNON

Huge artillery pieces, to which a variety of names applied, appeared during the 15th century. A notable example was "Dulle Griete" of Ghent that weighed 13 tons. But during the later years of the century and indeed up until about 1670 the word "cannon" was applied only to special types of guns. These were the short battering pieces used in sieges, and they were usually divided, at least among the English, into the cannon-royal or double cannon, which weighed 8,000 lb. and fired a ball weighing 60–63 lb.; the whole cannon, which weighed 7,000 lb. and fired a 38- to 40-lb. ball; and the demicannon of 6,000 lb., which shot a 28- to 30-lb. ball. Weights vary from one early listing to another; these are average figures. Other pieces of ordnance had their own distinctive names—culverin, minion, saker, falcon and the like—to indicate their size and function. Cannon became ornate creations during the 1500s and were covered with scrolls, royal escutcheons and inscriptions.

During the third quarter of the 17th century it became the practice to designate pieces of ordnance by the weight of the projectile they threw and secondarily by their other characteristics; *i.e.*, whether field or siege, light or heavy, short or long. England adopted a series of cannon known as 6-, 9-, 12-, 18-, 24-, 32- and 42-pounders. With this streamlining of terminology the complex system of individual names disappeared, and the term "cannon" gradually came to be applied to every gun that was fired from a carriage or fixed mount and had a bore larger than one inch. In the 20th century, artillery pieces mounted in aircraft were referred to as aircraft cannon; and the U.S. army's first atomic gun, announced in 1952, was generally referred to as the atomic cannon.

See also references under "Cannon" in the Index volume.

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CANNON-BALL TREE (*Couroupita guianensis*), a native of tropical South America (French Guiana), which bears large spherical woody fruits, containing numerous seeds, as in the allied genus *Bertholletia* (Brazil nut). The timber is of value.

CANO, ALONSO (1601–1667), was one of the few Spanish artists to practise painting, sculpture and architecture, and to produce numerous drawings. Baptized in Granada on March 19, 1601, he went as a youth to Seville where he was apprenticed in 1616 to Francisco Pacheco, master of Velázquez. He probably learned figure sculpture from Juan Martínez Montañes and architecture from his father, a maker of retables. In 1638 he moved to Madrid where he worked for the court and church. Influenced by Renaissance paintings in the royal collections and by contemporary baroque art, his style became increasingly eclectic. In 1652 he returned to Granada as prebendary of the cathedral. There he quarreled with the canons and was ejected, but after taking holy orders in Madrid was reinstated and appointed chief architect of the cathedral. His design for the façade was finished shortly before his death on Sept. 3, 1667.

Cano was chiefly a religious artist who created compositions and idealized types in painting and sculpture which were imitated by several followers.

See H. E. Wethey's monograph *Alonso Cano* (1955). (E. Hs.)

CANO, JUAN SEBASTIÁN DEL (d. 1526), Spanish navigator, the first to circumnavigate the globe, was born in Guetaria. He commanded one of the five vessels in the famous expedition of Magellan, and in 1521, on Magellan's death, became chief. He visited the Moluccas and returned to Spain on Sept. 8, 1522, having been around the world. He died at sea in Aug. 1526, while on an expedition to the Moluccas.

CANO, MELCHOR (MELCHIOR) (*c.* 1509–1560), Spanish theologian who upheld the rights of the Spanish crown against the claims of the papacy, was born at Tarancón, New Castile. He joined the Dominican order in 1523 and became professor of theology in Salamanca. In 1546 he defended the right of the Indians in America. He was strongly opposed to the influence of his fellow Dominican Bartolomé de Carranza (*q.v.*) and in 1558 accused him of Lutheran opinions. Charles V sent him to the Council of Trent (1551–52), where he participated actively in the discussions on the Eucharist and on penance. His close association with the ecclesiastical policies of Philip II incurred the enmity of Pope Paul IV. Cano's reputation as a theologian rests on his *De locis theologicis* (posthumously published in 1563), an analysis of the scientific value of theological statements which led him to evaluate the sources of theology. He also wrote commentaries on the Pauline epistles. He died at Toledo on Sept. 30, 1560.

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CANOE, a lightweight boat pointed at both ends, originally designed for propulsion by one or more paddles (not oars) held without a fixed fulcrum, the paddler facing the bow. The name is applied to boats that are open within from end to end (the modern Canadian canoe is of this type) and also to craft covered with a deck except for a well, or cockpit, where the paddler sits (the kayak). The class includes the cruising canoe, combining the use of paddle and sails, and the sailing canoe, designed for racing and equipped with sails only. For paddling and sailing racing canoes and events see *Organized Canoeing*, below.

The primitive canoes were light frames of wood over which skins, as in the old British coracle or in the Eskimo canoe or kayak, or the bark of trees, as in the North American Indians' birchbark, were tightly stretched. The canvas-covered canoe, built on Indian lines, was a natural development of this idea. The structural parts of both the birchbark and the kayak were curved or bow-shaped, which gave them the resilient quality of strength of a drawn bow. This construction not only imparted great strength in relation to weight but was streamlined, making it possible for even heavily loaded craft to be paddled through the water with a minimum of effort and a maximum of efficiency.

Primitive peoples also used and still use the dugout, made from a log hollowed out by chopping or fire or a combination of both. Many of these are wonderfully carved and ornamented with inlay and are of considerable size and carrying capacity; one in the American Museum of Natural History in New York city, from Queen Charlotte Island, B.C., is 63 ft. long, 8 ft. 3 in. wide and 5 ft. deep, cut from a single log. The war canoe of paddling races is its modern successor.

In the islands of the Pacific and elsewhere dugout canoes, mostly of the outrigger type and sometimes of a twin-hull, or catamaran, design, are handled with great skill by the natives, who make long sea voyages in them. In New Zealand the Maoris were masters of the art of dugout canoe construction, some of their ancient war canoes being of huge size. Along the coast of west Africa fishermen still use large dugout canoes for fishing at sea, remaining out of sight of land for days. (*See* also Boat.)

Modern canoes evolved out of the two basic types, the birchbark, propelled by one or more single-bladed paddles, and the kayak, propelled by one or more double-bladed paddles. The open Canadian canoe is the direct descendant of the birchbark. The early explorers in North America promptly adopted it. Being indigenous, it enjoyed a wider range of use than any other small boat. Modern versions of this canoe are made of wood (ash frame and spruce ribs covered with thin cedar planking), canvas (wood frame, ribs and thin planking covered with canvas), aluminum, magnesium, molded plywood, plastic and glass fibres. The all-wood canoe is the favourite in Canada, while canvas-covered and aluminum canoes of the popular sportsman type are more commonly used in the United States for hunting, fishing, camping, cruising and pleasure paddling.

Canoes are built in almost any size from 10 ft. up, but the usual size is 17 ft. long and 34 in. wide. The depth ranges from 12 to 14 in., the ends rising 4 to 6 in. higher. This size was gradually accepted as canoemen found few lengthy portages in their usual waters and discovered that it was still within the limits that one man could conveniently handle. In Canada, where long portages militate against the weight of the larger canoe, the general size is 15 to 16 ft. with 30 to 35 in. beam. Sometimes exceptionally light guide canoes are used as are, under some circumstances, 22-ft. freighters capable of carrying 2½ tons. The aluminum canoe became popular about 1942, and especially after 1945. It runs in length from 13 to 18 ft., the 17-ft. length being the standard size. This canoe has a beam of 36 in., a depth of 13 in. and a carrying capacity of 1,050 lb. It weighs 68 lb. and is extremely strong, withstanding a lot of abuse in rapids. It is easily repaired. It sails well with leeboards taking 65 sq.ft. of Dacron or nylon sail. With an outboard motor bracket it takes a 2½- to 3½-h.p. motor easily. Some canoes are designed with a square stern to accommodate an outboard.

The parts of the canoe—whether open, kayak or sailing—are identified by the terminology of old-time sailing ships, since the early explorers naturally applied the seafaring terms of the time to the craft they found among the Indians and the Eskimos. Hence a canoe has a bow and a stern, a keel, gunwales (or gunnels), a port side and a starboard side, the cover of a kayak is the "deck," etc.

The other basic design for canoes that are propelled by paddles is that of the kayak, in which the paddler sits on the bottom or on a low seat, using a double-bladed paddle. The modern kayak was developed largely in Great Britain, where it was known as a "canoe." In the early part of the 19th century it was popularly used for short river practice but the sport of boating in this type of craft dates from 1865, when Scottish canoeist and traveler John MacGregor designed the "Rob Roy" for long journeys by water, using both double-bladed paddle and sails, yet light enough (about 70 lb.) to be carried over portages. MacGregor's accounts of his cruises in the "Rob Roy" helped to popularize the sport and also popularized the Rob Roy as a type of craft. This was generally built of oak with a cedar deck, from 12 to 15 ft. in length with a beam of 26 to 30 in. and a depth of 10 to 16 in. The paddle was 7 ft. long with a 6 in. wide blade at each end. Decked, and with the canoeist's weight low in the cockpit, it was exceptionally seaworthy. The type gained many adherents in the United States, as well as in Great Britain and in Europe. The Royal Canoe club was founded in England in 1866 and its members made sea voyages in their tiny craft and explored many previously inaccessible waters, including the Jordan river, the Sea of Galilee and the Abana and Pharpar at Damascus.

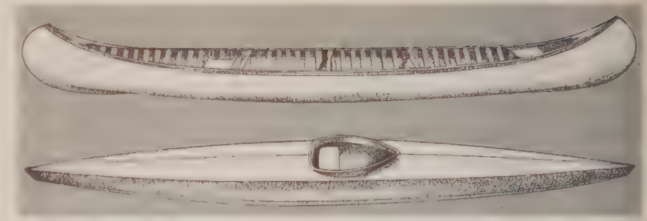


FIG. 1.—MODERN CANOES: (TOP) OPEN CANADIAN CANOE; (BOTTOM) K-1, ONE-MAN OLYMPIC RACING KAYAK

Modern canoes of the kayak type are made of a variety of materials, perhaps the most popular being a rubberized fabric over a light wood frame. Easily portable collapsible or folding versions of this type, called foldboats, or faltboats (Ger. *faltboot*), have been especially popular in Europe; such boats have been sailed across the Atlantic.

Sailing canoes, modifications of the Rob Roy design, were constructed by Royal Canoe club members W. Baden-Powell and E. B. Tredwen, who introduced the centreboard and two-masted yawl rig. Paul Butler of Lowell, Mass., did much to develop the out-and-out sailing canoe used for racing. He added the sliding outrigger seat, allowing the canoeist to slide out to windward as shifting ballast. Butler also developed clutch cleats and reefing gears; built hollow spars and other accessories; and introduced the sliding tiller, watertight compartments and self-bailing cockpits. This type of canoe was adopted for class racing in the United States, and was universal in Great Britain until, under the influence of Linton Hope's designs, the Royal Canoe club developed the B class canoe which replaced it. The B canoe was 17 ft. long, 3 ft. 6 in. wide and 1 ft. deep, decked, with the exception of the steering well, and divided into three compartments by two watertight bulkheads. Outboard seats were barred. The rig was sloop with sliding gunter or Bermuda mainsail and roller foresail, the total sail area being 150 sq.ft.

In the United States canoes derived from Butler's designs remained popular and customarily were 16 by 30s (16 ft. long by 30 in. beam). A 1909 rule limiting the sail area to 90 sq.ft. effectively blocked the building of larger craft until a sliding scale permitting sail area in proportion to boat dimensions was adopted in 1917, after which several canoes based on designs by Hilding Froling appeared with dimensions varying from 17 ft. by 34 in. to 18 ft. by 42 in. (*see* also *Organized Canoeing,* below). While the decked sailing canoe was recognized as the finest type of canoe sailing machine, it was frequently outnumbered at regattas by open or cruising canoes rigged with sails and leeboards.

The canoe is usually paddled by two persons, the helmsman doing most of the steering. Most of the canoes have two seats and two or three thwarts. However, the experienced canoeist ordinarily paddles his canoe without using the seats. Kneeling with his buttocks against a thwart allows him to apply greater power to his paddle and is much safer, the centre of gravity being lower. The canoe is often paddled by one person with a single paddle used continuously on one side. At the end of each stroke the canoeist steers his boat by an overhand twist of the paddle. The hand holding the upper end of the paddle and the paddle are so placed that the back of the hand is turned out toward the water on the same side of the canoe on which the canoeist is paddling. The blade of the paddle is kept in the water long enough to bring the canoe back on its course after each thrust of the paddle. The blade is always feathered on the recovery stroke. It is much better to paddle a canoe on the side opposite to that on which the wind strikes the hull, for the thrust of the paddle offsets the thrust of the wind.

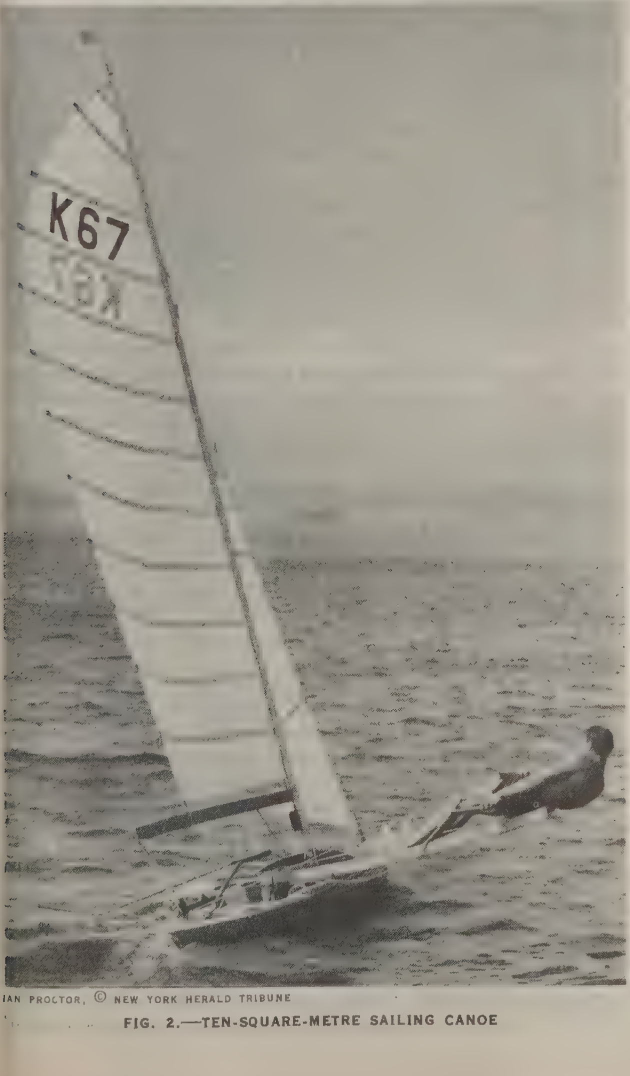
The major strokes of the canoe are divided into cruising strokes, draw or turning strokes, and jamming or stopping strokes.

Cruising Strokes.—These are the strokes used in going forward in a straight line. The bowsman strokes back straight to his hip (bow or forward bow stroke), while the sternman pulls the canoe back in at the end of the stroke by making a hook outward just enough to bring the canoe back on a straight course. This stern stroke is known as a cruising hook, or "J" stroke.

Draw or Turning Strokes.—These strokes are attained by reaching out at an angle and pulling to the canoe (draw stroke) or by placing the paddle by the canoe and shoving outward (pushover stroke), making the canoe turn or move to the angle of draw and opposite of the push or thrust. The same effect is obtained by an outward arc or an inward arc of the paddle. The latter draw strokes are called sweep strokes.

Jamming or Stopping Strokes.—These strokes are for stopping a canoe by placing the blade at right angles to the forward movement of the canoe, and locking it tight by holding it to the gunwale of the canoe. When done by both bow and stern paddler this can stop the canoe quickly, even with a heavy load. Locking or holding the blade tight to the gunwale, but turning the blade parallel to the centre beam of the canoe, is known as a keel lock. This gives stability to the craft, especially in heavy waves, acting like the centreboard in a sailing boat.

A properly trimmed canoe for ease in paddling has the bow slightly higher out of the water than the stern. In rapids a canoe should be bow-light going upstream when propelled by either pole or paddle. Going downstream it should be bow-heavy. Going ashore through the surf the canoe should be bow-heavy. Going out through the surf it should be bow-light. The single paddler, unless the bow end of the canoe is heavily loaded, kneels in the canoe about one-third of the way forward.



IAN PROCTOR, © NEW YORK HERALD TRIBUNE

FIG. 2.—TEN-SQUARE-METRE SAILING CANOE

Paddles are classified as soft or hard wood. The best paddles are made of spruce (soft wood) or maple or ash (hard wood). They should be in length equal to the height of the paddler.

If a canoe tips over, the occupants can hang on to it until it floats ashore or until picked up; they should never try to climb up on an overturned canoe. The water can be emptied out of an upset canoe even in deep water by "shaking out" the water, by splashing out the water or, if there is another canoe present, it can be pulled bottom side up over the other canoe to empty the water. (L. W. J.; C. W. Ha.)

Organized Canoeing.—All organized canoeing in the United States is headed by the American Canoe association (A.C.A.). This body, founded in 1880, is divided into nine geographic divisions. Each division holds paddling and sailing races and there is an annual national meet, held at a different site each year according to the best interests of the association. The first local organization in the U.S., the New York Canoe club, dates from 1871. In Canada the sport is supervised by the Canadian Canoe association (1900) and in Great Britain by the British Canoe union (1936). The leading English local organization is the Royal Canoe club (1866).

The world governing body is the International Canoe federation (I.C.F.), formed in 1945 as the successor to the Internationale Repräsentationsschaft des Kanusports (I.R.K.; 1924), which was dissolved during World War II. The I.R.K. was responsible for canoeing becoming an Olympic sport. The first competition took place at the 1936 games in Berlin with 19 nations entering teams. Canoeing has remained on the Olympic program since that time. (*See* Olympic Games.)

The annual national races in the United States include one-man single- and double-blade competition, tandem single- and double-blade competition and four-man single- and double-blade competition in the paddling events; and open-cruising and decked-canoe competition in the sailing races.

Olympic competition consists of events for single and double kayaks and single and double Canadian canoes over distances from 1,000 to 10,000 m. for men. Olympic canoe competition for women at 500 m. was inaugurated at the 1948 games in London. Canoes and kayaks used in all racing events must conform to specific measurements agreed upon by the A.C.A. and other national governing bodies.

I.C.F. specifications cover a V-bottom cedar Canadian canoe, 17 ft. by 29½ in. for either one-man (C-1) or two-man (C-2) crews; the single kayak (K-1), 17 ft. by 20 in.; the double kayak (K-2), 21 ft. by 21½ in.; and the four-man kayak (K-4), 36 ft. by 23½ in.

International class sailing canoes must conform to a 10-m. rule (*see* Yachting: *Rating Rules*). The A.C.A. also recognizes a cruising class with a 40 sq.ft. lateen cruising rig; a racing class with decked, self-bailing hulls, centreboards, sliding outrigger seats and upward of 90 sq.ft. of sail area; and A, B and C classes of standard canvas canoes with racing rigs of three sizes.

One of the oldest trophies still in contention in international competition is the International Challenge cup, first offered in 1885 by the New York Canoe club as a perpetual prize for decked sailing canoe racing.

Other types of canoe activities include "white water" running, or "shooting" the rapids of certain rivers (usually in aluminum canoes), and slalom racing over marked courses of fast-running water, marathon racing events over long distances, in laps lasting several days, as the classic race from Devizes to Westminster held at Easter in England, and ocean crossing or round-the-world trips in what are basically sailing canoes.

Canoeing instruction and safety demonstrations are part of American Red Cross chapter programs.

See also references under "Canoe" in the Index.

Bibliography.—One of the best instruction booklets is *Boy Scout Book of Canoeing,* prepared by W. Van B. Claussen and published by the Boy Scouts of America (1952); the most comprehensive textbook on the sport is *Canoeing,* prepared by the American Red Cross (1956). *See* also Percy W. Blandford, *Canoeing* (1957); C. W. Handel, *Canoe Camping* (1953), *Canoeing* (1956); Pierre Pulling, *Principles of Canoeing* (1954); R. E. Pinkerton, *The Canoe* (1959); T. Wells, *Scientific Sailboat Racing,* 5th ed. (1958); Peter Dwight, *White Water Sport* (1960). (G. Y.)

CANON, a musical device in counterpoint (*q.v.*), from the Greek *kanon,* a "law" or "rule," consisting of a theme played or sung as a single part but imitated during its course by other parts either at a specified distance in time or at a specified interval in pitch. The opening part of a canon is called *dux* ("leader") and the following parts *comes* ("companion").

Different forms of canon include exact repetition of the theme after a given time interval (as in the round); a canon at the unison (*i.e.,* at the same pitch) or at an interval of the second, third or fourth, etc.; a canon in augmentation or diminution (the note values being lengthened or shortened); a canon "mirror" in which the ascending intervals become descending in the imitating parts, and vice versa; and a cancrizans or "crab" canon, in which the theme is played backwards by the imitating part.

The principle of the canon underlies the form of the round: the medieval English six-part round "Sumer is icumen in" is in the form of a canon for four voices accompanied by a double canon. Many intellectual devices of canon were practised by Jakob Obrecht, Jean d'Okeghem and other composers of the 15th-century Netherlands school. In the 18th century devices of canon were incorporated in the fugue (*q.v.*), notably in J. S. Bach's *The Art of Fugue* and *Goldberg Variations.* Similar devices were revived in the 20th century by Schönberg and his followers, who made a wide use of the canon in 12-note music.

For clerical and religious usage of the word, *see* Augustinian Canons; Bible; Canonization; Canon Law; Constitutions, Apostolic; Kanon; Liturgy, Christian.

CANONESS, a title that first occurs in the 8th century, applied to communities of women vowed to obedience and chastity, though not to poverty, and generally under a rule less strict than that of nuns. A distinction grew up between regular (*i.e.,* living under rule) and secular canonesses, very few of the second of which survive. There are several congregations of regular canonesses, the best known of which are those of St. Augustine, of the Lateran and of the Holy Sepulchre. *See* Women's Religious Orders.

CANONIZATION, the official act of a Christian church declaring one of its deceased members worthy of public cult and entering his name in the Canon, the authorized list of recognized saints (*see* Saint).

History.—There was no formal canonization in the early church, though the cult of martyrs was widespread in the Christian world, being local in character and regulated by the bishop of the diocese. The bishop, having examined the circumstances of the martyrdom and the miracles attributed to the martyr's intercession, passed judgment on the legality of his cult. The translation of the martyr's remains from his place of burial to a church was equivalent to canonization.

In the 4th century the age of martyrs was followed by that of confessors, especially with St. Martin of Tours, who died in 397 (*see* Confessor). A widening of authority began to be the custom in matters of canonization and synodal intervention often was required. By the 10th century appeals were made to the pope in causes of canonization. The first saint canonized by a pope was Ulrich, bishop of Augsburg, who died in 973 and was canonized by Pope John XV in the Lateran council of 993. Pope Alexander III (1159–81) began to reserve the cases of canonization to the Apostolic See, and this became a general law under Gregory IX (1227–41).

The method of canonization during the 12th and 13th centuries was rather summary. Thomas à Becket, who died in 1170, was canonized in 1173, and Francis of Assisi, who died in 1226, was canonized in 1228. At this period there was no marked difference between beatification and canonization.

Pope Sixtus V (1585–90) assigned to the Sacred Congregation of Rites—a department of the Holy See consisting of cardinals and subordinate officers—among other duties that of conducting the processes of beatification and canonization. In the following century Pope Urban VIII, in *Coelestis Hierusalem* (1634), forbade the public cult of any servant of God not as yet beatified or canonized by the church. Exception was made only for those who were in possession of public cult from time immemorial or for at least 100 years. Thus two different canonization procedures came to be adopted, one by way of cult and one by way of non-cult.

The legislation of Pope Urban VIII, together with later legislation by Pope Benedict XIV, formed the basis of the procedures for beatification and canonization found today in the Code of Canon Law (canons 1999–2141), which contains the universal ecclesiastical law of the Roman Catholic Church.

Roman Catholic Code of Canon Law.—Two types of beatification are distinguished by the Code of Canon Law: ordinary or formal and extraordinary or equivalent.

Formal.—Formal beatification, the commoner procedure, entails four general steps: an informative process, introduction of the cause, the apostolic process and four definite judgments. The first of these steps is under the jurisdiction of the bishop in whose diocese it takes place, the other three being directly under the jurisdiction of the Sacred Congregation of Rites and the pope.

In the first step, the informative process, an ecclesiastical court gathers together the following: (1) all material pertaining to the candidate's reputation for sanctity or heroic virtue; (2) the writings of the candidate; and (3) information about miracles wrought by the candidate either during his life or after death. The bishop appoints a person, called postulator of the cause, to promote the cause, and also a promoter of the faith, commonly known as the "devil's advocate," whose task it is to see that the entire truth is made known about the candidate. An investigation is made into any public worship prematurely existing; if such unlawful veneration does exist, more extensive investigation is required and the cause is delayed.

At Rome, after the findings of the first court and the writings of the candidate are received, the introduction of the cause begins with an examination of the candidate's writings to determine if there is anything in them against faith or morals. This action is conducted under the surveillance of another "devil's advocate," the general promoter of the faith. If the writings are free of objectionable material, or if the pope gives his approval to something that could be objected to, the cardinals of the Sacred Congregation of Rites examine the material gathered in the informative process and state whether or not they judge the case as worthy of official introduction at Rome. If the pontiff approves the cardinals' recommendation, he issues the *litterae remissoriales* by which five judges from the diocese submitting the cause are appointed to begin the apostolic process.

This process is concerned with two points, although the first point may be considered unnecessary for investigation: (1) the candidate's reputation for sanctity and (2) the virtue and miracles attributed to him. The first is the point of great importance. Usually two miracles occurring after the death of the candidate are required for beatification.

The fourth step then follows, namely, four judgments by the Sacred Congregation of Rites with approval by the pontiff, concerning: (1) the validity of the apostolic process; (2) the virtue of the candidate to an heroic degree; (3) the authenticity of the miracles attributed to the person; and (4) whether it is safe to proceed with the beatification itself. The most important decision, again, is that concerning the heroic sanctity of the candidate; for heroic sanctity practised throughout life or by martyrdom at death is of the essence of sainthood.

If at the completion of the process the pope orders the beatification, it is in the form of a solemn proclamation, read usually in St. Peter's basilica, with a solemn mass. Veneration then may be carried on in specified localities according to certain restrictions, and efforts may be made to have the *beatus* elevated to the position of a saint. The canonization process is a repetition of the beatification procedure, except that the three congregations concerned with heroic virtue are omitted, this point being considered sufficiently established by the decision already rendered in the process of beatification. However, at least two authentic miracles obtained through invocation after beatification must occur before the cause for canonization may be introduced. The pope takes personal part in the ceremony of canonization, with a pontifical mass of extraordinary pomp and splendour at St. Peter's basilica.

The first formal papal canonization, as noted above, was that of Ulrich, bishop of Augsburg, by Pope John XV in 993; the first formal beatification is considered to be that of Francis of Sales, in 1661.

Extraordinary.—The other process for beatification and canonization, by way of cult—called extraordinary or equivalent canonization—is simply a papal confirmation that a person is a saint. It is applied only in the case of persons whose worship was immemorial at the time of the publication of *Coelestis Hierusalem* by Pope Urban VIII. Since beatification precedes canonization in the discipline of the modern Roman Catholic Church, equivalent beatification, according to canon 2125, can take place only in the case of servants of God who had been publicly venerated prior to the constitution of Pope Urban VIII and after the pontificate of Pope Alexander III. For canonization after equivalent beatification, three miracles are required instead of two. However, there is no difference in honour accorded saints canonized by either process, and many well-known saints were elevated by equivalent canonization: King Stephen of Hungary, Queen Margaret of Scotland, Pope Gregory VII, Cyril of Alexandria, Wenceslas of Bohemia, Cyril of Jerusalem, John of Matha, Bruno, Norbert, Peter Nolasco, Anselm, etc.

Eastern Orthodox Church.—The process of canonization in the Eastern Orthodox Church is less juridical, being a solemn proclamation rather than a process. Such canonizations are not always ecumenical, for the bishop of a particular locality has the authority to canonize. Spontaneous worship toward an individual on the part of the faithful establishes the usual basis for raising a holy person to the honour of sainthood. The bishop accepts the petition, examines it and delivers it over to a commission that will render a final decision. It is necessary that the person to be canonized possess moral perfection and holiness; moreover, the candidate must have worked miracles while on earth, or miracles must have taken place in connection with his relics after death.

Anglican Communion.—In 1950 the Anglican Church appointed a commission to study the question of canonization for eventual adoption in favour of deserving members of its own communion.

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(P. P. P.; W. J. EL.)

CANON LAW (*jus canonicum*), strictly speaking is the body of laws made by lawful ecclesiastical authority for the government of the whole church or of some part thereof. In the wider sense the term includes precepts of divine law, natural or positive, incorporated in the canonical collections and codes. The canon law concerns the constitution of the church, the relations between it and other bodies, and matters of internal discipline. It is not per se a formulation of dogma, although statements of the divine positive and natural law contained in the canons may be doctrinal in nature. Canon law has developed to the greatest extent in ecclesiastical bodies of the hierarchical type, and especially in the Roman Catholic Church.

ROMAN CATHOLIC CHURCH

HISTORY

The historical evolution of canon law may be divided into four epochs: (1) up to the *Decretum* of Gratian; (2) thence to the Council of Trent; (3) from Trent to the codification of 1917; and (4) under the *Codex juris canonici.*

From the Beginning to the Decretum of Gratian.—At no time, and least of all during the first centuries, was there any attempt to enact uniform legislation for the whole church. Each community was ruled by its own customs and traditions, with, however, a certain uniformity indicating a common origin. Such compilations of canon law as exist contain occasional decisions given by councils or by certain great bishops.

These compilations began in the east, the first appearing in the province of Pontus. This contained 20 canons of Nicaea (325), together with others from the Councils of Ancyra (314) and Neocaesarea (early 4th century). The collection later grew to more than 150 canons, so well known that they were referred to by number at the Council of Chalcedon (451). It was further augmented by canons from that council and from the Council of Constantinople and by placing the so-called Apostolic Canons at the head of the collection (*see* CONSTITUTIONS, APOSTOLIC). This was the Greek collection as first translated and introduced into the west. During the 6th century other documents were added, and from the Latin collection of Dionysius Exiguus (*see* below) were borrowed canons of the Councils of Sardica (342 or 343) and Carthage (419), the latter including most of the canons of the African councils. The Council *in Trullo* (692) enacted 102 canons and officially accepted the Greek collection above mentioned. The collection thus formed, together with 22 canons of the Council of Nicaea (787), became the official canon law of the Greek and subsequently of the Russian church (*see* below).

In the west, even local collections are not mentioned until the 5th century, and not until the 8th and 9th centuries are there found traces of unification as a result of exchange of these collections among various regions. The most ancient and homogeneous of these is the African collection deriving from the almost annual plenary meetings of the African episcopate. This survives only in the collection called the *Hispana* (*see* below) and in that of Dionysius Exiguus. The latter reproduces more or less fully almost all the synods of the African collection; this is the *Concilium Africanum*, so often quoted in the middle ages and also recognized by the Greeks.

The Roman church, even more than the others, governed itself by its own customs and traditions. Until the end of the 5th century the only non-Roman canonical document officially recognized there was the collection of the canons of Nicaea, including those of Sardica. The local law was founded on usage and on the papal decretals—letters addressed to bishops of the ecclesiastical province immediately subject to the pope, and others in reply to questions addressed to the pope from various quarters. At the beginning of the 6th century the Roman church adopted the collection by the monk called Dionysius Exiguus (*q.v.*). This was partly a new translation of the first 50 of the Apostolic Canons, which thus entered the law of the west. The second part contained 39 decretals of the popes from Siricius (384–399) to Anastasius II (496–498). Further decretals were added to this collection as they appeared. In 774 Pope Adrian I gave the augmented collection to Charlemagne as the canonical book of the Roman church (the *Dionysio-Hadriana*). It was officially received by the Frankish church, imposed by the Council of Aix-la-Chapelle (802), and thenceforward was recognized and quoted as the *liber canonum*, thus marking an important stage in the centralization of canon law.

In the Spanish church, which was strongly centralized around the see of Toledo, canon law was embodied in a collection that, though unofficial, was received everywhere; this was the *Hispana*. The first part is composed of the canons of the councils, arranged according to regions: Greek, African, Gallican and Spanish councils. Nearly all the latter were held at Toledo, beginning with the great council of 589 and continuing until interrupted by the Moorish invasion. The second part of the *Hispana* contains the papal decretals, as in the collection of Dionysius. It was this second part that later served as the basis for the collection of the False Decretals.

The British and Irish churches remained still longer outside the centralizing movement. Their main contribution to the later system of canon law was in the influence of the Penitentials, collections for the guidance of confessors in imposing penances for various sins (*see* PENITENTIAL). The otherwise unimportant Irish collection introduced the canonists to the practice of quoting from Scripture and the Fathers.

In the middle of the 9th century an enlarged edition of the *Hispana* began to circulate in France, where it was falsely attributed to St. Isidore of Seville (and hence today is called the *Pseudo-Isidoriana*). Besides many genuine additions to the *Hispana,* this collection included 60 spurious decretals from popes prior to Siricius in its first part, and in the third part of the collection at least 104 out of some 120 documents are today considered to be fictitious. For the historical questions connected with the False Decretals, *see* DECRETALS, FALSE; here we are concerned only with their influence on the development of canon law. Despite some doubts and hesitation, it is safe to say that the False Decretals were fairly generally accepted until the 15th century, and all later collections used them extensively.

The False Decretals did not greatly modify or corrupt canon law. The collection in general introduced little new legislation, but rather gave a new formulation to existing practices and tried to give the authority of law to what was already accepted in fact. They did contribute much, however, to the progress of canon law toward unity. For they were the last of the chronological collections. Thereafter, canonists began to arrange their collections according to a preconceived order, leading to the development of a common canon law and, ultimately, to the *Decretum* of Gratian. From the end of the 9th to the middle of the 12th century, there were about 40 systematic collections, containing both texts of the law and the authors' comments and discussion of controversies.

From the Decretum of Gratian to the Council of Trent.—It was against this background that Gratian, a Camaldolese monk, published, somewhere between 1139 and about 1150, his monumental treatise, called at first *Concordantia discordantium canonum* but soon known simply as the *Decretum Gratiani,* or *Decretum* (*see* GRATIAN). This immense work consists of three parts. (1) The first, treating of the sources of canon law and of ecclesiastical persons and offices, is divided according to the method of his pupil Paucapalea into 101 *distinctiones,* which are subdivided into 3,945 *canones.* (2) The second part consists of 36 *causae* (cases proposed for solution), subdivided into *quaestiones* (questions raised by the case), under which are arranged the various *canones* (canons, decretals, etc.) bearing on the question. (3) The third part gives, in five *distinctiones,* the law bearing on church ritual and the sacraments. The work is not a mere collection of texts but also a treatise giving the opinions and teaching of Gratian. He drew his materials from the existing collections and included the canons of recent councils and recently published decretals, up to and including the Lateran council (1139). When necessary, he had recourse to the Roman law and made extensive use of the Fathers and ecclesiastical writers. The apparent discordance of texts he explained away, or indicated the more authoritative.

From the viewpoint of its official authority, the *Decretum* occupies an intermediate position difficult to define. It is not an official code in which every text has the force of law: there was as yet no idea of producing an official compilation. It remains a work of private authority, and the texts contained in it have only that legal force they possess in themselves. On the other hand, it actually enjoys a public authority that is unique: for centuries it has been the text on which has been based the teaching of canon law in all the universities; it has been glossed and commented on by the most illustrious canonists; it became, without being a body of laws, the first part of the *Corpus juris canonici,* and as such it has been cited, corrected and edited by the popes. It thus, by usage, obtained an authority perfectly recognized and accepted by the church and served as an important source for the official codification of canon law in 1917.

Subsequent to the *Decretum,* the collections of texts were clearly separated from the commentaries in which the canonists continued the formation and interpretation of the law. Thus the way was prepared for official collections. New decretals as they appeared were collected in five large *Compilationes,* which soon contained a mass of materials greater than that of the *Decretum.* In 1234 the contents of these compilations were edited, together with later decretals, and promulgated officially as Decretals by Gregory IX. This first official code forms the second part of the *Corpus juris canonici.* While it was intended to supersede the *Compilationes,* it was not meant to supersede the *Decretum:* there was no thought of codifying the whole of canon law. A supplementary collection, called the *Liber Sextus* (because it was in addition to the five books of the Decretals of Gregory IX), was officially promulgated by Boniface VIII in 1298 and became the third part of the *Corpus.* An additional collection was prepared under the direction of Clement V and was even promulgated by him in consistory in 1314; but, owing to his death, it was not sent to the universities until 1317. It is known as the *Clementinae* and forms the fourth part of the *Corpus juris canonici.*

At this point the official collections stop. The two last, which have found a place in the editions of the *Corpus,* are collections of private authority. The *Extravagantes* (*i.e., extra collectiones publicas*) of John XXII number 20 and are divided into 14 titles. The *Extravagantes communes* (*i.e.,* coming from several popes) number 73, from Boniface VIII to Sixtus IV (1484), and are classified in books and titles. These two collections were included in the edition of Jean Chappuis in 1500; they passed into later editions and are considered as forming part of the *Corpus juris canonici* (parts 5 and 6). As such, and without receiving any complementary authority, they have been corrected and re-edited, like the others, by the *Correctores romani.*

Thus was closed, as the canonists say, the *Corpus juris canonici;* but this familiar expression is only a bibliographical term. Though the expression *corpus juris* is found, for example, at the Council of Basel, not even the official edition of Gregory XIII has as its title the words *Corpus juris canonici,* and this title is not used until the Lyons edition of 1671. Though there were no further collections, the sources of canon law were not dried up; decisions of councils and popes continued to appear; but no attempt was made to collect them. Canonists obtained the recent texts as best they could. The era of the Great Schism of the west, to be followed by the Reformation, was not a period favourable to the reorganization of ecclesiastical law.

After the Council of Trent.—The third epoch in the development of the canon law starts from the disciplinary decrees of the Council of Trent (1545–63), made in the second part of its sessions, called *de reformatione.* During this period there was a marked move toward centralization in the Roman Catholic Church and an increased tendency toward uniformity of legislation emanating from the Holy See.

At the same time, however, the dispersed condition of the canonical documents was not remedied; on the contrary, the large number of pontifical constitutions and of decrees from the Roman congregations even aggravated the situation. The constitutions were published in the *Bullarium;* but this was a collection of private authority, except that officially published by Benedict XIV in 1747; further, this compilation is in chronological order and rather unwieldy. The various Roman congregations published official collections of their decrees; the decrees of others were published by private authority. It is no surprise, therefore, to find that Catholic bishops from all quarters of the world petitioned for a codification of the canon law at the time of the Vatican council (1869–70). The position was thus stated by several French bishops:

> It is absolutely clear, and has for a long time past been universally acknowledged and asserted, that a revision and reform of the canon law is necessary and most urgent. As matters now stand, in consequence of the many and grave changes in human affairs and in society many laws have become useless, others difficult or impossible to obey With regard to a great number of canons, it is a matter of dispute whether they are still in force or abrogated. Finally, in the course of so many centuries, the number of ecclesiastical laws has increased to such an extent, and these laws have accumulated in such immense collections, that in a certain sense we can well say: We are crushed beneath the laws, *obruimur legibus.* Hence arise infinite and inextricable difficulties which obstruct the study of canon law; an immense

field for controversy and litigation; a thousand perplexities of conscience; and finally contempt for the laws.

The Vatican council was forced to dissolve without dealing with the question of canonical reform, but on March 19, 1904, Pope Pius X issued a *motu proprio* decreeing the revision and codification of the canon law of the Latin church. A commission of cardinals was appointed for this purpose, under the direction of Pietro Cardinal Gasparri, together with a body of consultants. A circular letter was issued to all archbishops throughout the world requiring them, after consultations with their suffragan bishops, to set forth to the Holy See within four months the changes in canon law that were deemed advisable; at the beginning of April 1904 the universities also were asked to collaborate. After years of concerted labour, the new *Codex juris canonici* was officially promulgated on May 27, 1917, and, with the exception of a few provisions effective immediately, went into force throughout the Latin church on May 19, 1918. This date therefore ushered in the fourth epoch in the development of canon law in the Roman Catholic Church.

CODE OF CANON LAW

Like the Code Napoléon, which was the prototype for most of the modern civil codes, the Code of Canon Law (*Codex juris canonici*) is a systematic arrangement of the ecclesiastical law in force. The code itself consists of five books, which, with the exception of the first, are divided into parts, and the parts at times into sections. The parts are also subdivided into titles; some of the titles into chapters; and some chapters into articles. The canons are the ultimate subdivision and are numbered consecutively throughout the code into 2,414 canons. Citation to the code is simply by the number of the canon.

Book I.—Book i is concerned with general norms for interpreting the code—on ecclesiastical laws, the force of custom, methods of computing time, rescripts, privileges and dispensations from ecclesiastical laws (canons 1–86).

Book II.—Book ii (can. 87–725) deals with three classes of persons in the church—clerics, religious and the laity. The Roman pontiff has the supreme power of jurisdiction within the church (can. 218), as does also an ecumenical council consisting of the Roman pontiff and the bishops of the whole church (can. 228). This power of the Roman pontiff is at the same time legislative, judicial and administrative. The administration of the church is ordinarily conducted through the Roman congregations (can. 246–257), and the judicial power through the tribunals of the Roman curia, consisting of the Sacred Penitentiary for the internal forum, the *Rota* for the external forum and the Apostolic *Signatura* as the supreme tribunal of the church (can. 258–259).

At the local level, the local ordinary (residential bishop) is the sole legislator for the diocese, and the diocesan synod has only a consultative role (can. 362). Provincial councils are composed of the ordinaries of the ecclesiastical province, and their decrees are binding within the dioceses of that province; such councils are to be held every 20 years (can. 283). Plenary councils are composed of the ordinaries of more than one province (usually on a national scale), convoked with the permission of the Holy See, and may enact legislation binding within those provinces to be promulgated after approval by the Sacred Congregation of the Council (can. 281). Plenary or provincial councils, as well as diocesan synods, may supplement the common canon law to meet local needs, but they cannot derogate from that law without the express approval of the Holy See. (The annual meetings of the bishops of the United States are an informal conference, not a plenary council, and the conference has no power to enact legislation binding upon the member bishops.)

Book III.—Book iii of the code, entitled "De Rebus," legislates concerning things—the discipline for the administration of the sacraments (can. 731–1153), sacred places such as churches and chapels (can. 1154–1242) and sacred seasons (can. 1243–54), divine worship (can. 1255–1321), the teaching authority of the church, including the qualification of preachers and the censorship of books on religion (can. 1322–1408), the rules governing ecclesiastical benefices (can. 1409–94) and the temporal goods of the church (can. 1495–1551). Of particular interest in this book are the canons establishing the impediments to marriage (can. 1035–80), the canonical formalities required for the validity of marriage of a Catholic (can. 1094–96, 1098–99), and the power of the church to dissolve a valid marriage (can. 1118–27).

Book IV.—Book iv of the code (can. 1552–2194) establishes the various tribunals or courts in the judicial system of the church, sets forth rules for the conduct of trials and the offering of evidence. The second part of this book establishes the procedure to be followed for beatification and canonization (can. 1999–2141).

Book V.—Book v, "On Crimes and Penalties," contains the criminal law of the church (can. 2195–2414). It establishes the mental and moral responsibility required for a criminal violation of canon law, defines the effect of the various penalties—such as excommunication or interdict—and then sets forth the particular laws, the violation of which is punished by such penalties.

Since its codification in 1917 the canon law of the Roman Catholic Church has not remained static. Thus, in 1948 a change was made in the formalities for marriage (*cf.* can. 1099, sec. 2); in 1950 the penalty of excommunication was added to the law forbidding clerics to engage in certain forms of commercial enterprises (*cf.* can. 142); and in 1953 and 1957 radical changes were made in the law of fasting before communion (*cf.* can. 858).

EASTERN CHURCHES

The development of canon law in the eastern churches was even more haphazard than that in the west, largely because of the strongly autonomous character of the great eastern patriarchates. After the final break with Rome in 1054, the eastern churches were cut off from the centralizing movement in the canon law of the west and came predominantly under the influence of Constantinople.

Orthodox.—The early Greek collections are referred to above. As adopted and augmented by the Council *in Trullo* (692) and subsequently supplemented by 22 canons of the Council of Nicaea (787), this collection became the official canon law of the Greek and later of the Russian church. Toward the end of the 6th century, a new type of collection began to appear in the east, composed of both ecclesiastical canons and imperial laws. Of these collections, called *nomocanones,* the most influential was the Nomocanon of Photius, patriarch of Constantinople in the latter part of the 9th century. This, together with the commentaries of the 12th-century monk John Zonaras, the *scholia* of Theodore Balsamon, patriarch of Antioch, and the compendium of Matthew Blastares (14th century), is considered to be the chief authentic source of law in the Orthodox Church. This nucleus has been further supplemented through the centuries by legislation of synods held in the various patriarchates of the east; but, while there has been a certain amount of mutual borrowing, there has not developed in the eastern churches a common canon law in the way that such a body of law developed in the western church.

Catholic Eastern.—In the Roman Catholic eastern churches that follow non-Roman rites the prevailing canon law did not differ radically from that of the Orthodox counterpart of each church, except, of course, for their recognition of the primacy and jurisdiction of the Holy See. In their case, the local patriarchal law is supplemented by a large body of legislation by the Holy See for the individual eastern rites of the church, but there was little or no attempt to make any systematic collection of this legislation or to codify it. The diversity of legislation was considerably augmented by the multiplicity of rites.

The success of the Latin Code of Canon Law, however, led Pope Pius XI in 1929 to establish a commission of cardinals for the codification of the law of the eastern churches and to invite the eastern bishops to submit their suggestions; and in 1930 a committee of consultants from each of the rites was put to work. The proposed eastern code was to be modeled on the Latin code. The resulting canons are in Latin and follow the text of the Latin code where possible, but many of these canons provide for supplementation by the local or customary law of the various rites, thus preserving many of the cherished traditions of the individual eastern churches.

Unlike the Latin code, the code for the eastern churches was not published as a whole, but various sections were promulgated as they were completed. The first section to be promulgated was that containing the 131 canons on marriage, which came into force on May 2, 1949, and correspond closely to the 132 canons of the Latin code. The greatest differences affect the impediments of consanguinity and affinity and the very wide powers of dispensation possessed by the eastern patriarchs. The procedural law, corresponding to book iv of the Latin code, became effective on Jan. 6, 1951. Another section, dealing with the law of religious and temporal goods, with a definition of the terms used in the eastern code, went into effect on Nov. 21, 1952. The section on the law of persons, corresponding to book ii of the Latin code, raised problems of the utmost delicacy, since it would concern the juridical status of the eastern patriarchs and bishops, the scope of their jurisdiction and the method of their selection. When finally promulgated in 1957, this part of the codification was found to preserve most of the traditional prerogatives and powers of the eastern prelates, and provided for the continuance of their selection by means of election with subsequent confirmation by the Holy See. A pontifical commission was created to give authentic interpretations of the eastern codification, and the gigantic task of collecting and publishing the *fontes*, or sources, of the eastern law was begun in 1930. (Jo. M. S.)

ANGLICAN COMMUNION

England.—The English courts, both temporal and spiritual, have since the Reformation consistently maintained that the Church of England is and has always been the national and independent branch of the Catholic Church operating in England. Though the Reformation severed the connection with Rome, so that thereafter further developments of the Roman canon law left England unaffected, the canon law of pre-Reformation England continued into the post-Reformation period. While the theory has been advanced and disputed that the pre-Reformation canon law of the western church was binding in England only insofar as it had been "received" into England, there can be no doubt that the vast bulk of pre-Reformation canon law remained and is still part of the law of the Church of England except insofar as it has been lawfully abrogated or varied by or since the Reformation.

The church remained, as before, established, so that the law of the church and the law of the state together make up the one law of England, which is the law of both church and state. This is so, even where there is an apparent conflict, as, for example, over marriage; while the state recognizes the validity of a secular divorce, no minister of the Church of England need perform the marriage ceremony for a divorced person whose former partner is still living. At the Reformation the papal claim to supremacy was decisively rejected and the royal supremacy as decisively enthroned, with the result that the church, with the rest of the nation, was equally affected by subsequent constitutional developments and the royal supremacy has effectively become a parliamentary supremacy. The church courts survived and became the king's courts. The two convocations of the two provinces of Canterbury and York survived with their limited powers of making canons, which, when they have received the royal assent, are binding on the clergy, and in 1603 and 1604 they supplemented the existing canon law with a further body of purely Anglican canons; they also from time to time pass resolutions, known as acts of convocation, which, though without legislative effect, carry considerable weight as considered pronouncements of the church's view. The bishops, too, retained their seats in the house of lords, though their number there is limited to 26.

From the time of the Reformation until 1919 the only source of new legislation (apart from the canons of convocation) was parliament, and there are many acts of parliament, varying in importance from the Act of Uniformity (giving statutory authority to the Book of Common Prayer) down to acts regulating the burial of the dead, all of which go toward the making of English ecclesiastical law. In 1919, however, parliament passed an Enabling act (the Church of England Assembly [Powers] act) that gave statutory recognition to the already existing Church assembly. This body consists of three houses, namely, a house of bishops (consisting of the upper houses of the two convocations), a house of clergy (consisting of the lower houses of the two convocations) and a house of laity (elected by the diocesan conferences). It passes measures which, with the consent of parliament, may be presented to the sovereign and which, when they have received the royal assent, have the full force of an act of parliament. After 1919 much legislation was effected by measures of the Church assembly that, before that date, could have been done only by parliament.

The canon law of the Church of England consists, therefore, primarily of the pre-Reformation canon law of the western church, except insofar as it has been rejected or varied; acts of parliament; measures of the Church assembly; legislation passed by virtue of powers delegated by parliament or the assembly; canons passed by the convocations; and, so far as it is applicable, the general law of England. As in the case of every other branch of English law the interpretation of the canon law rests with the courts of the land, both spiritual and temporal. (*See* also ECCLESIASTICAL LAW [ENGLISH].) (E. G. Mo.)

Ireland.—The Church of Ireland was disestablished in 1869 by act of parliament, and that church thus was freed from the prohibition against holding synods and legislating for itself. Under this authority, the bishops met with representatives of the clergy and laity in a general convention in 1870. This convention declared that a general synod of the bishops, with representatives of the clergy and laity, should have supreme legislative authority in the Church of Ireland, together with certain administrative powers not inconsistent with the episcopal constitution of the church. The synod was to consist of two houses—the house of bishops and the house of clerical and lay representatives. To carry any measure there was required a majority of the clerical and lay representatives, voting either conjointly or by orders, and also a majority of the house of bishops, if the latter wished to vote. For any alteration of "articles, doctrines, rites or rubrics," a two-thirds majority of each order of the representative house was required, with a year's delay for consultation of diocesan synods, in which provision also was made for lay representation.

Scotland.—The canon law of the Anglican communion in Scotland prior to the 16th century was generally that of the continent. The usages of the church were similar to those in France and had not the insular character of those in England and Ireland. The canon law regulating marriage, legitimacy and succession was taken over by the Scottish secular courts and survived almost unimpaired as part of the common law of the land. In the post-Reformation period no canon law was recognized as being authoritative in Scotland unless it emanated from a national council or was adopted by such a council. The general canon law, except where acknowledged by act of parliament, or a decision of the courts, or sanctioned by the canons of a provincial council, is regarded in Scotland as having only persuasive force according to the rules of equity and comity, and is not per se binding.

United States.—The Protestant Episcopal Church in the United States of America is the successor of the Anglican Church as it existed in the American colonies before the Revolution. The Anglican body in the colonies was subject to "all the laws of the Church of England applicable to its situation," and this body of law was inherited by the Protestant Episcopal Church. It was recognized, however, that not all the canon law of the established English church could be applied in the United States; and in 1789 a general convention, consisting of clerical and lay representatives as well as of bishops, assumed for itself and its successors supreme legislative authority. The constitution adopted by the first general convention, with subsequent amendments, forms the organic law for the Protestant Episcopal Church in the United States of America. The general convention consists of a house of bishops and a house of deputies, the latter being composed of four presbyters and four laymen elected by each diocese. Voting in the house of deputies may be required to be by orders, and in such case the concurrence of both orders, clerical and lay, is required for the passage of any measure. The house of bishops may propose measures to the house of deputies and also may veto acts of that house provided certain formalities are observed. Similar constitutions providing for representation of the laity have been adopted by the various dioceses. Standing committees composed of both clergy and laity are responsible for the government of the dioceses in the interim between diocesan conventions. A great body of canonical legislation has been enacted and amended by these bodies, and this was codified in 66 canons by the general convention of 1943. Although the Protestant Episcopal Church, except for a brief period immediately after the Revolution, has maintained cordial and more or less close relations with the parent Church of England, it is both de jure and de facto completely independent of that body. Together with other bodies in communion with the Church of England, the Protestant Episcopal Church participates in the decennial Lambeth conferences headed by the archbishop of Canterbury, but the conference has no legislative authority.

South Africa.—After 1870 the Church of the Province of South Africa secured autonomy while remaining a part of the Anglican communion. By its constitution of that year the English Church in South Africa adopted the laws and usages of the Church of England, insofar as they were applicable to an unestablished church. It disclaimed the right to alter doctrinal standards, except in agreement with such doctrinal alterations as might be adopted by a general synod of the Anglican communion. But in interpreting these standards of faith and doctrine, and even more so in interpreting disciplinary canons, the Church of the Province of South Africa was bound only by the decisions of its own ecclesiastical courts. (Jo. M. S.)

CHURCH OF SOUTH INDIA

This church provides an important and interesting example of a current attempt at the reunion of severed portions of Christendom. It consists of what were formerly four dioceses of the Anglican Church of India, Burma and Ceylon; the former Methodist province of South India; and the former South India United Church, consisting of Presbyterians and Congregationalists and members of the Dutch Reformed Church together with other European Protestant bodies. All these, after nearly 30 years of preparation, joined together in 1947 to form the Church of South India. The basis of this reunion includes the continuation of the ministries of the ministers of the constituent bodies under a constitutional version of the historic episcopate, with the intention that eventually every minister will have been episcopally ordained. The constitution is, of course, a written one in which care was taken both to avoid too close a definition in respect of points of theological difference and also to safeguard various aspects of the traditions of the constituent bodies. The governmental system is pyramidal, having at its head the synod, consisting of the bishops (one of whose number is moderator), together with representatives of the presbyterate and laity. Below the synod are the diocesan councils, consisting of the bishop, presbyters with charge of pastorates and lay representatives; they frame their own differing constitutions, subject to the general oversight of the synod. Below the diocesan councils come the pastorates; each has a pastorate committee, consisting of the pastor-in-charge and elected representatives of the congregations which form the pastorate. There are spiritual courts at three levels, the members of which are clerical and lay rather than legal. The marriage law of the church, while aiming at the Orthodox Christian ideal, is somewhat complicated and endeavours to take account of the complicating factors that the mission field provides. Since the constitution envisaged an interim period of 30 years, a more mature system of canon law may perhaps be expected to evolve at the end of that period; one that will, no doubt, bear the marks of its own interesting and unusual genesis.

See ECCLESIASTICAL LAW (ENGLISH); *see* also references under "Canon Law" in the Index. (E. G. Mo.)

BIBLIOGRAPHY.—The literature on the subject in all its branches is very elaborate, and this is particularly true of the canon law of the Roman Catholic Church. The articles "Law (Christian, Western)" and "Law (Christian, Eastern)" by A. Fortescue and "Law (Christian, Anglican)" by A. J. Maclean in *J. Hastings, Encyclopedia of Religion and Ethics,* give concise statements of information with references for further study. For an extended study of the history of western canon law, *see* A. G. Cicognani, *Canon Law,* authorized English version (1934). A fine discussion of legislation in the Roman Catholic Church is contained in R. Metz, *What Is Canon Law?* (1960); brief surveys of the current *Codex juris canonici* will be found in T. L. Bouscaren and A. C. Ellis, *Canon Law: a Text and Commentary,* 2nd ed. (1951), and in J. A. Abbo and J. D. Hannan, *The Sacred Canons,* 2 vol. (1952); while the post-code legislation and interpretation is collected by T. L. Bouscaren, *Canon Law Digest,* 4 vol. (1934–58), which is kept up to date by annual loose-leaf supplements. The Catholic University of America has published, under the general title of "Canon Law Studies," numerous doctoral theses dealing with particular canons. The sources used in drafting the Latin code have been published by the Vatican Press under the title *Fontes juris canonici;* publication of the *Fontes juris canonici orientalis* was begun in 1930. (Jo. M. S.)

CANOPUS (CANOBUS), an ancient city on the western coast of the Nile delta of Egypt, on a site 15 mi. N.E. of Alexandria, near the modern village of Abu Qir. Known to the Greeks as Kanopos, its Egyptian name was PeGewat. The Canopic branch of the Nile, which entered the Mediterranean in the Bay of Abu Qir, is entirely silted up, but on the shore at Towfiqiyya, about 2 mi. from Abu Qir, there are extensive remains including those of the temple of the Greco-Egyptian god Sarapis, which was a place of pilgrimage from Hellenistic times until its destruction in the 4th century A.D. Canopus was a centre of the unguent industry and a pleasure resort for the people of Alexandria and was notorious for its dissoluteness in the Roman epoch. On March 7, 238 B.C., an assemblage of priests from all Egypt passed a decree honouring Ptolemy Euergetes and his consort Berenice; copies of this decree were set up in the principal temples of Egypt and fragments of several have been found. The emperor Hadrian gave the name Canopus to part of his villa at Tivoli where he had gathered together Egyptian antiquities.

Osiris was worshiped at Canopus under the curious form of a human-headed vessel. The name "canopic jars" was therefore mistakenly applied by early archaeologists to the jars with human and animal heads in which the viscera were placed by the ancient Egyptians after mummification, and is still often applied to Egyptian and other jars, including Etruscan, with lids of this type.

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CANOPY, a hood or cover, supported or suspended above an object. In modern usage, canopies serve the primarily functional purpose of providing protection from the weather, as awnings, or canopy hoods above doors. Originally, however, the canopy was a variant of the revered domical shape, which symbolized a divine and royal presence (*see* DOME); it probably derived ultimately from the cosmic audience tent of the Achaemenid kings of Persia. Used by Roman and Byzantine emperors in their state appearances as supreme beings, it passed into the middle ages as a symbol of the divine presence, as in the small canopies placed over statues of saints on medieval church façades; in baldachins (*q.v.*); in testers (*i.e.,* canopies suspended from the ceiling or bracketed from a wall) placed above altars; and in the embroidered hangings supported on poles and carried over officiating priests in religious processions.

GIRAUDON

CANOPY OVER THRONE OF NAPOLEON AT FONTAINEBLEAU; FRENCH 19TH CENTURY

The canopy as a symbol of a royal presence also passed into the middle ages and beyond; beneath this mark of their divine right to rule, monarchs gave audience and dispensed justice down to modern times. Typical surviving examples are the canopies above the audience beds of French kings; the elaborate canopied thrones erected for Napoleon in the Luxembourg palace and elsewhere; and the canopies used in British coronation ceremonies. (An. G.)

CANOSA DI PUGLIA (anc. Canusium), a town in the province of Bari, Italy, is 24 km. (15 mi.) S.W. of Barletta, dominating the tableland of Puglia, on the right bank of the Ofanto (Aufidus). Pop. (1969 est.) 32,489 (commune). There are a number of Roman remains, including an arch dedicated to Trajan.

Ancient Canusium stood about 19 km. (12 mi.) from the mouth of the Aufidus. It was said to have been founded by the legendary Diomedes (*q.v.*), and its people spoke both Greek and Latin in the time of Horace (*Sat.* i, 10, 30). A large number of Greek relics have been found, including fine polychrome vases made there (3rd century B.C.). Canusium came voluntarily under Roman sovereignty and remained loyal throughout the Punic Wars, but revolted in the Social War, in which it appears to have suffered (Strabo vi, 283).

It stood on the Via Traiana and had a trade in agricultural products and in Apulian wool (cleaned and dyed there). Under the early empire it was a municipium, and later became a *colonia.* In the 6th century it was still the most important city in Apulia. The Normans rebuilt the town after its destruction by the Saracens (9th century); a medieval castle crowns the hill above the town. The southern Romanesque former cathedral of S. Sabino (bishop of Canosa, 514–566; the bishopric passed to Andria in 1818) was consecrated in 1801, and contains interesting Byzantine relics. To the south of it is the detached mausoleum of Bohemund, son of Robert Guiscard, who captured Antioch during the first crusade (1096). It is entirely faced with *cipollino* (Carystian) marble, and has fine bronze doors with long inscriptions.

The Barletta-Melfi and Cerignola-Andria roads intersect there, and the station is on the Barletta-Spinazzola railway, by which agricultural products are sent to Barletta port. Early in the 20th century large-scale emigration, principally to the Americas, depleted the population. Those who remained were chiefly farmers engaged in stock breeding. The rich yield of dairy produce is supplemented by cereals and herbs, grown on the banks of the Ofanto, and by almonds and olives; olive oil and wine are manufactured. A chalky, porous stone is quarried for building. Pottery is also manufactured.

See T. Ashby and R. Gardner in *Papers of the British School at Rome,* vol. viii, pp. 154 ff.; G. Iacobone, *Canusium* (1925).

(M. T. A. N.)

CANOSSA, a ruined castle, 1,890 ft. above sea level, 12 mi. (19 km.) S.W. of Reggio nell'Emilia in Italy, famous as the seat of a powerful feudal family. The stronghold was built by Atto Adalbert (d. 988), the founder of the house of the Attoni, which derived the title of counts of Canossa from it. Adelaide, the widowed queen of Italy and future empress, is said to have taken refuge there in 951. Atto Adalbert acquired the counties of Modena, Reggio and Mantua, his son Tedald (d. 1012) those of Brescia and Ferrara. Tedald's son Boniface (d. 1052) received the march of Tuscany *c.* 1027 from the emperor Conrad II and acquired Upper Lorraine through his marriage with Beatrice of Lorraine (d. 1076). The well-known countess Matilda (*q.v.*) was their daughter.

In 1077 Pope Gregory VII stayed at Canossa on his way to preside over the diet at Augsburg convened to determine whether the excommunicated emperor Henry IV (*see* Henry [German kings]) was fit to rule. To forestall this, Henry journeyed to Canossa as a simple penitent and, on Jan. 28, after waiting for three days, received absolution. The castle was destroyed in 1255 by the people of Reggio.

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(N. R.)

CANOVA, ANTONIO (1757–1822), Italian sculptor, achieved international fame as one of the greatest exponents of neoclassicism. He was born in Possagno (near Venice) on Nov. 1, 1757, of a family of stonemasons. By 1774 he had his own workshop in Venice and was producing works in a lively and naturalistic style linked to the sculptural tradition of the works he saw around him. By 1778, however, a classicizing tendency had already become apparent in the "Daedalus and Icarus" (Museo Correr, Venice), and in 1779 he set out for Rome, soon afterward visiting Naples, Herculaneum, and Pompeii. In the decision to follow the ideals of classical antiquity, which determined his subsequent style, he is said to have been influenced by the Scottish-born painter Gavin Hamilton. Canova's first important neoclassical work, the "Theseus and the Minotaur" of 1782 (Coll. Lord Londonderry, London), led to the major commission for the monument to Pope Clement XIV (completed 1787, SS. Apostoli), and this, in turn, to the larger monument to Pope Clement XIII (1787–92, St. Peter's). This latter monument, in common with most of Canova's works of this period, shows a certain unresolved tension between qualities that had characterized the Venetian period (realism, elegance, and grace) and the more studied classicism of the Roman period. The conflict was never completely eradicated from Canova's work, but in his fully mature period he produced such accomplished works as the "Perseus" (1801) and the "Pugilists" (1802), the only modern works considered worthy to be shown in the Vatican's Belvedere in company with works of classical antiquity.

The French invasion of Rome in 1798 sent Canova northward, and in Vienna he worked on a monument to Maria Christina (Augustinerkirche). In 1802, at the pope's instigation, he accepted Napoleon's invitation to Paris, where he became court sculptor and had considerable influence on French art. Among his many portraits of Napoleon were two colossal nude figures (one of which, in marble, was captured by Wellington and is now in Apsley House, London). The portrait of the emperor's sister, Pauline Borghese as "Venus Victrix" (begun 1805, Borghese Gallery, Rome), is also outstanding. After the fall of Bonaparte, Canova was named head of the commission appointed by the pope to restore works looted by the French to their original owners in Italy. In this he was aided by the English, and during a visit to London studied the Elgin marbles soon after they had been bought for the British Museum in 1816. For his success in this enterprise he received from the pope the title of marquis of Ischia. Canova's only work for America, the statue of George Washington erected at Raleigh, N.C., in 1821, was destroyed by fire; a gesso version can be seen at Possagno. Canova died in Venice on Oct. 13, 1822, and was buried in a temple at Possagno, designed by himself in imitation o the Pantheon in Rome; the town houses a museum of his works.

Canova's reputation, which could hardly have been higher in his own time, has since declined steeply. The attempt to reach a more balanced evaluation of his merits is still being made.

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CÁNOVAS DEL CASTILLO, ANTONIO (1828–1897), Spanish statesman, who was the architect of the restoration of th Bourbon monarchy in Dec. 1874 and of the system of governmen thereafter established, was born at Málaga on Feb. 8, 1828. H studied law at Madrid university and earned his living by writin and journalism. He entered the Cortes in 1854, and held variou offices in Liberal cabinets between 1860 and 1868. After the abdication of King Amadeo and the proclamation of the federal republic (1873), Cánovas advocated the return of the Bourbons an it was he who drew up the manifesto issued in 1874 by Alfonso XII. But he opposed the method of the *pronunciamiento.* After Alfonso had been proclaimed king, Cánovas formed a ministry an held office, with two brief interruptions, for six years. He had t construct a Conservative party out of the least reactionary partie of the reign of Isabella II and out of the more moderate element of the revolution. With such followers he made the constitutio of 1876 (*see* Spain: *History*). Cánovas was guided by two principles: the exclusion of the army from politics and the undesirability of free elections. Holding the latter view because of th insecure position of the monarchy, he instituted the system o "made" elections, which was crowned when he permitted the creation of a Liberal party under P. M. Sagasta, who took office in 1881 and with whom Cánovas thenceforward alternated as prime minister. However necessary the faking of elections may have been in the years immediately after the restoration, the practice begun by Cánovas proved ineradicable and ultimately harmed the monarchy by associating it with a discredited political system. Cánovas became prime minister for the fourth time in March 1895 immediately after the outbreak of the Cuban insurrection, and prepared to send 200,000 men to the West Indies to carry his policy of no surrender. The Cuban question was still undecided when he was assassinated at Santa Agueda (Guipúzcoa) on Aug. 8, 1897.

Cánovas was a cultured and intelligent man. He continues to enjoy a considerable reputation as a historian, especially for his studies of 17th-century Spanish decadence, on which *Estudios del reinado de Felipe IV*, two volumes (1888–89), is his most notable work.

See M. Fernández Almagro, *Cánovas, su vida y su política* (1951).

CANROBERT, FRANÇOIS CERTAIN (1809–1895), marshal of France, whose early service in north Africa led to his appointment as French commander in chief in the Crimean War, was born at St. Céré, Lot, on June 27, 1809. After study at St. Cyr, he was commissioned sublieutenant in 1828. Sent to Algeria in 1835, he distinguished himself at the taking of Constantine. He was recalled to Paris in 1839 to organize a battalion of the Foreign Legion, but returned to Africa in 1841. As a colonel in 1847, he won renown with the Zouaves at the siege of Zaatcha. Summoned to Paris in 1850, he was made brigadier general and aide-de-camp to the prince-president Louis Napoleon and took part in the *coup d'état* of Dec. 2, 1851. He was promoted general of division in 1853. The Crimean War (1854–56), while confirming his merits, also exposed his limitations. Courageous, a magnificent leader of men and a good speaker, he feared responsibility and showed himself irresolute when he became commander in chief on the death of the marshal de Saint-Arnaud (Sept. 1854). He was aware of his own limitations and, on the pretext of ill-health and of a disagreement with the British, asked the emperor to appoint a new commander in chief (May 16, 1855) but to leave him the command of a division. Recalled to Paris in July 1855, he was made a marshal of France. He took part in the campaign of 1859 in Lombardy, distinguishing himself at the battles of Solferino and Magenta. On the outbreak of the Franco-German War, his fear of responsibility led him to serve under the junior marshal, A. F. Bazaine. In command in the battle of St. Privat, he at first withstood the Prussians but eventually had to retreat when his ammunition ran out and reinforcements failed to arrive. He was taken prisoner at Metz. Resuming his military career after the war, he became a member of the superior council of war. Elected senator for Lot (1876) and for Charente (1879 and 1885), he represented Bonapartist ideas under the third republic. In 1856 he married Lelia Flora de Macdonald, who bore him two children and died in 1889. He died in Paris on Jan. 28, 1895.

See L. Bapst, *Le Maréchal Canrobert,* 3 vol. (1898–1913). (L. G.)

CANTABRI, an Iberian tribe with a strong celtic element which occupied the centre of the northern coast of Spain and lived in the Cantabrian mountains situated parallel to the coast in the modern province of Santander. They occupied the territory now comprised by the modern province of Oviedo on the west as far as the Salia (Sella) river, beyond which lay the Astures tribe. They were bounded on the east by the Autrigones and on the south by the Vaccaei and Celtiberi. The Cantabri were little mentioned before they were incorporated by the emperor Augustus after protracted campaigns (29–19 B.C.) into the Roman province of Hispania Tarraconensis and were governed from Roman Clunia (mod. Peñalba de Castro) in Celtiberia.

Unlike the other Iberian tribes of Spain, the Cantabri were divided into distinct clans: Orgenomesci on the coast from the Sella to the Namnasa (Nansa) river, the Aurini to the east, Conisci in the area behind Santander, Vadinienses in the southeast, Concani round modern Potes, Tamarici round Velilla del Río Carrión, Velegienses in the Alto Pisuerga, Morecanni in the region of Sedano, and Juliobrigenses about the Cantabrian capital of Juliobriga near the origin of the Ebro river (perhaps Retortillo south of Reinosa).

The Cantabri were regarded as the fiercest people in the peninsula. They were subjugated by the Roman emperor Augustus in 25 B.C. but he, Tiberius and M. Vipsanius Agrippa were forced to keep them in check by a series of wars lasting until 19 B.C. which almost annihilated them.

Under the Romans, according to Pliny the Elder (1st century A.D.), Cantabria was made up of seven tribal groups, some retaining their old names while other names such as the Pleutauroi and Barduetai appear, but no details of this regrouping are known.

See P. Bosch-Gimpera, "El problema de los Cántabros y de su origen," *Boletín de la Biblioteca Menéndez Pelayo* (1933); A. Schulten, *Los Cántabros y Astures y su guerra con Roma* (1943). (Wm. C.)

CANTABRIAN MOUNTAINS (Cordillera Cantábrica), a mountain chain loosely defined as extending along the north coast of Spain, more specifically defined as the series of high ridges rising inland from Torrelavega in Santander province and extending westward for 150 mi. toward Foz near the Galician border. Fractures have sharply demarcated the range from the Castilian plateau in the south and from the Cantabrian coastlands, but the eastern and western limits are indistinct. Between the valleys of the Navia and the Lesaya the mountain chain lies in the Asturias, sharing geological affinities with the hercynian structures of Galicia. East of the Lesaya, the eastern Cantabrians of Santander share features characteristic of the Basque mountains. As far west as the pass of Leitariegos, the ranges run nearly parallel with the coast: lower and near the coast and the main ridge to the interior. The eastern foothills south of Santander rise abruptly into the gigantic limestone mountains of the Picos de Europa (8,688 ft.) and the Peña Labra (6,581 ft.). The main ridge continues westward, usually less than 60 mi. wide but with altitudes of 5,000–7,000 ft. Compared with the Pyrenees, these chains are a more impressive barrier, and the Oviedo-Léon railway crosses the Puerto de Pajares at 4,524 ft., one of the most difficult railway passes in Europe. Most of the highest summits are along this main ridge: Espigüete (8,040 ft.), Prieta (8,300 ft.), Peña Vieja (8,573 ft.), Mampodre (7,185 ft.), Ubiña (7,929 ft.) and farther west Rubia (6,332 ft.). Locally, sedimentary rocks may be weathered into wild, serrated pinnacles but more characteristic are the isolated mountain blocks (*parameras*) whose desolate plateaulike summits are surrounded by steep or vertical cliffs. West of the Narcea valley, the ranges change their east-west trend and the Sas de Rañadoiro runs almost north-south. The main ridge bifurcates into the Sas de Picos and Caurel to the northwest and the Sas de Jistredo and Montañas de León, to enclose the basin of El Bierzo, drained by the upper Sil. On the Atlantic slopes, gradients on the rivers are steep but gentler on the southern valleys. The zone is rich in minerals. *See* also Spain: *Physical Geography.*

See M. de Terán (ed.), L. Solé Sabarís (author) and others, *Geografía de España y Portugal,* vol. i (1952). (J. M. Ho.)

CANTACUZINO, a Phanariote family prominent in Rumanian history, descended from the Byzantine Cantacuzeni, one of whom was Byzantine emperor as John VI (*q.v.*) from 1341 to 1354. After the fall of Constantinople (1453) the Cantacuzeni entered the Turkish service and rose to eminence in the Ottoman court. The Moldavian and Walachian Cantacuzinos are descended from the five sons of Andronic Cantacuzino (*c.* 1553–*c.* 1600) who settled in Moldavia late in life.

Andronic's youngest son, Constantin Cantacuzino, called Postelnicul, moved to Walachia in the 1620s, where he became marshal of the court (*postelnic*) and married Elena, daughter of the ruler Radu Şerban Basarab. He was murdered by Grigore Ghica in 1663. Constantin's second son, Şerban Cantacuzino (*c.* 1640–1688), was ruler of Walachia from 1679 to 1688. He introduced maize (corn), now the staple diet, and encouraged the printing of books (including the Bible of 1688, named after him). He planned to drive the Turks out of the Balkans and secretly helped the Austrians in the seige of Vienna (1683). He died suddenly, apparently from poison. Şerban's younger brother Constantin Cantacuzino, called Stolnicul or the Steward, was a historian, geographer and diplomat who conducted foreign affairs under three rulers: his brother Şerban, Constantin Brancovan and his own son, Stefan Cantacuzino, who took Brancovan's place in 1714. In 1716, however, both Constantin Stolnicul and Stefan were executed by the Turks.

Dumitraşcu Cantacuzino (1648–85), a nephew of Constantin Postelnicul, was prince of Moldavia from 1673 to 1675 and from 1684 to 1685. He was hated for his heavy taxation and incompetence.

Of the later generations of the family the most notable were: Mihail Cantacuzino (born 1723; d. between 1790 and 1793), the historian of Walachia who went to Russia in 1776 and became a general; Constantin Cantacuzino (1793–1877), who tried, with Turkish support, to make himself prince of Walachia in 1849; and Gheorghe Grigore Cantacuzino (1837–1913), leader of the Conservative party in Rumania from 1899 and prime minister from 1905 to 1907.

CANTAL, a *département* of central France, lies in the higher, southern portion of the ancient province of Auvergne. It is bounded north by Puy-de-Dôme, east by Haute-Loire, southeast by Lozère, south by Aveyron and west by Corrèze and Lot. Pop. (1954) 177,065. Area 2,231 sq.mi. It extends eastward into the heart of the Massif Central and consists largely of ancient granites and schists that form high plateaus, with extensive cappings of young, volcanic rocks. Such a volcanic superstructure are the Monts du Cantal that occupy the centre of the *département*. They form an imposing, symmetrical volcanic mass, culminating at 1,858 m. (6,096 ft.) in the Plomb du Cantal. Beyond the central core of ash and breccia are great tongues of lava that form tablelike plateaus, notably the *planèzes* of St. Flour and Aubrac, extending southeastward, and that of Cézalier, which links the Cantal massif with the similar Mont-Dore to the north. Streams radiate from the Cantal to the Allier, Dordogne and Truyère. Beneath the volcanic heights the valley of the Cère river opens westward into the fertile little basin of Aurillac. The radiating streams have vigorously eroded the heterogeneous volcanic rocks in the centre of the Cantal, and there are easy passes at the valley heads. Such is the Col de Lioran leading from the Cère valley to that of the Alagnon. The upper portion of the Truyère represents a diversion from the Allier drainage to that of the Lot, brought about by a lava flow that blocked the old valley.

Winters are wet and severe, with snow covering the ground for a long period. On the higher parts an alpine type of pastoral economy has developed, with seasonal use of the high pastures (*chaumes*) by cattle. The herdsmen occupy seasonal shelters (*burons*) associated with a dairy, where the large Cantal cheeses are made. At lower levels, permanent pasture is combined with some arable cultivation, and formerly a shifting type of cultivation, known as *écobuage*, was extensively practised. In modern times, however, the rural economy has become increasingly specialized upon cattle. Fodder crops and potatoes have largely replaced rye and buckwheat, and sheep have declined in importance. There is little manufacturing or mineral wealth, but there are numerous thermal springs, notably at Chaudesaigues. The population is sparse and there is a tradition of temporary migration, both short-term, as to lowland areas at harvest time, and for longer periods, Auvergnats being well known in the catering trades in Paris. Permanent migration greatly reduced the population after the 1860s.

Cantal is divided into three *arrondissements*, based upon Aurillac (*q.v.*), the capital, Mauriac and St. Flour. The last is the centre of the bishopric, which comes under the archbishop of Bourges. Cantal lies within the educational division of Clermont-Ferrand, and its court of appeal is at Riom.

For the history of the region, *see* Auvergne. (Ar. E. S.)

CANTALOUPE is a common name for a botanical variety of muskmelon whose fruit has a hard warty rind without netting. The name comes from the castle Cantalupo in Italy where this kind of melon was early grown. In the United States the name is most often applied to small netted kinds, but sometimes to muskmelons in general. *See* Muskmelon.

CANTATA, a musical term derived from the Italian *cantare*, "to sing"; it indicates primarily a composition intended to be sung, in contradistinction to a sonata, which is one to be played instrumentally. The term is now loosely used to describe any work for voices and instruments; it may take almost any form, as is seen in application of the title to works by Bartók, Stravinsky and Schönberg, who have adapted new techniques to the old form.

In its earliest form the word appears in Alessandro Grandi's *Cantade et arie a voce sola* (1620), in which the individual items are constructed on much the same pattern as the strophic arias of Giulio Caccini and Jacopo Peri (*see* Aria). The *Lettera amorosa* and *Partenza amorosa* of Monteverdi (1567–1643) are also regarded as forerunners of the cantata. The true chamber cantata (*cantata da camera*), which became one of the most important forms of the late 17th and early 18th centuries, consisted of a sequence of movements following a recitative-aria-recitative-aria pattern, sometimes with only a figured bass accompaniment, sometimes with an orchestral one. The pattern could be extended to include an overture, duets, trios and even choruses, though the apparently choral items were often sung by the soloists. Early composers of chamber cantatas were Francesco Rasi, Giovanni Berti, Giovanni Sances and Benedetto Ferrari; and, more famous, Luigi Rossi, Giacomo Carissimi and Pietro Antonio Cesti. Later the cantata form was taken over by the great Neapolitans, Alessandro Stradella and Alessandro Scarlatti; the latter is credited with over 600 cantatas, and in his hands the form became one of the most thoughtful and expressive of musical mediums. Handel, Leonardo Leo, Leonardo Vinci and Johann Hasse later contributed to the enormous repertory of chamber cantatas, Handel writing a large number, of which *Apollo e Dafne*, almost a miniature opera, is perhaps his best known. Although the chamber cantata died out among Italian composers of the later 18th century, an amusing late example is *Il Maestro di Cappella* by Domenico Cimarosa (1749–1801), in which the basic cantata pattern is still apparent, the whole forming a sparkling satire on contemporary operatic rehearsal methods.

In England the cantata appeared in the late 17th century as a forerunner of the strong Italian influence of the 18th century; the extended songs of Henry Purcell are claimed as early examples. Many cantatas were composed and published in England during the 18th century by both English and foreign musicians, some as satires on the prevailing Italian operatic fashions; *e.g.*, James Oswald's *Dustcart Cantata* (1753) and James Hook's *Musical Courtship* (*c.* 1787).

Italian influence was also strong in 18th-century France, where the Italian type of cantata with French texts was introduced about 1700. Jean Baptiste Lully's rival, Marc Antoine Charpentier (1634–1704), was one of the first to enter the field, but the next generation with André Campra, Nicolas Bernier, Michel Montéclair, Jean Baptiste Morin, Jean Joseph Mouret and, especially distinguished, Louis N. Clérambault and Jean (Philippe) Rameau represented the greatest period of cantata composition.

In the German Protestant states the development of the cantata took a religious turn, and the most noteworthy contributions to the form were the church cantatas, which were serious in style and purpose. Franz Tunder, Matthias Weckmann, Dietrich Buxtehude and members of the Bach family all composed numerous church cantatas, especially "chorale" cantatas in which a well-known chorale-melody was used as the basis for at least part of the composition. Johann Krieger, Philipp Erlebach, G. P. Telemann and above all J. S. Bach are the most celebrated names in the history of the German church cantata; their texts frequently were provided by the highly dramatic religious poems of Erdmann Neumeister (1671–1756). A typical Bach church cantata opens with a more or less extended chorus, followed by a group o recitatives and arias, and ends with a chorale for chorus and orchestra, in which the congregation probably joined. Cantata and service were closely interwoven, an aspect that is lost when Bach's cantatas are performed away from the Lutheran service. Some German composers, Telemann in particular, wrote large numbers of church cantatas for solo voice with varying instrumental accompaniment.

North German composers also produced many secular cantata as birthday or congratulatory odes; J. S. Bach composed several including the *Coffee Cantata* (*c.* 1732) and the *Peasant Cantata* (1742)—titles conferred by a later generation. Telemann's *Schoolmaster* cantata is another example of the secular type, of which there were both comic and serious versions. In the Roman Catholic provinces of south Germany and Austria, cantatas were more often secular than sacred, for church music consisted mainly of settings of Latin texts, but in Czechoslovakia strong local patriotism produced a thriving religious music that used vernacular texts; the charming Bohemian Christmas pastorales form a special type of church cantata. The great Viennese composers also wrote occasional secular cantatas to German words; *e.g.*, Haydn's *Esterhazy Festkantate* (1763–64) and Mozart's Masonic cantata *Die Maurerfreude* (1785).

From about 1800 the style of the cantata became increasingly free, and the term was generally applied to any fairly large work for solo voice or voices, chorus and orchestra from Beethoven's *Der glorreiche Augenblick* (1814) onward, though the word cantata may not appear in the title. Mendelssohn's *Die erste Walpurgisnacht* (final version, 1843) and Brahms's *Rinaldo* (1869) are two 19th-century examples. Mendelssohn even combined the cantata with the symphony in the so-called symphony-cantata *Lobgesang* ("Hymn of Praise") (1840), while Benjamin Britten on the other hand called what is actually a cantata *Spring Symphony* (1949). Numerous English examples are provided in the works of Sir Arthur Sullivan, Sir Charles Stanford, Sir Hubert Parry, Ralph Vaughan Williams, Herbert Howells and Britten.

(Cs. Ch.)

CANTEEN, a soldier's or sailor's combined clubroom, reading and writing room, recreation hall or place where refreshments are available. By an extension of meaning, it also denotes the place where meals are provided for their employees by large business and industrial organizations. It is also the naval or military equivalent of a universal store for the sale of a wide range of foodstuffs, dry goods, clothing and equipment. The term is of long standing in both British and U.S. armed services.

In the days of the duke of Marlborough the British army was accompanied by a swarm of sutlers peddling foodstuffs, liquor and tobacco at prices strictly controlled by the authorities. When the marching column halted for the night, a booth contrived of the sutler's tilt cart and a tarpaulin served as an elementary canteen. One of the most notorious of these sutlers was the former Scots Grey trooper "Mother" Ross. (*See* Daniel Defoe, *The Life and Adventures of . . . Mother Ross.*) The armies of the French Directory were also accompanied by many *cantinières*—motherly, capable women, usually married to one of the noncommissioned officers. With the expansion of permanent barrack accommodations in the early 19th century, canteens were included in the new buildings. Rented from the board of ordnance by contractors intent on speedily recouping the considerable "privilege money" demanded for the right to trade, these canteens became little more than sordid drinking dens, although the duke of York sought to provide a counterattraction by reserving space within the barrack confines for bowling alleys.

Much-needed reform came with the foundation, by three regimental officers, of the Canteen and Mess Co-operative society in 1894, a movement which paved the way for the establishment in 1915 of the officially sponsored but privately operated Expeditionary Force canteens (E.F.C.). Their activities were supplemented by the Church army, the Y.M.C.A. and other bodies, while the work of the "Sailors' Homes," founded by Agnes Weston, was greatly expanded. The responsibilities of the E.F.C. became so great that in 1921 the enterprise was taken over by the Navy, Army and Air Force institutes (N.A.A.F.I.), controlled by a council and a board representative of both service and catering interests, profits being "plowed back" or devoted to the provision of amenities for the serviceman.

The British "dry" canteen, for the sale of groceries and the like, has its counterpart in the U.S. "post exchange" and commissary. The lineal descendant of the elementary canteen stores organized for Washington's Continental forces, the trading scope of the PX, as it is called, is that of the supermarket. Presided over by a council, with the post commander as ex officio chairman, its profits are devoted to the general interests of the serviceman, and it is to be found wherever U.S. forces are established.

A soldier's water bottle is called a canteen. In the days of antiquity the canteen as a water container was fashioned of leather. Then came wood, pewter, tin and subsequently aluminum canteens, partly insulated from heat or cold by a jacket of cloth or felt.

See Hon. Sir J. W. Fortescue, *A Short Account of Canteens in the British Army* (1928). (R. C. H.)

CANTELUPE (Cantilupe), **SAINT THOMAS DE** (*c.* 1218–1282), bishop of Hereford, known for his ascetic life, strict discipline and martial spirit, was the son of William, 2nd baron Cantelupe. Educated at Paris and Orléans, he taught canon law at Paris and at Oxford and in 1262 became chancellor of Oxford. He held a dispensation from the pope for a plurality of benefices. During the Barons' War he favoured Simon de Montfort and represented the barons at the court of St. Louis IX of France.

Cantelupe became chancellor of the realm in 1265 but lost the post the same year, after Montfort's death; whereupon he returned to Paris as a teacher. He returned to Oxford shortly for a second term as chancellor. In 1274 he attended the second council of Lyons and in the following year was made bishop of Hereford. He was also a counselor of Edward I and a friend of Archbishop Robert Kilwardby. But on the accession of John Peckham to the primacy in 1279, succeeding Kilwardby, Cantelupe became involved in a number of jurisdictional disputes, and in 1282 he was excommunicated.

He went to Italy to plead his cause but died at Orvieto on Aug. 25, 1282. He was buried at Hereford. His canonization took place in 1320, and his feast day is Oct. 3.

See Richard Strange, *Life and Gests of Thomas of Cantilupe* (1674). (T. L. C.)

CANTELUPE (Cantilupe), **WALTER DE** (d. 1266), bishop of Worcester, uncle of St. Thomas de Cantelupe (*q.v.*), was the son of William, 1st baron Cantelupe, a partisan of King John. Educated at Rome for a time, he was named bishop of Worcester while still a subdeacon and was consecrated (1237) at Viterbo by Pope Gregory IX.

Cantelupe was known in Worcester for his energetic administration and for his numerous reforms. He identified himself with the nationalist clergy led by the bishops Edmund Rich and Robert Grosseteste, and opposed the visitation policies of Archbishop Boniface of Savoy and the attempted suppression of plural holding of benefices by the papal legate Otho.

At the parliament of Oxford (1258) Cantelupe was chosen one of the 24 who virtually ruled the kingdom, and in 1259 he became a member of the council which ruled in the king's absence. He sided with Simon de Montfort in the Barons' War and acted as an arbiter in the baronial party's internal disputes. He was also sent on a number of diplomatic missions abroad. For his continued support of the barons Cantelupe was suspended from his see and summoned to Rome, but he died on Feb. 12, 1266, before making the journey. (T. L. C.)

CANTEMIR (Russ. Kantemir), a family distinguished first in the principality of Moldavia, then in Russia, where its importance was chiefly in the field of literature. Of Tatar origin, the Cantemirs came from the Crimea in the 17th century and settled in Moldavia.

Constantin Cantemir was prince of Moldavia from 1685 to 1693. A conscientious ruler, he brought peace to the country. He was succeeded by his son Antioch, who ruled twice (1696–1700 and 1705–07) in a period of great instability, during which Turkish influence was paramount.

Antioch's youngest brother Dimitrie, born on Nov. 5 (new style; Oct. 26, old style), 1673, was made ruler of Moldavia in 1710. Ready to acknowledge Russian suzerainty instead of Turkish, he concluded an alliance with Peter the Great at Lutsk on April 24 (N.S.; 13, O.S.), 1711. After the Russian defeat at the battle of Stanilești on the Pruth, Dimitrie fled to Russia, where he settled and wrote the greater part of his work. Peter the Great appointed him imperial chancellor.

Dimitrie Cantemir was one of the greatest linguists of his time, speaking and writing 11 languages. He was interested in scientific matters and was elected to the Berlin Academy in 1714 for his work in this field. The best known of his works is his *Historia incrementorum atque decrementorum aulae Othomanicae* (1716; Eng. trans., *History of the Growth and Decay of the Othman Empire*, two parts, 1734–35). His other works include *Hronicul vechimii a Romano-Moldo-Vlahilor*, the first critical history of Moldo-Walachia; *Descriptio Moldaviae*, the first geographical, ethnographical and economic description of Moldavia; *Historia hieroglyphica*, a Rumanian equivalent of the story of Reynard the Fox; a history of the two ruling houses of Brancovan and Cantacuzino; and the *Divan*, a philosophical treatise in the guise of a disputation between body and soul. There is an edition of his works by the Rumanian Academy, *Operele principelui D. Cantemir* (1872–1901). He died at Kharkov on Sept. 1 (N.S.; Aug. 21, O.S.), 1723.

Dimitrie's younger son ANTIOCH (Russ. ANTIOKH DIMITRIEVICH KANTEMIR; 1708–44) was educated at St. Petersburg and was elected a member of the academy there when still quite young. Between 1729 and 1731 he wrote a number of poems, the most important being two satires, "To His Own Mind: On Those Who Blame Education" and "On the Envy and Pride of Evil-Minded Courtiers." These denounced the opposition to Peter the Great's reforms and enjoyed great success when circulated in manuscript (they were not printed until 1762). Russian ambassador in England from 1732 to 1736, Cantemir brought to London the manuscript of his father's history of the Ottoman empire and furnished the biography of the author that appeared with the English translation (*see* above). From 1736 until his death he was minister plenipotentiary in Paris.

As well as Russian translations from several classical and modern authors, including one of Fontenelle's *Entretiens sur la pluralité des mondes* (1740), which was suppressed as heretical, Cantemir also wrote a philosophical work, *Letters on Nature and Man* (1742), and a *Letter* on the old syllabic system of Russian verse composition (1742).

CANTERBURY, CHARLES MANNERS-SUTTON, 1ST VISCOUNT (1780–1845), English lawyer and a notable speaker of the house of commons, was born on Jan. 29, 1780, the elder son of Charles Manners-Sutton (1755–1828), who afterward became archbishop of Canterbury. Educated at Eton and at Trinity college, Cambridge, in 1806 he was called to the bar and entered parliament as Tory member for Scarborough. He became judge advocate general in 1809. He was elected speaker in June 1817. His strong voice, dignified presence and even temper fitted him well for this post, to which he was seven times re-elected. He refused to exchange it for the home secretaryship in April 1827, or for the premiership in the crisis over the Reform bill in May 1832. He was persuaded to remain speaker by the Whig government of 1832, but outside parliament made no secret of his Tory leanings. This led to resentment and complaints from radicals and extreme Whigs. When a new parliament met in Feb. 1835, a sharp contest for the speakership ensued and Manners-Sutton was defeated by ten votes. He was made a viscount in March 1835. He died in London on July 21, 1845. (M. R. D. F.)

CANTERBURY, a provincial district in the east central part of South Island, New Zealand. Pop. (1961) 339,883. Area 13,940 sq.mi. It extends from the Conway river to the Waitaki river and includes Banks peninsula, the Canterbury plains, the enclosing foothills, inland basins, alpine ranges and valleys, together with part of South Canterbury and of the Waitaki valley. Population is confined to a narrow coastal strip and largely to Christchurch and its port, Lyttelton. The wealth of Canterbury derives from the mixed farming of the plains and the fine-wooled sheep of the alpine grazing lands. Ashburton is the chief town of mid-Canterbury; the port of Timaru serves South Canterbury and is also a tourist resort. Canterbury is famous for its alpine scenery and the mountaineering and skiing in the Mt. Cook area. (K. B. C.)

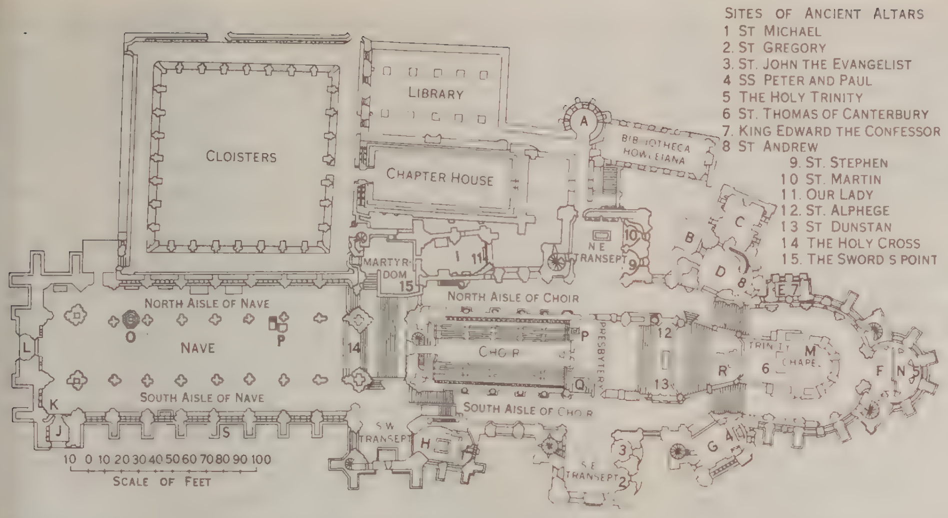
CANTERBURY, a city and county borough, metropolis of an archdiocese of the Church of England, in the Canterbury parliamentary division of Kent, Eng., 55 mi. E.S.E. of London by road, 16 mi. N.W. of Dover and 27 mi. E. of Maidstone. Pop. (1961) 30,376. It is a picturesque city, dominated by the magnificent cathedral, and lies on the Kentish Stour, which there debouches from a narrow valley into a broadening marshy plain, representing a one-time creek running from the belt of water that separated the Isle of Thanet from the mainland.

History.—Canterbury seems originally to have been a settlement at the head of this creek, at an ancient mouth of the Stour. The site was occupied long before the Roman period. Excavations have shown that as early as 200 B.C. there was a heavily stockaded and ditched settlement with at least one complex gateway in what is now the southeastern quadrant of the city walls. Julius Caesar stormed Bigbury camp (two miles west) in 55 B.C. and was again near Canterbury on his second campaign (like the first, abortive) in 54 B.C. After the invasion of the emperor Claudius (A.D. 43), the Romans immediately established a community called Durovernum (a Latinized version of the native name). The town, though with no great population, must have been of some cultural significance, judging from the remains of the vast Roman theatre, greater than anything in this class yet found in Roman Britain, of which the foundations were identified (1950) in the Watling street area. A wall, built around the city (*c.* A.D. 200), and still partly standing, was heightened in medieval times.

After the collapse of Roman rule, Canterbury emerged in the late 6th century as the capital of Aethelberht (Ethelbert), fifth Jutish king of Kent and overlord of Britain. The place acquired the name Cantwaraburh or Cantwarabyrig, "the borough of the men of Kent." Aethelberht married the Frankish Christian princess Berta, a fact that made the way easy for the mission from Rome (597) dispatched by Pope Gregory I and headed by St. Augustine (*q.v.*). Augustine founded a Benedictine monastery, converted Aethelberht and many of his subjects, and upon his later return as bishop of the English set up a cathedral in a building said to have been used as a church by Romans of Christian belief. Canterbury thus became established as the prime see of England, a position maintained ever after. With Christ Church cathedral and St. Augustine's abbey, the city was an outstanding religious and cultural centre during the whole Saxon period. It suffered badly in Danish raids, notably in 1011, and surrendered to William the Conqueror in 1066 just after the battle of Hastings. Archbishop Thomas Becket was murdered in the cathedral, on Dec. 29, 1170. Some phase, or side issue at least, of most of the major struggles and political events of medieval English history was enacted at Canterbury, as of the Peasants' Revolt or of the Wars of the Roses. In the 12th century it appeared among the dozen or so economically most important boroughs in England, when the most outstanding local activity was minting, in which Canterbury surpassed every other centre except London. In the 14th century there was a flourishing tourist industry, based on the pilgrimage to the shrine of St. Thomas. This aspect was immortalized by Geoffrey Chaucer in *The Canterbury Tales*.

During the Reformation all the monastic houses were dissolved, the cathedral alone surviving, when a dean and chapter took the place of the monks (1541). The greatest holocaust of Protestant martyrs outside London took place at Canterbury under Mary I (1553–58) when 41 persons were burned at the stake. In the 16th century there was a state of decay, as in other boroughs, though a great influx of Walloon and Huguenot Protestant refugees (nearly all weavers) from France and the Low Countries brought in a vigorous textile industry. There were periodic disturbances during the English Civil War, especially in 1647–48. Charles II entered Canterbury at the Restoration (1660). A garrison was established in Canterbury in the later 18th century, bringing in new life.

Half the circuit of the city walls still survives, with fine stretches at the Dane John and in Broad street. Westgate alone (1380) of the six gates remains. The Dane John mound, a great tumulus, is a survivor of a group of such mounds, probably Roman burial mounds. Of the Norman castle the battered shell of the keep alone stands (in Castle street, by the gasworks which were once housed inside it).


SITES OF ANCIENT ALTARS
1 ST MICHAEL
2. ST GREGORY
3. ST. JOHN THE EVANGELIST
4 SS PETER AND PAUL
5 THE HOLY TRINITY
6 ST. THOMAS OF CANTERBURY
7. KING EDWARD THE CONFESSOR
8 ST ANDREW
9. ST. STEPHEN
10 ST. MARTIN
11. OUR LADY
12. ST. ALPHEGE
13 ST DUNSTAN
14 THE HOLY CROSS
15. THE SWORD S POINT
LIBRARY
CLOISTERS
CHAPTER HOUSE
BIBLIOTHECA HOWLEIANA
MARTYRDOM
NE TRANSEPT
NORTH AISLE OF NAVE
NORTH AISLE OF CHOIR
NAVE
CHOIR
PRESBYTERY
TRINITY CHAPEL
SOUTH AISLE OF NAVE
SOUTH AISLE OF CHOIR
SW TRANSEPT
SE TRANSEPT
10 0 10 20 30 40 50 60 70 80 90 100
SCALE OF FEET
A. WATER TOWER
B SUBVAULTS
C. TREASURY
D ST ANDREW S CHAPEL
E. HENRY IV CHANTRY
F. CORONA OR BECKET'S CROWN
G. ST. ANSELM S CHAPEL
H. ST. MICHAEL'S CHAPEL
I. THE LADY CHAPEL
J SOUTH PORCH
K STAIRS TO PARVISE
L WESTERN ENTRANCE
M SITE OF ARCHBISHOP BECKET'S SHRINE
N ST AUGUSTINE S CHAIR
O. FONT
P. PULPITS
Q ARCHBISHOP S THRONE
R HIGH ALTAR
S. SITE OF CHANTRY CHAPEL OF ST. JOHN BAPTIST SUBSEQUENTLY NEVIL CHAPEL

PLAN OF CANTERBURY CATHEDRAL

Local government can be traced from an early date. Several old English reeves are named. By the 14th century the ancient borough moot had divided into court and council, the latter consisting in 1350 of 2 provosts or bailiffs, 6 aldermen, 12 jurats, and 36 councilors. This constitution was modified from time to time. In 1448 the two bailiffs were superseded by a mayor, and in 1461 a sheriff was added when the city was promoted to county status. In modern times there are a mayor and a sheriff, and a council having 6 aldermen and 18 councilors.

Since the end of the 19th century there has been an ever increasing influx of tourists. Among the industries are tanning, brickmaking, and light metalwork. The city is a natural centre for the agricultural industry of east Kent as well as being the main shopping and educational centre.

THE CATHEDRAL

The original cathedral was reconstructed several times. Archbishop Lanfranc (*q.v.*) undertook the building (1070–89) of an entirely new church. Early in the 12th century the choir of the new building was demolished and extended, this new work, the "glorious choir" of Prior Conrad, being dedicated with great ceremony in 1130. Fire destroyed the choir in 1174, and thenceforward the rebuilding was conducted by the French master-mason William of Sens until he was crippled by a fall in 1178, when another William, commonly distinguished as the Englishman, carried on the work and completed it in 1184. In 1376 Archbishop Simon of Sudbury entered upon the construction of a new nave, and Prior Chillenden continued this under Archbishop William Courtenay while additional chapels were added. The building of the central tower was undertaken between 1495 and 1503 by Prior Thomas Goldstone.

Canterbury was severely damaged in World War II, principally in the air raid of June 1, 1942. The cathedral received superficial damage, the chapter library was blown up and large numbers of buildings throughout the city were destroyed. The chapter library was rebuilt in 1954 and houses extensive collections of early capitular and diocesan archives.

Exterior.—The Perpendicular central tower is the most notable feature of the exterior. It rises in two stories to a height of 235 ft. and is known variously as Bell Harry or as the Angel steeple from the gilded figure of an angel which formerly adorned the summit. The Perpendicular nave is flanked at the west front by towers, whose massive buttresses, rising in tiers, enhance by contrast the beautiful effect of the straight lines of Bell Harry tower. The southwestern tower is an original Perpendicular structure finished about 1465, while the northwestern was copied from it in 1834–40, replacing a Norman tower of Lanfranc which had become unsafe. The cathedral plan is characterized by double cross aisles. The choir is flanked by projecting chapels (of SS. Andrew and Anselm). The building terminates at the east in a circular tower known as the Corona or Becket's crown. The principal dimensions of the cathedral are: length (outside) 522 ft., nave 178 ft., choir 180 ft. The nave is 71 ft. in breadth and 80 ft. in height. The main entrance is by the South porch (1400).

Interior.—An unusual feature of the interior is its separation into two parts which represent the two main periods of building. In most English cathedrals the choir is separated from the nave by a screen; at Canterbury the separation is further marked by a broad flight of steps leading up to the screen, the choir floor (but not its roof) being much higher than that of the nave. Chillenden, in rebuilding the nave, retained only the lower parts of some of the early Norman walls of Lanfranc and the piers of the central tower arches. These piers were encased or altered on Perpendicular lines. In the choir (the late 12th-century work of the two Williams), the notable features are its great length, the fine ornamentation and the use of arches both round and pointed, a remarkable illustration of the transition between the Norman and Early English styles; the prolific use of dark marble in the shafts and moldings strongly contrasting with the prevailing light stone; and, finally, the graceful incurve of the main arcades and walls at the eastern end of the choir where it joins the Trinity chapel. From the altar eastward the floor of the church is raised again above that of the choir. The choir screen was built by Prior Eastry, about 1300. There are several tombs of archbishops in the choir.

Next to the site of Becket's shrine (*see* below) is the tomb of Edward the Black Prince (d. 1376) with a remarkable portrait effigy and in a cabinet, close by, his helmet, shield, scabbard and surcoat. Near at hand is the tomb of Henry IV (d. 1413) and Queen Joan of Navarre. In the Corona is the so-called chair of St. Augustine, a marble throne of undetermined date.

The western crypt dates from the early 12th century, and the eastern, most lofty portion, from 1181. The capitals of the western crypt bear a remarkable series of grotesque carvings. St. Gabriel's chapel contains an important group of mid-12th-century paintings depicting the birth of St. John the Baptist. The crypt was granted to the Huguenot refugees as their church in the 16th century, and weekly services in French are still held.

Becket's Shrine and the Pilgrimages.—The priory owed its chief fame to the murder of Archbishop Becket, his canonization and the pilgrimages to his tomb. St. Thomas Becket was credited with a vast number of miraculous cures. Henry II performed his famous penance in 1174, walking barefoot into Canterbury and undergoing a flogging at the tomb. The fact that the king of Scotland, who was invading England, was captured at the moment of the completion of the penance was attributed to St. Thomas' intercession, and henceforth the popularity of the pilgrimages was well established. In 1220 the body was removed from the old tomb in the crypt to a magnificent new shrine in the Trinity chapel behind the high altar, visited by a constant stream of pilgrims. Great inns for accommodation of pilgrims were erected, such as the Chequers (*c.* 1400, part of which still stands).

Chaucer's *The Canterbury Tales* recount the journey of a typical group of pilgrims setting out from London about 1390.

The English language embodies two expressions originating in the pilgrimage—"Canterbury bell," a flower resembling the little bells bought as souvenirs at Canterbury, and "canter," the easy trot to which pilgrims set their horses. In 1538 Henry VIII decreed the destruction of the shrine, and every effort was made to obliterate the cult, though the 13th-century windows (depicting anecdotes from the miracles of St. Thomas) around the shrine were largely spared.

Province and Diocese.—The archbishop of Canterbury is primate of all England; the ecclesiastical province of Canterbury covers England south of Cheshire and Yorkshire; and the diocese covers a great part of Kent. The archbishop has a seat at Lambeth palace, London. In Canterbury there are fragments in Palace street of the old archbishop's palace which have been incorporated into a modern palace.

The following is a list of archbishops of Canterbury:

1. St. Augustine, 597–*c.* 607.
2. St. Laurentius, *c.* 607–619.
3. St. Mellitus, 619–624.
4. St. Justus, 624–627.
5. St. Honorius, 627–653.
6. St. Deusdedit, 655–664.
7. St. Theodore, 668–690.
8. Beorhtweald, 692–731.
9. Tatwine, 731-734.
10. St. Nothhelm, 735–739.
11. Cuthbeorht (or Cuthbert), 740–760.
12. Breguwine, 761–764.
13. Jaenbeorht, 765–792.
14. Aethelheard, 793–805.
15. Wulfred, 805–832.
16. Feologild, 832.
17. Ceolnoth, 833–870.
18. Aethelred, 870–889.
19. Plegmund, 890–914.
20. Aethelhelm, 914–923.
21. Wulfhelm, 923–942.
22. St. Odo (or Oda), 942–958.
23. Aelfsige, 959.
24. Beorhthelm, 959.
25. St. Dunstan, 960–988.
26. Aethelgar, 988–990.
27. Sigeric Serio, 990–994.
28. Aelfric, 995–1005.
29. St. Alphege (Aelfheah), 1005–1012.
30. Lyfing, 1013–20.
31. St. Aethelnoth (Ethelnoth or Egelnodus), 1020–38.
32. St. Eadsige, 1038–50.
33. Robert of Jumièges, 1051–52.
34. Stigand, 1052–70.
35. Lanfranc, 1070–89.
36. St. Anselm, 1093–1109.
37. Ralph d'Escures (or de Turbine), 1114–22.
38. William of Corbeil, 1123–36.
39. Theobald, 1138–61.
40. St. Thomas Becket, 1162–70.
41. Richard (of Dover), 1174–84.
42. Baldwin, 1184–90.
43. Hubert Walter, 1193–1205.
44. Stephen Langton, 1207–28.
45. Richard le Grant (of Wethershed), 1229–31.
46. St. Edmund (Edmund Rich), 1233–40.
47. Boniface of Savoy, 1245–70.
48. Robert Kilwardby, 1273–78.
49. John Pecham (Peckham), 1279–92.
50. Robert de Winchelsea, 1293–1313.
51. Walter Reynolds, 1313–27.
52. Simon Mepeham (or Meopham), 1328–33.
53. John de Stratford, 1333–48.
54. Thomas Bradwardine, 1349.
55. Simon Islip, 1349–66.
56. Simon Langham, 1366–68.
57. William Whittlesey, 1368–74.
58. Simon of Sudbury, 1375–81.
59. William Courtenay, 1381–96.
60. Thomas Arundel, 1396–97.
61. Roger Walden, 1398. (Thomas Arundel; restored), 1399–1414.
62. Henry Chichele, 1414–43.
63. John Stafford, 1443–52.
64. John Kempe, 1452–54.
65. Thomas Bourchier, 1454–86.
66. John Morton, 1486–1500.
67. Henry Dean, 1501–03.
68. William Warham, 1504–32.
69. Thomas Cranmer, 1533–56.
70. Reginald Pole, 1556–58.
71. Matthew Parker, 1559–75.
72. Edmund Grindal, 1576–83.
73. John Whitgift, 1583–1604.
74. Richard Bancroft, 1604–10.
75. George Abbot, 1611–33.
76. William Laud, 1633–45.
77. William Juxon, 1660–63.
78. Gilbert Sheldon, 1663–77.
79. William Sancroft, 1678–91.
80. John Tillotson, 1691–94.
81. Thomas Tenison, 1695–1715.
82. William Wake, 1716–37.
83. John Potter, 1737–47.
84. Thomas Herring, 1747–57.
85. Matthew Hutton, 1757–58.
86. Thomas Secker, 1758–68.
87. Frederick Cornwallis, 1768–83.
88. John Moore, 1783–1805.
89. Charles Manners-Sutton, 1805–28.
90. William Howley, 1828–48.
91. John Bird Sumner, 1848–62.
92. Charles Thomas Longley, 1862–68.
93. Archibald Campbell Tait, 1868–82.
94. Edward White Benson, 1883–96.
95. Frederick Temple, 1896–1902.
96. Randall Thomas Davidson, 1903–28.
97. Cosmo Gordon Lang, 1928–42.
98. William Temple, 1942–44.
99. Geoffrey Francis Fisher, 1945–61.
100. Arthur Michael Ramsey, 1961–

Monastic Buildings.—Ornate Christ Church gate (1517) gives entrance from the southwest. The northern side of the precincts is covered by the remains of the monastic buildings. The Great cloister (144 ft. square) was built in the early 15th century, but embodies Norman and 13th-century work. The vaulting is enriched by more than 800 shields of arms. The chapter house (*c.* 1300 in the lower stages, early 15th century in the upper) is covered by a vast roof of oak. The great Norman dormitory (90 by 155 ft.), flanking the chapter house, is now in ruins. Important among the many architectural features of the precincts is the Norman staircase (*c.* 1160) built by Prior Wibert which leads to the hall of the King's school, founded in the early middle ages and refounded by Henry VIII in 1541.

Other Ecclesiastical Foundations.—The most important of these was the abbey of SS. Peter and Paul (St. Augustine's) outside the walls, founded by Augustine about 600. Substantial remains survive of the abbey church (11th century). The Great gate (*c.* 1300) now gives access to St. Augustine's theological college. Outside the city Northgate was a house of canons (St. Gregory's) founded by Archbishop Lanfranc about 1080. The Austin friars, the Dominicans and the Franciscans had houses at Canterbury.

There are several almshouses, some of early date, such as St. John's (*c.* 1080), Maynard's (*c.* 1200) established by Mainer the Rich, a moneyer, and St. Thomas's of Eastbridge (*c.* 1175). In the 12th century there were 22 parish churches, though the number diminished as time went on. St. Martin's, still in use, was a Christian chapel where Queen Berta worshiped even before the arrival of St. Augustine. None of the local churches is of any great size, though many contain architectural features of interest, such as the nave arcades of St. Alphege and St. Dunstan. The head of Sir Thomas More is interred at the last-mentioned church. At Harbledown, where the traveler first comes in full view of the cathedral, stands the leper hospital, now an almshouse, founded about 1080. It still enjoys the pension of 20 silver marks (£13 6*s.* 8*d.*) a year, assigned by Henry II on the day of his great penance, which started at this point.

See also references under "Canterbury" in the Index volume.

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(W. G. U.)

CANTERBURY BELLS: *see* Campanula.

CANTH, MINNA (Ulrika Vilhelmina Canth, née Johnsson) (1844–1897), Finnish novelist and dramatist, a leader of the revival of the vernacular and of the realist movement in Finland in the latter part of the 19th century. Born at Tampere (March 19, 1844) she went to school at Kuopio, Finland, and in 1863 entered the new seminary at Jyväskylä, where she married her teacher, J. F. Canth, in 1865. Widowed in 1879, with seven children, she went into business at Kuopio, but still found time to produce literary works that had a powerful impact on her time. In her early short stories *Novelleja ja Kertomuksia* (1878) she was somewhat influenced by Bjørnson's idealistic descriptions of country life, but in later novels and plays she turned to the realistic treatment of urban social problems, as in *Työmiehen Vaimo* (1885), a feminist play which, like *Sylvi* (1893), shows the influence of Henrik Ibsen. Among her best works are the short story *Kauppa-Lopo* (1889) and the play *Anna-Liisa* (1895), the latter influenced by Leo Tolstoy. As a dramatist she long ranked second only to Aleksis Kivi, and as a personality she was in the front rank of notable Finnish women. She died at Kuopio, May 12, 1897.

(Ko. S.)

CANTICLES is one of the names of the biblical book also known as the Song of Songs and the Song of Solomon (*q.v.*). The word further denotes those biblical and nonbiblical "songs" or "odes" other than the Psalms that are used in church worship. At matins in the Orthodox Church there are nine canticles (on which are based the nine odes of the Kanon; *q.v.*): the two songs of Moses (Ex. xv, 1–19; Deut. xxxii, 1–43), the prayers of Hannah (I Sam. ii, 1–10), Habbakuk (Hab. iii, 2–19), Isaiah (Isa. xxvi, 9–20) and Jonah (Jonah ii, 2–9), the Song of the Three Holy Children (Dan. iii, 52–88 in the Septuagint), the *Magnificat* (Luke i, 46–55) and the *Benedictus* (Luke i, 68–79). The *Nunc dimittis* (Luke ii, 29–32) is sung at vespers. In the Roman breviary, Old

Testament canticles and the *Benedictus* are used at lauds, the *Magnificat* at vespers and the *Nunc dimittis* at compline (*see* LITURGY, CHRISTIAN). On Sundays the *Te deum* is used at matins and the Athanasian creed at prime.

CANTILEVER, a beam supported at one end and carrying a load at the free extremity or distributed evenly all along the exposed portion. The upper half of the thickness of such a beam is subjected to tensile stress, tending to elongate the fibres; the lower half to compressive stress, tending to crush them. Cantilevers are employed extensively in building, steel constructional work and machines. In the first specified any sort of wood or steel or masonry or concrete beam built into a wall and with free end projecting forms a cantilever; brackets of braced type are also used in small and large dimensions. The longer cantilevers have to be incorporated in a building when clear space is required below, the cantilevers carrying a gallery, roof, canopy, part of the building above or a runway for an overhead traveling crane. A good example of a cantilever sustaining a portion of a workshop built out over a yard appears in fig. 1.

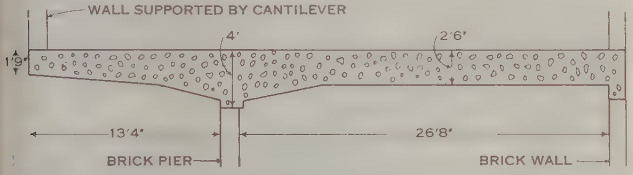

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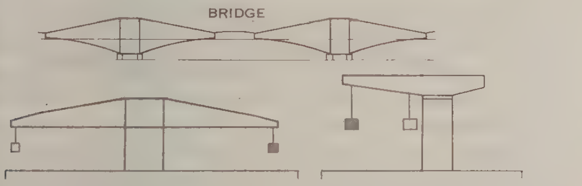
FIG. 1.—LONG CANTILEVER

This type is used in sustaining a portion of a workshop built over a yard

In bridge building a cantilever construction is employed for large spans, the classic type being that of the Forth bridge (*see* fig. 2), having girders connecting up the ends of the huge cantilevers. The clear span between the piers is nearly one-third of a mile. Cantilever cranes are necessary when a considerable area has to be served, as in steel stockyards, and shipbuilding berths. In the lighter types a central traveling tower sustains the cantilever girders on either side: the big hammerhead cranes (made in capacities up to 300 tons) for fitting-out basins have a fixed tower and revolving pivot reaching down therein, to rotate the cantilever in a circle. Block-setting Titan cranes have a very large reach of the cantilever, besides being mounted on a traveling carriage, to move out to sea as the block setting proceeds.



LONG-SPAN DOUBLE CANTILEVER CRANE GIANT OR HAMMER-HEAD CRANE

FIG. 2.—THE CANTILEVER IN BRIDGE BUILDING AND IN CRANES

Upper drawing shows the cantilever Forth bridge, Scot.; the span between the piers is nearly ⅓ mi. Lower drawings show the cantilever principle applied to large cranes used in steel stockyards and shipbuilding berths

In motor car construction a cantilever spring was formerly much used for rear suspensions. Such a spring was anchored to the frame at the centre and at the forward end, the rear end being supported by the axle housing.

CANTON (KWANGCHOW; KUANG-CHOU), the great commercial metropolis of south China, is the capital of Kwangtung province and the historic vestibule of western influences from the late 17th century. The city had a population of 1,867,000 in 1958, including thousands of families living on small boats. It lies largely on the north bank of the Pearl (or Canton) river (Chu Chiang) in the northeast corner of the delta of the Hsi Chiang (or West river) and between the mouths of the Pei (North) river and of the Tung (East) river. The whole delta covers 2,900 sq.mi., and is one of the most crowded areas of China, containing an estimated 10,000,000 persons. It is a maze of streams and canals between small rice paddies constantly being expanded and dotted with isolated hills that were once coastal islands. A 12-month growing season permits two rice crops and often a third dry crop each year, while ample water ensures rich returns from fish farming, and the marketing of tropical fruits, vegetables, sugar and firewood; silk, hogs and poultry also supplement farm income in the delta. The area is not self-sufficient, drawing rice and firewood from the upper reaches of its major stream valleys, as well as rice from central Hunan via the Che-ling pass, central Kiangsi over the Mei-ling pass, and from the Yangtze delta, Bangkok and Saigon by sea.

Ocean ships cannot enter the city but must anchor 12 mi. downstream at the port of Whampoa (Huang-pu), where dredging is steadily carried on to prevent silting. River craft bypass the port farther south by sailing up the Hsi to Wuchow, on the eastern border of Kwangsi, 230 mi. upstream. The two main railways of Canton lead south to Hong Kong, 111 mi. away, and north over the Yangtze river bridge between Wu-ch'ang and Hankow to Peking, 1,428 mi. away. Many bus and truck routes, and the 32-mi.-long railway to San-shui (Samshui) on the Hsi river, are used for local passengers and freight. Traveling by water, ancient roads over the northern passes, and later by rail and air, the merchants of Canton spread over south China and into southeast Asia.

Because of the relatively late advance of the Chinese to the South China sea, the Canton delta was for long an outpost in a barbarian region. It was brought into the empire by the Ch'in dynasty (221–207 B.C.), and from the time of the Han dynasty (202 B.C.–A.D. 221) the city was known as Kuang-chou, its modern official name. The people of the delta, the Cantonese, are known as "the sons of T'ang," presumably because of large migrations from the north in the T'ang period (A.D. 618–906) and also because the Cantonese dialect is believed to be much closer to the spoken language of antiquity prior to the strong influences of later peoples in north China. Also, there are persistent culture traits from southeast Asia that have helped to distinguish Cantonese from other Chinese. One of the major differences may be explained by the close contact over many centuries with foreigners: Hindus, Arabs, Malayans and Europeans, both abroad and in Canton itself.

Canton was the first Chinese port regularly visited by European traders, for there was the main outlet of tea, silk, spices, rhubarb and handcrafted articles. After more than a century of efforts by these traders to establish permanent stations along the south China coast, the British East India company began regular ship sailings in 1699, followed by the French in 1725 and the Dutch in 1762, and their trading agents or factors set up office-residence-warehouses or "factories" in a small area known as Shameen along the Pearl river. Canton became the pivot of official Chinese policy toward western trade whereby the foreigners were confined to a special area and compelled to deal only with a small group of Chinese merchants (Co-hong) directly responsible to the imperial government (imperial decree of 1757). This system, plus the rise of opium imports from India, led to increasing friction that erupted in the first of the so-called opium wars between Great Britain and China, 1839–42. The treaty of Nanking, signed Aug. 29, 1842, ended the war and replaced the Chinese merchants' monopoly or Hong system by five treaty ports where foreigners could live and work outside of Chinese legal jurisdiction. Although Canton was one of these ports, the British also gained Hong Kong, 80 mi. S., and built it into one of the greatest commercial bases in the far east. This realization spurred Chinese plans to develop Whampoa into a deepwater port able to handle 8,000–10,000-ton ships and eventually to reduce Hong Kong's dominance in the interport and foreign trade of south China.

In common with the other south China ports and reflecting its southward aspect, Canton long was a centre of overseas emigration to southeast Asia and other parts of the world. This carried a Cantonese version of Chinese culture abroad in the form of Cantonese foods and restaurants, handicrafts, dialects, by merchant and labouring classes rather than by scholars and families tied to the area. Remittances and visits from overseas family members helped to maintain the interest of those abroad in conditions back home, while many Cantonese educated abroad returned to introduce new ideas and new methods to the city as well as to their native villages, particularly in the San-shui, T'ai-shan and Chung-shan districts. Christian missionaries in Canton founded China's first modern newspaper and established at an early date a printing plant, a hospital and a medical school; they founded Lingnan university and its well-known school of agriculture in 1916. Thus, Canton has played a conspicuous part in changing China, bearing out the saying that "Everything new begins in Canton."

Always restive under the imperial regime and a source of anxiety to the emperors of the Ch'ing (Manchu) dynasty, Canton became the centre of the revolutionary propaganda which led to the downfall of that dynasty in 1912. Many of the active parts were played by Cantonese, several of whom had lived in, or had been influenced by the examples of, western countries. Such men as Sun Yat-sen (*q.v.*), Wang Ch'ung-hui, Liao Chung-k'ai, Huang Hsing and Hu Han-min, as well as many of the 72 "martyrs" killed in the abortive uprising at Canton in April 1911, were of this region and background.

In the subsequent civil wars, Canton became the centre of opposition to the northern militarists. It was there that the Kuomintang or Nationalist party before Sun's death in 1925 began, under Soviet advisers, to develop into an all-inclusive one-party apparatus. For support against regional warlords, Sun set up the Whampoa Military academy in 1924, under the direction of Chiang Kai-shek to train a corps of officers loyal to the Kuomintang as the leader of a revived China.

It was from Canton that the Nationalist armies in 1926–27, including some of the later Communist leaders, advanced north over the Che-ling pass to the capture of Hankow and the lower Yangtze. The government set up in Nanking in 1927 as the national government of China proclaimed itself based on the "Three Principles of the People" expounded by Sun in Canton during 1923–24.

Beginning in 1919 a great program of street widening, razing of city walls, transfer of old graves, creation of public parks and a pleasant water front, building a bridge across the Pearl and dredging the harbour were all undertaken entirely through local initiative. In 1924 Sun promoted a university, later renamed the National Sun Yat-Sen university, 10 mi. E. of the city.

An early attraction for foreign trade was in the handcrafted articles, much in demand in Europe at the end of the 18th century. When the fashion was at its height, thousands of artisans of all ages toiled in making porcelain, silks, embroidery, lacquered furniture, ivory carvings, enamels, paper umbrellas, fans and sundry toys. Declining demand in Europe and less skilled workers in China, plus the classical revival, broke this trade until the end of the 19th century when handicraft exports from Canton rose in other wares (palm-leaf fans, firecrackers, woven matting and fine paper) mainly for an expanded overseas Chinese market.

Powered industry came early, beginning with a steam-powered silk filature in Nanhai, 10 mi. W. of Canton, in 1880. From that time, more filatures for raw silk exports rather than to furnish thread for local weavers were the rule. Other kinds of light industry (rather than heavy industry) were developed, reflecting the lack of political stability that would attract large capital investment. The absence of sufficient coal also influenced this trend. Coal occurs around Chiu-chiang on the upper Pei river, but its high sulfur content and poor transportation in rugged mountain areas, as well as the constant political upheavals, inhibited extraction in sizable quantity. The city long obtained its coal by sea from north China and elsewhere. In and around Canton were located 9 of the 11 industries wholly or partially financed and operated by the provincial government from the late 1920s. These were a cement mill, two sugar refineries, a spinning and weaving factory, a paper mill, a machinery works, a communications equipment factory, a sulfuric acid plant, a fertilizer plant and a beverage plant. With the Japanese occupation of Canton (1938–45) much of the equipment was destroyed or removed, while inflation and easy imports from Hong Kong after World War II discouraged speedy industrial rehabilitation.

PETER SCHMID—PIX FROM PUBLIX

STREET SCENE, CANTON

A vendor uses a replica of a rooster to attract attention

Compared with other areas, the Chinese People's Republic did not announce any extensive plans for industrial growth in Canton. Plans emphasized previous trends in linking industry with local agriculture by the opening of plants for sugar refining, manufacture of insecticides, fertilizers, jute for rice sacks, farm tools and the stimulation of light skilled industries for making sewing machines and small internal-combustion engines. The government enlarged the Canton paper mill, China's largest newsprint factory. Surveys were in progress in the early 1960s for hydroelectric development along the nearby tributaries of the Pearl river, which has an estimated potential of 8,400,000 kw.

Under the Nationalists' coastal blockade and the United States embargo of the latter 1950s, Canton served as a funnel for goods and persons moving in and out via Hong Kong. Thus, it maintained its old function reminiscent of the century before the opening of the original treaty ports.

See also CHINA. (TE. H.)

CANTON, a city of northeastern Ohio, U.S., 60 mi. SE of Cleveland and the seat of Stark County. Corporate limits have lagged behind population, which in 1970 was 110,053 in the city itself and 372,210 in the standard metropolitan statistical area—which includes all of Stark County. (For comparative population figures *see* table in OHIO: *Population.*)

Canton is a leading producer of electric furnace alloy steel and a major producer of tapered roller bearings. Brick and ceramics in many varieties, form another important group of industries Other leading products are safes, vaults and office equipment household appliances, voting machines, heavy steel presses, wate softeners and cleansers, forgings, gasoline and diesel internal combustion engines, street lighting standards, foundation piles rubber gloves, and titanium steel.

Canton was the permanent home of Pres. William McKinley from 1867 until his death in 1901. He and Mrs. McKinley are buried in a granite memorial in Monument Park, since 1943 a state memorial administered by the Ohio Historical Society.

Canton was laid out in 1805. The name probably derives from Canton, China, via Baltimore, where Canton's founder, Bezaleel Wells, had been a neighbour to the Canton estate, a private home founded on the profits of a famous shipload of goods from China. It became the county seat in 1808 and was incorporated as a village in 1822, as a town in 1838, and as a city in 1854. Its period of fastest growth was from 1900 to 1920, when the population increased from 30,667 to 87,094. This period saw an influx of central, southern, and eastern Europeans and of Negroes. There is also a large Jewish community. Among the original settlers Germans predominated, followed by Irish, French, and Swiss.

Malone College, a four-year Quaker liberal arts college founded in 1892, was moved in 1957 to Canton from Cleveland, where it was known as Bible College. The Stark County Branch of Kent State University was established in 1967 in Canton. Walsh College, a Roman Catholic institution, moved from Maine to Canton in 1960. Brunnerdale, a Roman Catholic seminary operated by the Society of the Precious Blood, was opened in 1931. Sancta Clara Monastery is a monastery of the Perpetual Adoration of the Blessed Sacrament.

Canton is known to the sports world as the cradle of U.S. professional football, the American Professional Football Association having been formed there in 1920 with Jim Thorpe (*q.v.*) of the Canton team ("Bulldogs") as its first president. The Professional Football Hall of Fame is also headquartered there.

The Cultural Centre, dedicated in 1970, houses the Canton Art Institute, the Players Guild, the Canton Symphony Orchestra, the Canton Civic Opera, the Civic Music, and the Canton Poetry Society. The Stark County Historical Society is in Canton.

(E. T. He.; X.)

CANTON, a word used for certain divisions of some European countries. In France, the canton, a subdivision of the *arrondissement,* was a territorial rather than an administrative unit. The cantons were created by the law Dec. 22, 1789, but their administrative character was taken away by the consular constitution of the year VIII (Dec. 24, 1799). The canton, the seat of a justice of the peace, returned a member to the *conseil d'arrondissement.* In Switzerland, canton is the name given to each of the 22 states comprising the Swiss confederation. (*See* also FRANCE; SWITZERLAND; LOCAL GOVERNMENT.)

In heraldry (*q.v.*), a canton is a corner or square division on a shield, occupying the upper corner (usually the dexter). It is in area two-thirds of the quarter.

CANTON ISLAND, the largest and northernmost of the Phoenix group in the South Pacific, 1,630 mi. S.W. of Honolulu, Hawaii (lat. 2° 50′ S., long. 171° 43′ W.). A coral atoll, its narrow fringe of land encloses a lagoon 7 mi. by 3 mi. Several ships visited it before 1820 and it was named for a New Bedford whaler wrecked there in 1854. U.S. guano companies claimed Canton in 1856; later British interests worked its guano deposits and Great Britain annexed it in 1889–92. The British again asserted sovereignty in 1936 and the United States in 1938: the rival claims were settled by an agreement on April 6, 1939, in which Canton and Enderbury Island (32 mi. S.E.) were to be jointly administered for 50 years. Pan American Airways built facilities there and began using Canton for stops on transpacific flights in 1940. During World War II it was an important U.S. air base. U.S. and British airlines resumed using Canton after the war and in 1951 it gained some importance for commercial fishing.

Pop. (1960) 320. (J. H. K.)

CANTONMENT: *see* CAMP.

CANTOR, GEORG FERDINAND LUDWIG PHILIP (1845–1918), German mathematician, renowned for his contributions to the theories of analysis, topology and mathematical logic, was born of Danish parents on March 3, 1845, at St. Petersburg (Leningrad), Russia. The family moved to Germany in Cantor's boyhood, and he was educated at Frankfurt, Zürich, Berlin and Göttingen. Most of his academic career was spent at the University of Halle (Wittenberg), where he became extraordinary professor (1872) and ordinary professor (1879) of mathematics. His hope of becoming professor at the University of Berlin was disappointed, and his work gained little recognition during his lifetime.

Cantor's early work was on the Fourier series (*q.v.*), and in extending the results obtained he developed a theory of irrational numbers that became classical. He also developed an arithmetic of the infinite and a new branch of mathematics—the theory of sets, which underlies modern mathematical analysis. This theory had a profound influence on subsequent work in the foundations of mathematics and mathematical logic.

In 1895–97 he published his famous work *Beiträge zur Begründung der transfiniten Mengenlehre,* Eng. trans., *Contributions to the Founding of the Theory of Transfinite Numbers,* by P. E. B. Jourdain (1915). Cantor suffered from nervous breakdowns in his later years, and died on Jan. 6, 1918 in a mental hospital at Halle. *See* also references under "Cantor, Georg Ferdinand Ludwig Philip" in the Index.

See *Gesammelte Abhandlungen,* ed. by Ernst Zermelo, with biography by Adolf Fraenkel (1932); E. T. Bell, *Men of Mathematics* (1937).

CANTOR, MORITZ BENEDIKT (1829–1920), German mathematician, who wrote a classic history of mathematics, was born at Mannheim on Aug. 23, 1829. He studied at Heidelberg, Göttingen and Berlin. In 1853 he became a tutor and in 1863 professor of mathematics at Heidelberg. His first important book was *Mathematische Beiträge zum Kulturleben der Völker* (1863); this was followed by his well-known *Vorlesungen über die Geschichte der Mathematik,* the first volume of which was published in 1880, the second in 1892 and the third in successive parts between 1894 and 1898. By this time Cantor was too old to undertake the fourth volume; consequently the work was divided among nine men, under the editorship of Cantor. This work gives an account of the history of mathematics from earliest times up to 1799.

Between 1856 and 1898 Cantor wrote a number of papers that were published chiefly in the *Zeitschrift für Mathematik und Physik,* of which he was an editor, among them being "Euclid und sein Jahrhundert" (1867) and "Die Römischen Agrimensoren" (1875). Cantor's eyesight failed him toward the end of his life. He died on April 10, 1920, at Heidelberg.

CANTOR, a Latin term used in the middle ages for the ecclesiastical official in charge of music at a cathedral, known also as the chanter or precentor. His duty, later undertaken by the organist, was to supervise the singing of the choir, particularly in the psalms and canticles. The term was also used for the head of a college of church music, such as the Roman Schola Cantorum of the early middle ages, and the singing schools founded by Charlemagne. In Germany in the 17th and 18th centuries the cantor (or *Kantor*) was the choirmaster and organist of a school or college subordinate to the rector; J. S. Bach held this post at the Thomasschule in Leipzig. The duties of the German cantor corresponded to those of the French *maître de chapelle* and of the Italian *maestro di cappella.* In the synagogue the cantor is the minister (*hazan*) who chants the service, accompanied by the choir, and who leads the congregation in prayer.

CANTUS FIRMUS, in Italian *canto fermo,* a form of chant deriving from plainsong melodies, generally of equal note values, and serving as a fixed theme around which a polyphonic structure is woven. In motets of the 13th and 14th centuries the part of the *cantus firmus* was usually given to the tenor. Later it was used as a contrapuntal device in instrumental works, notably the organ works of Antonio de Cabezón and Jean Titelouze, which were constructed on the principle of the embroidered *cantus firmus.* In organ works by Johann Sebastian Bach, such as *Wachet auf, ruft uns die Stimme* ("Sleepers, wake!"), the *cantus firmus* derives from a Protestant chorale (*q.v.*), while in the masses by Guillaume Dufay, Jakob Obrecht, Jean d'Okeghem and others it is based on a folk-song tune. "L'Homme armé," a 15th-century folk song, served as a *cantus firmus* for over 30 masses. The practice of building an ornamental texture around a given theme has persisted in the improvised chorale preludes and variations played by organists. The principle of the *cantus firmus* is not confined to European music. It is characteristic of certain eastern music, notably the contrapuntal system used in the music of the Javanese gamelan. *See* also COUNTERPOINT.

CANUSIUM: *see* CANOSA DI PUGLIA.

CANUTE (CNUT or KNUT) (d. 1035), king of Denmark, England and Norway, son of Sweyn, king of Denmark, as a very young man accompanied his father on the expedition of 1013 by which he gained control of all England. On the death of Sweyn (Feb. 3, 1014), the English invited the native king, Aethelred II, to return. Canute was declared king by his crews at Gainsborough, but when Aethelred appeared in the district, he fled, mutilating and putting ashore at Sandwich the hostages given to his father. In Denmark he was probably recognized as joint king with his brother Harald; in any event he was permitted to fit out an expedition for the reconquest of England, which reached Sandwich in the autumn of 1015. England was riven by treachery and internal quarrels, yet the opposition to Canute was long and bitter. Aethelred died on April 23, 1016, but the struggle was continued by his son Edmund Ironside. Despite the great Danish victory of Ashingdon (Oct. 18, 1016), a peace was ultimately concluded which gave Wessex to Edmund and Mercia to Canute. Northumbria had already submitted to Canute, who had appointed Earl Eric of Hlathir to govern it. Edmund died on Nov. 30, 1016, and Canute was accepted in 1017 as king by all England. His brother Harald appears to have died in 1018 or 1019, so Canute became sole king of Denmark also. He sought to strengthen his position in England by a marriage with Emma of Normandy, the widow of Aethelred.

Canute's attempt to govern England as a fourfold state proved short-lived. Having already appointed Eric as earl of Northumbria, he placed in Mercia Eadric Streona, a treacherous English thegn, and in East Anglia Thorkel the Tall, a Danish invader who had entered Aethelred's service; he kept Wessex in his personal control. But Eric's premature death (*c.* 1023) led to utter confusion in Northumbria, Canute himself had second thoughts and allowed or authorized the murder of Eadric (1017), while Thorkel was relegated to Denmark (1023) as the guardian of the king's son Hardicanute. Soon also the rise (*c.* 1019) of Earl Godwin weakened the direct rule of Wessex by the crown. But despite the resurgence of a multiplicity of earldoms, Canute's reign was a period of good rule, conducted within the framework of native institutions, lay and clerical. His code of laws derives mainly from earlier English codes. He made no effort to approximate the English to the Danish constitution. He seems to have felt that he was the head of a number of separate kingdoms, which would ultimately fall apart, rather than of an empire. The king was a strong supporter and benefactor of the church; he undertook at least one pilgrimage to Rome (1026–27), and was seen at St. Omer, on his way there, extravagantly repenting his sins, by a monk or cleric who later wrote at his widow's request the *Encomium Emmae reginae* in his honour. After his visit to Denmark in 1019–20, and once when in Rome, he addressed to his subjects an explanation of his absence. The former of these documents incorporates an interesting statement of legal policy, especially relating to the church.

In foreign affairs Canute's main aim was to add Norway to his empire and to maintain peace elsewhere. His relationship with Normandy was satisfactory till his wife's brother, Richard II, died (1026) and was succeeded by his sons Richard III and Robert. The marriage of Canute's widowed sister Estrith to Robert seems to have ended in divorce, and Robert planned an invasion of England on behalf of Aethelred's sons who were sheltering with him; but it did not eventuate. The ascendancy of the Scots on his northern borders consequent upon the weakness and confusion of the government of Northumbria roused Canute in 1031. He led an expedition in person and received the homage of the Scots without striking a blow.

Friendly relations with the emperor Conrad II were sealed by the engagement of Canute's daughter Gunhild to Conrad's son Henry and led to a peaceful settlement of the Dano-German frontier by the return to the Danes of Schleswig, an old Danish area which had been subject to gradual German encroachments.

Canute had continuous trouble with Norway which in 1015 was being ruled in the Danish interest by the brothers Eric and Sweyn, earls of Hlathir. Eric accompanied Canute to England, and Olaf II (Haraldsson), an exile of the native royal house, easily conquered the kingdom, expelling Sweyn and Eric's son Haakon. Canute worked to destroy Olaf by fomenting treachery. His only open attack (1027) was foiled at the battle of the Holy river, but Olaf was forced by his rebellious subjects to withdraw to Russia (1028) and on attempting to return he was killed at the battle of Stiklestad (1030). Canute then ruled Norway through his mistress Aelfgifu (of Northhampton) and Sweyn, his son by her, until 1035, when Magnus, the son of Olaf II, established himself as king of Norway and Sweyn fled to Denmark and died.

Canute died on Nov. 12, 1035, at Shaftesbury, Dorset. Harold I, who was also his son by Aelfgifu, became king of England, but Hardicanute, his son by Emma, who had been sent to Denmark as viceroy by his father, continued to rule there. On Harold's death (1040) Hardicanute became king of England also.

See also references under "Canute" in the Index volume.

BIBLIOGRAPHY.—A. Campbell (ed.), *Encomium Emmae reginae* (1949); L. M. Larson, *Canute the Great* (1912); F. M. Stenton, *Anglo-Saxon England,* 2nd ed. (1947). (AL. C.)

CANUTE VI (CNUT or KNUT) (1163–1202), king of Denmark, the eldest son of Valdemar I, was crowned as his father's coregent on June 25, 1170, and succeeded to the throne in 1182. As a ruler he was overshadowed by his closest associates—at first by the archbishop Absalon (*q.v.*), later by his younger brother Valdemar, duke of Schleswig (afterward king as Valdemar II), but during his reign the kingdom asserted its independence of the Holy Roman empire and began the establishment of its own authority along the Baltic coast. Absalon won a crushing victory over the Pomeranian duke Bogislav's fleet at Strela (Stralsund) in 1184. Immediately afterward the German frontier princes began to submit to Danish supremacy, and in 1185 Bogislav swore fealty for Pomorze, followed in 1186 by two Obodrite princes for territories covering modern Mecklenburg. Canute then added the words *Slavorumque rex* ("and king of the Slavs") to his regal title. Thus Denmark entered into European high politics—an event clearly marked when, in 1193, Canute's sister Ingeborg married Philip II Augustus of France—and became increasingly active and influential in German internal disputes. A conspiracy against the reigning house by Valdemar, bishop of Schleswig, a member of a branch of the royal family, in concert with the emperor Henry VI was crushed in 1192 by Duke Valdemar, who thenceforward conducted Danish policy toward the south: during 1200–01 the whole of Holstein as far as the Elbe was conquered and incorporated in the Danish realm under the name of North Albingia. At the same time Lübeck acknowledged Danish sovereignty, so that Denmark dominated all the eastern Baltic territories to beyond the Oder. Canute died, childless, on Nov. 12, 1202. (A. E. CN.)

CANVAS, a stout cloth that probably derives its name from *cannabis,* the Latin word for hemp. This would appear to indicate that canvas was originally made from yarns of hemp fibre, and there is some ground for the assumption. Hemp fibre and that of flax have been used for ages to produce cloth for sails; for certain classes of cloth used for this purpose the terms sailcloth and canvas are synonymous. The manufacture of sailcloth was established in England in 1590, but a similar cloth with the same name had been used centuries before by the Egyptians and Phoenicians After the introduction of the power loom the cloth underwent sev eral modifications, and it was later made from flax, hemp, tow, jute and cotton or a mixture of these. Flax canvas is essentially o double warp, for it is invariably intended to withstand pressure or rough usage.

The structure of canvas is similar to jute tarpaulin; bagging tarpaulin and canvas form an ascending series of cloths as regard fineness, although the finest tarpaulins are finer than some of the lower canvases. Canvas may be natural colour, bleached or dyed a very common colour being tan.

Among the articles made from canvas in addition to sailcloth are: carrying devices for photographic and other apparatus; bag for fishing, shooting, golf and other sporting equipment; shoes for cricket and other games, and for yachting; tents; mail bags; tire casings; traveling cases and holdalls, letter bags, schoolbags and nose bags for horses. Large quantities of flax and cotton canvases are tarred and then used for covering goods on railways, wharves, docks, etc.

Sail canvas, since it is of a strong build, is quite different from art canvas, the canvas cloth used for embroidery purposes. The latter is similar in structure to cheesecloths and strainers, the chief difference being that the yarns for art canvas are, in general, of a superior nature.

The chief vegetable fibres used to produce canvas are cotton, flax and jute. The yarns are almost invariably two or more ply, an arrangement that tends to produce a uniform thickness—a desirable element in open-built fabrics. A plain weave is extensively used for these fabrics, but in many cases special weaves are used that leave the open spaces well defined.

Artists' canvas, a single-warp variety, is used, as its name implies, for painting in oils. It is much lighter than sail canvas, but must, of necessity, be made of level yarns. The best qualities are made of cream or bleached flax line, although it is not unusual to find an admixture of tow and even of cotton in the commoner kinds. When the cloth comes from the loom it is treated to prepare the surface for the paint.

CANVASBACK, a diving duck related to the pochard (*q.v.*), but larger. The canvasback (*Aythya valisineria*), an American bird much esteemed for the table, takes its name from the light colour of the back. The head is chestnut, the beak long and narrow. The canvasback is found in the whole of North America, and breeds from Great Slave lake south to eastern Oregon, northern New Mexico and central Minnesota; wintering from southern British Columbia and Chesapeake bay to the Gulf states and Mexico. Feeding on wild celery in winter was supposed to give its flesh a delectable flavour. (G. F. Ss.)

BY COURTESY OF ZOOLOGICAL SOCIETY OF PHILADELPHIA

CANVASBACK (AYTHYA VALISINERIA), A NORTH AMERICAN DIVING DUCK

CANZONA (Canzone), a term derived from the Provençal *canso* (French *chanson*), and used at different times to describe various musical forms, both vocal and instrumental. It was applied in the early 16th century in Italy to an important song form preceding the madrigal, and later in the century to secular pieces in a lighter vein than the madrigal (*e.g., canzoni villanesche,* the first collection of which was published in 1537); though works in this style were more commonly called by the diminutive form *canzonetta.* In the 18th and 19th centuries the term was used occasionally for lyrical songs (sometimes in opera) and for instrumental pieces of a songlike nature.

In the above cases the word is loosely used in its original meaning to denote a type of song. A more precise, specialized and important use occurs in reference to instrumental music of the 16th and 17th centuries, though here too the form of the canzona derives from the French *chanson* for voices, known in Italy as *canzon(a) francese.* Instrumental canzonas are usually fairly light and lively pieces, in common time, beginning, like *chansons,* with three repeated notes in dactylic rhythm and consisting of alternating polyphonic and homophonic sections. At first they were composed mainly by Italians, who did not distinguish initially between those for the keyboard and those for instrumental ensemble. Gradually the form spread to other countries, notably Germany, though Italy remained its principal home, and with the emergence in the later 16th century of idiosyncratic instrumental styles, canzonas written for the two different media began to grow apart. Keyboard canzonas became more concentratedly polyphonic and prepared the way for the fugue, though more than one subject was often still treated in succession, while those for an instrumental group led to the trio sonata of the 17th century. Of the former the important composers are, first, Girolamo Cavazzoni (*c.* 1540) and later his fellow countrymen Claudio Merulo (1533–1604), Andrea Gabrieli (*c.* 1520–86), Giovanni Maria Trabaci (d. 1647) and Girolamo Frescobaldi (1583–1643), with J. J. Froberger (1600–67) in Germany, where quite early in the 17th century the term "fugue" was used synonymously with "canzona." Some canzonas for instrumental ensemble continued to resemble those for keyboard, but the most distinctive are those that, unlike keyboard *canzonas,* emphasize diversity rather than unity of texture. From the clearly defined sections of the canzonas of Giovanni Gabrieli (1557–1612) and Frescobaldi, with their contrasting tempi, metres and rhythms, the movements of the trio sonata emerged. When, toward the middle of the 17th century, the movements were reduced to four and became longer, the terms "trio sonata" (more especially *sonata da chiesa*) and "canzona" became synonymous. Italian composers such as Biagio Marini (d. 1665) and Giovanni Legrenzi (1626–90) clearly illustrate the new tendencies. By the time sonatas were habitually called sonatas, the word "canzona" was still sometimes applied (*e.g.,* by Purcell) to a fugal movement in a sonata.

See G. S. Bedbrook, *Keyboard Music From the Middle Ages to the Beginnings of the Baroque* (1949); G. Reese, *Music in the Renaissance* (1954). (N. Fo.)

CANZONE, the oldest metrical form of verse in Italian literature. The word is believed to derive from the Provençal *canso,* a song, and according to Dante and Boccaccio the early Italian literary forms of the canzone were accompanied by music.

The canzone strophe consists of two parts, the opening one being distinguished by Dante as the *fronte,* the closing one as the *sirma.* These parts are connected by rhyme, it being usual to make the rhyme of the last line of the *fronte* identical with that of the first line of the *sirma.* In other respects the canzone shows great liberty in regard to number and length of lines, arrangement of rhymes and structure. The best Italian model of 14 lines resembles an irregular sonnet. The form reached a high development in Dante's *Vita Nuova* which contains many examples, with explanations of their use. Petrarch's *Canzoniere* similarly shows a classical use of the form. Canzone on the models of Petrarch were later written by Alfieri, Ugo Foscolo, Manzoni, Carducci and d'Annunzio. Though the form was essentially Italian it was introduced into England at the end of the 16th century by William Drummond who left some beautiful examples. In German poetry it was cultivated by A. W. von Schlegel and other poets of the romantic period.

See H. Wilkins, "The Derivation of the Canzone," in *Modern Philology,* xii, 9 (1915).

CAOUTCHOUC, the principal constituent of natural rubber and therefore sometimes called pure rubber. It occurs as a vegetable gum, mixed with from $\frac{1}{20}$ to 8 times its own weight of other substances. Caoutchouc is a white resilient solid; at 0–10° C. it is hard and opaque, but it becomes soft and translucent above 20° C. It contains carbon and hydrogen only, and, chemically, belongs to the terpenes (*q.v.*). By polymerization isoprene can be converted to a product resembling caoutchouc but inferior to that synthesized by the plant. Mineral caoutchouc is one of the names of elaterite (*q.v.*), or elastic bitumen. *See* also Rubber.

CAPACITANCE is the modern term for what was formerly called "capacity" in electrical circuits. It may relate to an isolated conductor when it is defined as the constant ratio of the charge Q on the conductor to the potential, V, to which that charge raises the conductor, *i.e.,* $C = Q/V$. If the conductor is an isolated sphere in vacuo the potential $V = Q/r$ where r is the radius of the sphere. Hence the capacitance of an isolated sphere equals its radius.

Capacitance is often concentrated in electrical condensers (*see* Capacitor) and in many such cases may be simply calculated. On the other hand in many electrical circuits the capacitance is distributed throughout the circuit and more technical methods are required to find its value.

The capacitance of conductors or electrical circuits in general depends on the presence of neighbouring charges or conductors, also on the medium between them. *See* Electricity: *Electrostatics: Condensers; see* also references under "Capacitance" in the Index volume. (H. B. Lm.)

CAPACITOR, a fundamental electric circuit element, sometimes called a condenser, to perform many functions in electric and electronic circuits. It was discovered by E. G. von Kleist in 1745 and independently by P. van Musschenbroek of the University of Leyden at about the same time, while in the process of investigating electrostatic phenomena. They discovered that electricity obtained from an electrostatic machine could be stored for a period of time and then released. The device, which came to be known as the Leyden jar, consisted of a stoppered glass vial or jar filled with water, with a nail piercing the stopper and dipping into the water. By holding the jar in the hand and touching the nail to the conductor of an electrostatic machine they found that a shock could be obtained from the nail after disconnecting it, by touching it with the free hand. This reaction showed that some of the electricity from the machine had been stored.

A simple but fundamental step in the evolution of the capacitor was taken by John Bevis in 1746 when he replaced the water by metal foil forming a lining on the inside surface of the glass and another covering the outside surface. This form of the capacitor with a conductor projecting from the mouth of the jar and touching the lining had, as its principal physical features, two conductors of extended area kept nearly equally separated by an insulating or dielectric layer made as thin as practicable. These features have been retained in every modern form of capacitor.

Capacitors differ only in the size and geometrical arrangement of the metal foils or plates (as they are more generally called) and, most important of all, in the kind of dielectric material used. The dielectric is the heart of the capacitor and has been the subject of much scientific and engineering investigation in the past. A great deal of progress has been made possible by the rapid advances in the chemistry of dielectric materials, which has revealed the intimate relation between molecular structure and dielectric properties.

Fundamental Properties.—The electricity stored by a capacitor when electrified by a direct current voltage is in the form of discrete electrical charges held on the surface of the plates. One plate has positive charges and the other an equal number of negative charges. The charge, which it is possible to store, is dependent on the voltage applied between the plates. The theory of electrostatics provides a mathematical formula, given by equation 1, relating the voltage V, the charge Q and the capacitance C that together characterize a capacitor electrically. These are expressed in practical electrostatic units of volts, coulombs and farads respectively.

$$C = Q/V \qquad (1)$$

The capacitance C depends only on the geometrical area of the plates, their separation and the type of dielectric. For a capacitor with two parallel plates of equal area electrostatic theory gives equation 2:

$$C = K\,\frac{A}{4\pi d} \qquad (2)$$

where A is the area in centimetres squared, d the separation of the plates in centimetres and K is a numerical constant called the dielectric constant or specific inductive capacity. This constant is, by definition, equal to 1 when the space between the plates is a perfect vacuum. But for any dielectric substance the value is greater than 1 and is characteristic of the substance when measured under well-defined conditions of frequency, voltage and temperature. The value was first measured by Henry Cavendish between 1770 and 1780. Modern values for K for several technically important dielectrics are shown in Table I. The technical importance of the dielectric constant is evident from equation 2. The capacity of a capacitor is increased by a factor of K relative to that of vacuum when the space between the plates is filled with a dielectric or, conversely, the size of the capacitor plates is decreased by the same factor for the same capacitance; *e.g.*, replacing a vacuum by barium titanate increases the capacity by 6,000 times. This material was discovered by E. Wainier in 1942 and has led to a host of combinations of titanate ceramic dielectrics. Similar efforts have been made to find liquid dielectrics of high K for use as impregnants for kraft paper and led to the discovery of chlorinated diphenyl in the early 1930s. The dielectric increases the capacity because under the action of the voltage the electrical charges of which it is composed are slightly displaced from their position of equilibrium. In this condition it is said to be polarized, and the degree of polarization attainable is determined by the molecular structure of the dielectric.

TABLE I.—*Dielectric Constants of Various Dielectric Materials Used in Modern Capacitors*

Dielectric	K	Dielectric	K
Vacuum	1	Polytetraflourethylene	2.0
Air	1.00059	Polyethylene terephthalate	3.1
Glass	4–8	Polyethylene	2.2
Mica	5.4	Mineral oil	2.2
Titanium dioxide	125	Chlorinated diphenyl	6.5
Barium titanate	6,000	Aluminium oxide	8.7
Kraft paper	2.2	Tantalum pentoxide	22.0
Polystyrene	2.6		

The capacitance of a capacitor cannot be made indefinitely large by decreasing the thickness of the dielectric as equation 2 might suggest, because the dielectric strength comes into play. If too high a voltage is applied to a capacitor an electric arc will pierce the dielectric and destroy its insulating properties. This reaction is known as dielectric breakdown and each dielectric is characterized by a maximum ratio of voltage to thickness called the dielectric strength and expressed in volts/centimetres. It varies from 10^7 v./cm. to a few hundred.

Another important characteristic of the dielectric is its resistivity. This determines how much current continues to flow through it after the capacitor has been charged. This residual current is known as the leakage current, and may vary as much as 1,000,000 to 1 for different dielectrics. It is also referred to as leakage resistance since by Ohm's law an equivalent resistance can be derived. The leakage resistance decreases rapidly with increasing temperature and voltage. In some cases the heating resulting from the leakage current may be sufficient to degrade the dielectric by thermochemical changes.

Cavendish discovered that it takes time to charge a capacitor with a dielectric compared to one in which the plates are separated by air. This phenomenon is due to the finite time required to displace the charges in the dielectric and may vary from a few seconds to months.

For this reason, a capacitor charged on direct current (D.C.) will discharge repeatedly with decreasing intensity after being charged only once. This phenomenon is known as dielectric absorption. When alternating current (A.C.) voltage is applied to a capacitor new phenomena arise on this account.

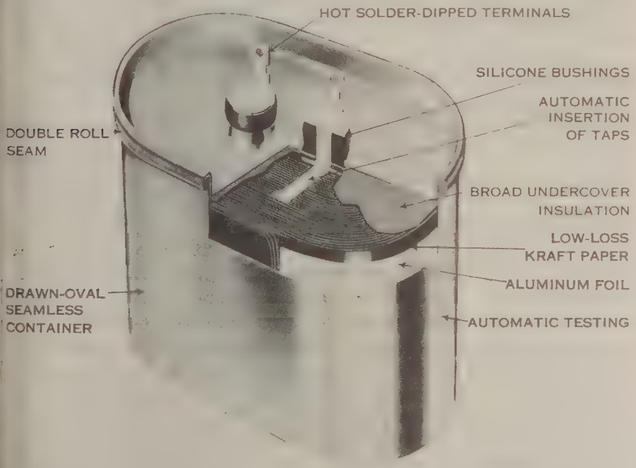
A capacitor connected to an A.C. voltage source is alternately charged and discharged each half-cycle. The time for charging or discharging is thus limited by the period of the A.C. and if the time required to polarize the dielectric is greater, the polarization is not complete. This condition makes the dielectric constant appear to be less than it really is and results in its variation with frequency. The constant is thus lower the higher the frequency During the alternation of polarity of the plates the charges in the dielectric must be displaced first in one direction and then in the other and the friction which they encounter internally leads to a production of heat which is known as dielectric loss and which has a great technical importance in modern electrical engineering These dielectric losses are dependent on frequency and tempera ture.

Another phenomenon not observed on D.C., which A.C. produces, is the flow of current through a capacitor. Except for the residual leakage current, no current flows through a capacitor on D.C. voltage after it is charged. A.C. will pass readily, however and is called a displacement current because unlike D.C. in which actual charges move through the dielectric, in this case charges are only displaced. This discrimination between D.C. and A.C. and the dependence of the A.C. capacitance on frequency makes th capacitor so important in modern radio, television and communica tion circuits.

Some dielectrics exhibit maximum dielectric losses in certain frequency bands and, correspondingly, the dielectric constan changes rapidly in this range. In 1912, P. J. Debye developed theory based on quantum theory to explain this phenomenon and showed that this may be explained by presence of groups of unlike atoms in a molecule in which a permanent internal displacement of charges is localized. In an alternating electric field these molecular groups are aligned by the field, oscillate as it changes direction and give rise to an additional polarization superimposed on that produced by the direct displacement of charges in the dielectric. This additional polarization gives polar substances a higher dielectric constant. The motion of such groups gives rise to additional dielectric losses and so these materials also have greater losses.

Kinds and Uses of Capacitors.—Electric circuit theory deals with ideal capacitors that have no dielectric or ohmic losses, have infinite resistance, no residual inductance and a capacity that is independent of frequency and temperature. To a great extent the engineering problems encountered in their application have to do with the deviation of the real device from the ideal one. The large variety and complexity of modern electronic equipment has led to the development of many kinds of capacitors from which those best suited to the electrical requirements and the physical environment may be chosen. These differ mainly in physical design and type of dielectric and fall into two broad classifications, A.C. and D.C.

A.C. Capacitors.—This classification is further divided into low (or power) frequency and radio-frequency types. At power frequencies, paper capacitors impregnated with chlorinated diphenyl and mineral oil are used and vary in size from a few to 1,000 cu.in. An example of this type of capacitor used to improve the efficiency of motors and fluorescent lamps is shown in Figure 1. These capacitors improve the transmission efficiency of power lines and are economically important in conserving generating equipment at the power stations. Large mica, ceramic and vacuum capacitors are used at radio frequencies because of their low dielectric losses. This characteristic is of special importance in high-power radio, television and loran transmitters and industrial equipment for dielectric heating.


HOT SOLDER-DIPPED TERMINALS
SILICONE BUSHINGS
AUTOMATIC INSERTION OF TAPS
DOUBLE ROLL SEAM
BROAD UNDERCOVER INSULATION
LOW-LOSS KRAFT PAPER
ALUMINUM FOIL
DRAWN-OVAL SEAMLESS CONTAINER
AUTOMATIC TESTING

BY COURTESY OF GENERAL ELECTRIC CO.

FIG. 1.—SMALL A.C. CAPACITOR (CUTAWAY SHOWS CONSTRUCTION)

Small capacitors find use in radio and television receivers, telephone and telegraphic equipment, electronic instruments and mobile and airborne communication equipment. Some of the small ones are made variable to allow an adjustment to be made after they are connected in a circuit. These are called trimmers and when air is the dielectric are called variable capacitors. The variation in most cases is affected by changing the effective plate area.

Vacuum capacitors (*see* fig. 2) find special use in high-frequency high-voltage A.C. applications because of their very low losses.

D.C. Capacitors.—These capacitors are more varied in form and size and use many more dielectrics in addition to those used for A.C. The sizes range from .001 cu.in. for a 2-v. tantalum electrolytic to several thousand cubic inches for a 100,000-v. paper capacitor. The most widely used paper capacitors (*see* fig. 3) for electronic circuits are tubular types encased in metal or plastic tubes sealed against the atmosphere and impregnated with dielectric liquids such as chlorinated diphenyl, chlorinated naphthalene, mineral oil, castor oil and synthetic polyisobutylene. Other polymers introduced between 1940 and 1950 include polyvinyl carbazole, polyesters and polystyrene. Usually these are introduced as liquids into the paper and polymerized *in situ.*

BY COURTESY OF JENNINGS RADIO MFG. CO.

FIG. 2.—VACUUM CAPACITOR

This capacitor, housed in a glass envelope and made of tubular shaped plates that nest into each other, is used in high-frequency high-voltage A.C. applications

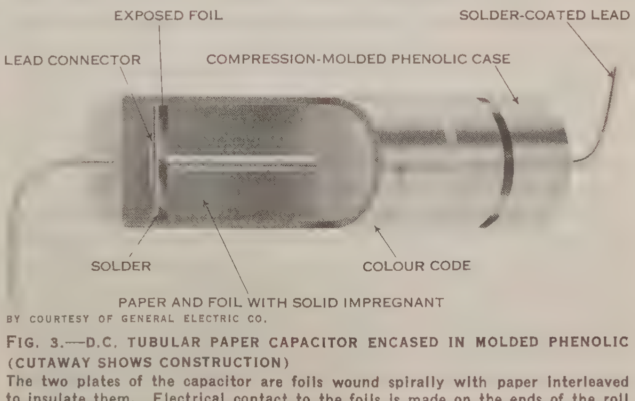
Developments in the manufacture of thin plastic films have led to the development of plastic film capacitors using polystyrene, polyethylene, polytetraflourethylene and polyethylene terphthalate films in which no paper is used. These polymers are among the best organic dielectrics known. Polytetraflourethylene films retain good properties even at 200° C. Capacitors made of high and medium dielectric constant titanate ceramics are also used in large numbers. They are usually disc or tubular in shape and are smaller than the corresponding rating in paper, consequently where the electrical application permits these replace the paper.

Their main limitation is that the capacitance varies steeply with frequency, voltage and temperature.

The paper, plastic and ceramic capacitors which make up the bulk of D.C. capacitors used in modern electronic equipment are all of the electrostatic (also called nonpolar) type. They operate equally well, whether one plate or the other is the positive one. However, there is a special D.C. type known as an electrolytic capacitor which functions as a capacitor only when the proper plate is made positive. This type was discovered in Germany about 1880, but assumed technical importance only with the advent of A.C.-powered radios in the late 1920s. This created a need for capacitors of reasonable size having capacitances several thousand times greater than a Leyden jar. The electrolytic filled this need and its continued development has made it practically indispensable in modern radio, television and communication equipment of all types.

The merit of the electrolytic lies in concentrating a large capacity in a small space, a virtue made possible by the extremely thin dielectric layer (only a few millionths of an inch thick) between the plates. The layer consists of an oxide film formed electrolytically on the surface of one plate which is usually a foil of high-purity aluminum or tantalum. Such thin films of dielectrics are impossible to make without flaws, but in the electrolytic this difficulty is overcome by the presence of the electrolyte in contact with the oxide which heals up any flaws, by the action of the leakage current.

The capacitor gets its name from the fact that the other plate


EXPOSED FOIL
SOLDER-COATED LEAD
LEAD CONNECTOR
COMPRESSION-MOLDED PHENOLIC CASE
SOLDER
COLOUR CODE
PAPER AND FOIL WITH SOLID IMPREGNANT

BY COURTESY OF GENERAL ELECTRIC CO.

FIG. 3.—D.C. TUBULAR PAPER CAPACITOR ENCASED IN MOLDED PHENOLIC (CUTAWAY SHOWS CONSTRUCTION)

The two plates of the capacitor are foils wound spirally with paper interleaved to insulate them. Electrical contact to the foils is made on the ends of the roll is an electrolytic solution similar to that used initially to produce the oxide layer. It is necessary to use specific salts in it and their concentration must be controlled. One reason the polarity is important is that the aluminum will not oxidize in the solution unless it is positive. But the most important reason is that if it is negative, current flows freely and the oxide layer loses its insulating properties. This one property the electrolytic capacitor has in common with a rectifier, and it is in fact possible to use these capacitors as rectifiers in special circuits.

The presence of a liquid electrolyte-cathode makes it possible to increase the surface area of the anode by etching it and still have the cathode follow the microscopic undulations of the surface. This allows the capacitance to be increased by almost an order of magnitude and use is made of it in etched plate electrolytics which have almost entirely supplanted the plain plate type.

A development of the 1930s is an electrode of sintered tantalum with a high surface-to-weight ratio. These capacitors are even smaller than the etched plate type. A more recent development is the use of a semiconductor in place of a solution; tantalum electrolytics using manganese dioxide, a semiconductor, were first made commercially in 1955 using sintered tantalum anodes. These capacitors are known as tantalum solid electrolytics. They retain the preferred polarity so that a rectifying junction is still present, but they lose the self-healing properties.

D.C. capacitors are used in radio and TV receivers, telephone carrier and central office equipment, airborne and mobile communication equipment, electronic instruments and radar equipment.

Electrolytic capacitors mainly filter and by-pass to keep undesired A.C. voltages out of parts of the circuit. In radios, for example, the A.C. line frequency causes undesirable loudspeaker hum and the large capacitances of electrolytics filter this out, thus the name filter capacitors. Such capacitors perform other functions of coupling, blocking, integrating and timing.

The increasing use of electronic equipment in military planes, land and sea military craft, rocket-powered guided missiles and ballistic missiles created a demand for capacitors of the smallest possible weight and capable of operating up to 200° C.

Tantalum electrolytic capacitors have found wide application in the guidance systems of guided missiles because of their small size. These complement the small size of transistors which are replacing vacuum tubes in electronic equipment.

See Electricity; Dielectric; Electrolyte; *see* also references under "Capacitor" in the Index.

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CAP DE LA MADELEINE, industrial city and site of a famous shrine in Quebec, Can., on the north shore of the St. Lawrence river, 80 mi. above the city of Quebec and near Three Rivers. Population (1966) 29,433. It was named after Jacques de la Ferté, abbot of Ste. Marie Madeleine de Châteaudun, France, to whom the seigniory was granted in 1636. It was settled during the 17th century but development really began only after 1900, when sawmills and wood-pulp mills were established, making the place a large centre for the production of newsprint. A shrine to the Virgin of the Rosary was dedicated in 1888 and was taken over by the Oblates of Mary the Immaculate in 1902. A large basilica has been erected in honour of "Our Lady of the Cape," and Cap de la Madeleine has become an important place of pilgrimage, receiving around 1,000,000 pilgrims each year.

See James G. Shaw, *Our Lady of the Cape* (1961). (J.-C. B.)

CAPE BRETON HIGHLANDS NATIONAL PARK, in the highlands of Cape Breton Island, northern Nova Scotia, is reminiscent of the Scottish Highlands. Established in 1936 when almost 400 sq.mi. of the northern section of the island were set apart for public use, it lies between the Atlantic ocean and the Gulf of St. Lawrence and is more than 1,700 ft. above sea level.

Adjacent to the park are a number of picturesque fishing villages and small settlements inhabited mainly by people of Highland Scottish and French ancestry. Many of them are skilled homecraft workers, noted for their hooked rugs and other handicrafts. Around the park runs a scenic highway, the Cabot trail, named after the Cabots, who in 1497 made their first landfall on the North American continent along the shores of Cape Breton Island.

Park headquarters are at Ingonish on the Atlantic side of the park and in that area are most of the accommodations for tourists, including Keltic Lodge, operated by the government of Nova Scotia. There are also various campgrounds. (J. G. P.)

CAPE BRETON ISLAND, the northeastern portion of Nova Scotia, Can., separated from the mainland by a narrow strait known as the Gut of Canso; length (north to south) 110 mi., greatest breadth about 75 mi., land area 3,970 sq.mi. A headland on the east coast is also known as Cape Breton and is said by some to be the first land visited by John Cabot on his voyage in 1497–98. The surface of the island is hilly and the northern part is a tableland 1,000 ft. high. Valuable seams of coal are worked, and the lumber, agricultural products and fisheries are also important. The island's population of 166,943 (1966) is largely concentrated in the east coast mining and steel centres of Sydney and Glace Bay. After 1955 a causeway provided direct road and rail connections with the mainland. *See* Nova Scotia.

CAPE COAST, a town in the centre of the seaboard of Ghana 90 mi. W. of Accra by the new coast road. Pop. (1960) 41,230. The name is a corruption of the Portuguese *Cabo Corso*, but the local people call it Gua or Oegua. The town stands on a low promontory dominated by a castle partly built on and incorporating a large rock. This rock is referred to as Tarbir by the natives who venerate it as one of the 77 tutelary gods of the town. To its east and sheltered by it is a landing beach for surfboats and the canoes of a large fishing community. The castle was built in 1652 on land granted to the Swedes by the king of Fetu (as the state was called) and passed through several hands before coming finally into British possession in 1664. The town, which grew up around the castle, was the chief port of the Gold Coast and the commercial and administrative headquarters of the British settlements until 1877 when Accra became the capital. Following the construction of railways leading inland from Sekondi-Takoradi and from Accra, Cape Coast declined in importance as a port and trading centre. Notable buildings in Cape Coast include Christ Church (1865), the first Anglican church in the country, the cathedral of St. Francis, seat of the Roman Catholic archbishop of Ghana, the Wesley Chapel founded by Methodist missionaries in 1838 and the A. M. E. Zion Mission Church. A bust of Queen Victoria stands in Victoria Park. The town has lon been the educational centre of the country and has several secondary schools, together with a government Teachers' Training College, enlarged and converted (1962) into the University College of Cape Coast, having accommodation for 1,200 students and awarding its own degrees and diplomas in arts and science as wel as certificates in general education. Cape Coast is linked by tarred roads to Accra, Sekondi-Takoradi, and Kumasi, and shipping vessels call occasionally at the port. The principal imports include building materials, provisions, and hardware, and the chief exports are cocoa and citrus products. The town, which is the seat of the regional administration, is governed by a fully elected municipa council. National Welfare institutions include a central prison without walls, a central leprosarium, and a central mental hospita accommodating large numbers of patients. (W. S. K. J.)

CAPE COD CANAL, an artificial waterway which join Cape Cod bay, Mass., with the waters of Buzzards bay, an inle of Long Island sound, and traverses the narrow isthmus of Cap Cod. It is 17.5 mi. long including its dredged approaches. I has a controlling width of 450 ft. and a minimum depth of 30 ft There are no locks. Put into operation in 1914 by private capital the canal cut the distance for water-borne traffic between New York and Boston, via the East river, Long Island sound and th canal, by more than 75 mi. The Cape Cod canal was purchase by the U.S. government in the late 1920s and is operated toll fre as the northernmost section of the Atlantic Intracoastal waterway (*q.v.*). *See* also Water Transport, Inland.

CAPE COLONY: *see* Cape of Good Hope.

CAPE COLOUREDS, the largest of the racially mixe peoples of South Africa. In 1960 they numbered 1,488,267, living mostly in Cape Town, its suburbs, Port Elizabeth and rural areas of western Cape of Good Hope province. Total population of Cape Coloureds in Cape of Good Hope province in 1960 was 1,314,392.

The Cape Coloured originated from interbreeding between slaves (from Madagascar, the Malayan archipelago, Ceylon and India, who were originally held in Cape Town by the Dutch East India Co. during the 17th and 18th centuries), Hottentots, Bushmen and Europeans, the latter mostly from the Low Countries. The majority of unions were illicit and almost invariably between men of higher and women of lower social groups, for instance, between European men and slave or Hottentot women, and between slave men and Hottentot or Bushmen women. The Bantu (Negro) element has been small until recent years.

The Cape Coloureds form a group socially intermediate between Europeans and Negroes. They speak Afrikaans and English, are Christians, live in a European manner and regard themselves as affiliated to the Europeans. There is a minority of about 60,000 Muslims, the so-called Cape Malays, who are mainly artisans and traders; they live mostly in separate communities and marry among themselves for religious reasons. Although the Cape Coloureds are racially mixed, they have a strong sense of community as a consequence of the Europeans' refusal to accept them as equals and their own refusal to be classed socially with the Negroes. Until recently there was considerable intermarriage between lighter-skinned Cape Coloureds and Europeans, and many Coloureds were absorbed into the white community. Also, the offspring of Coloureds and Negroes have been frequently accepted as Coloureds.

Cape Coloureds living outside the towns are mostly labourers on European-owned farms. In the ports of Cape Town and Port Elizabeth their communities are divided into several classes: teachers and salaried workers; shopkeepers, artisans and other skilled workers; and casual labourers and factory workers, which are the biggest group.

Under the Nationalist government, from 1948 onward, there was more rigid separation of occupation, the common franchise was removed, and intermarriage and sexual relations were prohibited; the social status of Cape Coloureds tended to be grouped more and more with that of the Negro community as "nonwhite." *See* also SOUTH AFRICA, REPUBLIC OF.

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CAPE GIRARDEAU, a city of Missouri, U.S., is on the west bank of the Mississippi river at the southeast edge of the Ozark plateau. Established prior to 1793 by French-Canadian Louis Lorimier, its name derives from an even earlier trader, Sieur Jean B. Girardot (1704?). One of five seats of administration in Upper Louisiana during the Spanish regime, it was incorporated as a town in 1806 and as a city in 1843. Cape Girardeau during the American Civil War was a Union stronghold. River traffic and trade from a rich hinterland, largely funneled to the river there because of swamps to the south and hilly terrain to the north, made it the largest community in southeast Missouri; in the 20th century it remained the cultural, scientific, educational and commercial centre of the area.

Manufactures include shoes and clothing; cement, concrete, crushed stone, gravel and sand; timber; beverages and foods; surgical dressings; printed materials; and towboats, barges, pressure tanks and electrical items. Southeast Missouri State college (founded 1873) is in Cape Girardeau. The Trail of Tears state park is nearby. Pop. (1970) 31,282. For comparative population figures *see* table in MISSOURI: *Population.* (F. E. SN.)

ČAPEK, KAREL (1890–1938), Czech novelist, short-story writer, playwright, and essayist, whose narrative and dramatic fantasies of the future gained him worldwide fame. Son of a country doctor, he was born at Malé Svatoňovice in northeastern Bohemia on Jan. 9, 1890. He studied philosophy in Prague, Berlin, and Paris, and in 1917 began his career as a journalist in Prague. During the 1920s and early 1930s he traveled widely in Europe. In 1935 he married the actress Olga Scheinpflugová (1902–68). He died in Prague on Dec. 25, 1938.

Čapek published his first writings at 14. Ill health (he suffered all his life from a spinal disease) had intensified his intellectual development, and writing seemed a compensation. From 1907 until well into the 1920s much of his work was written with his brother Josef (1887–1945), who, becoming a notable painter, illustrated several of Karel's books.

Almost all Čapek's literary works are inquiries into philosophical ideas. Influenced by Henri Bergson and American pragmatism, the early short stories—in *Zářivé hlubiny* ("The Luminous Depths," with Josef, 1916), *Krakonošova zahrada* ("The Garden of Krakonoš," with Josef, 1918), and *Trapné povídky* ("Painful Tales," 1921; trans. in *Money and Other Stories*, 1929)—are mainly concerned with man's efforts to break out of the narrow circle of destiny and lay hold on ultimate values. But the attempt is both doomed to failure and dangerous to the race. Scientific discoveries and technological progress tempt man into titanic rebellions. Čapek presents these in a series of "black utopias" that incidentally made him a pioneer of science fiction. Thus, in the play *R.U.R.* ("Rossum's Universal Robots," publ. 1920, performed 1921; trans. 1923), man constructs a manlike machine (its name, "robot," has become an international word) more precise and reliable than man himself. He is thus freed from toil, but instead of becoming master of the universe, falls under the robots' domination and faces extinction. At the last moment life reasserts itself, when the robots are changed into human beings.

Although *R.U.R.* lacks the comic invention, satire, and parody that intensify the effect of many of Čapek's other works in this kind, it sets their pattern. This is clearly discernible in his first novel, *Továrna na absolutno* (1922; *The Absolute at Large*, 1944), in which the Absolute, freed from matter, creates chaos and almost destroys humanity; and in its successors. Thus, in *Krakatit* (1924; *An Atomic Phantasy*, 1948), the energy released by splitting the atom promises power over the natural world but instead sets off a chain reaction of tragedy and confronts mankind with annihilation until (at God's command) it is turned to man's service; and in *Válka s mloky* (1936; *The War with the Newts*, 1937), instead of a mechanical man-made device, man uses a newly discovered species to further his craving for riches and power, but is again brought to the brink of disaster.

The comic fantasy *Ze života hmyzu* (with Josef, 1921; *The Insect Play*, 1923), satirizing human greed, complacency, and selfishness, emphasizes the relativity of human values and the need to come to terms with life. Man cannot solve his problems by finding the secret of longevity—as in the play *Věc Makropulos* (1922; *The Macropoulos Secret*, 1927)—or by any other attempt, however radical, to change the conditions imposed by nature—as, for example, that described in the play *Adam Stvořitel* (with Josef, 1927; *Adam the Creator*, 1930), in which man destroys the world, recreates it according to his own ideas, but is finally forced to realize that he must accept it as God has made it.

Čapek thus rejects titanism of every kind, including the totalitarian state; and, accepting human nature and destiny with all their limitations and dangerous potentialities, concerns himself with ordinary men and improvement of their lot by working to establish right, justice, and peace. This, the basis of his faith in democracy, made him support Masaryk's Czechoslovakia. He wrote an account of the life of Masaryk (a personal friend), *Hovory s T. G. Masarykem* (3 vol., 1928–35; *President Masaryk Tells His Story*, 1935). The quest for justice inspired most of the stories in *Povídky z jedné kapsy* and *Povídky z druhé kapsy* (1929; trans. in *Tales from Two Pockets*, 1932). Here Čapek's philosophical inquiry, presented as an investigation, borrows detective-story techniques.

The problem of identity and the mystery of the hidden layers of motivation and consciousness beneath the surface of the most apparently ordinary life are the theme of Čapek's most mature work, a trilogy made up of separate novels which together present three aspects of knowledge. *Hordubal* (1933; trans. 1934) contrasts an inarticulate man's awareness of the causes of his actions with the world's incomprehension; *Povětroň* (1934; *Meteor*, 1935) illustrates the subjective causes of objective judgments; and *Obyčejný život* (1934; *An Ordinary Life*, 1936) explores the complex layers of personality underlying the "self" an "ordinary" man thinks himself to be. The isolation of the individual in *Hordubal* is thus resolved: within himself each man can find the links that bind him within the community of man.

The growing threat to Czechoslovakia's independent existence, and to democracy, from Hitlerite Germany in the 1930s drew from Čapek a series of works intended to warn and mobilize. The sombre allegory of *The War with the Newts* (1936) was meant to bring home the true nature of totalitarianism; the realistic novel *První parta* (1937; *The First Rescue Party*, 1940) stresses the need for solidarity. In his last plays the appeal becomes more direct. *Bílá nemoc* (1937; *Power and Glory*, 1938) presents the tragedy of the noble pacifist; *Matka* (1938; *The Mother*, 1940) vindicates armed resistance to barbaric invasion.

Čapek's travel books, keenly observant, rich in wit and humour, and often illustrated with his own sketches (*e.g.*, *Anglické listy*, 1924; *Letters from England*, 1925), with his lively essays and original, widely translated stories for children, assured him a large international readership; his patriotism gained him many admirers and his personality, many friends.

BIBLIOGRAPHY.—Works by Čapek not mentioned above include his first play, *Loupežník* (1920); *Zahradníkův rok* (1929; *The Gardener's Year*, 1930); *Apokryfy* (1932, enlarged as *Kniha apokryfů*, 1945; *Apocryphal Stories*, 1949); *Mlčení s T. G. Masarykem* (1935; *Masaryk on Thought and Life*, 1938); *Život a dílo skladatele Foltýna* (1939; his last novel, unfinished; trans. as *The Cheat*, 1941). Collected works in *Spisy bratří Čapků*, including works by Josef, 51 vol. (1929–47), in *Dílo bratří Čapků*, 23 vol. (1945–69), and in *Výbor z díla*, 5 vol. (1958). Critical and biographical studies by V. Nezval (in Czech, 1937); O. Elton, in *Essays and Addresses* (1939); A. van Santen (in Dutch, 1949); W. E. Harkins (in English, 1962); I. Klíma (in Czech, 1962; 2nd ed. 1966); A. Matuška (in Czech, 1963; Eng. trans. 1964).

(ED. GO.)

CAPELLA, MARTIANUS MINNEUS FELIX (fl. late 4th and early 5th century A.D.), was a native of north Africa and an advocate at Carthage who mixed prose and poetry in an introduction to the liberal arts written perhaps *c.* A.D. 400 and certainly before 439. It was a work of his old age and dedicated to his son. His title for the whole work is not known. Manuscripts give the title *De nuptiis Philologiae et Mercurii* to the first two books and entitle the remaining seven *De arte grammatica*, *De arte dialectica*, *De arte rhetorica*, *De geometrica*, *De arithmetica*, *De astrologia*, and *De harmonia*. Mercury gives his bride, who is made divine, seven maidens, and each declaims on that one of the seven liberal arts which she represents. The prose style is often dry, but in parts it is influenced by the style of the *Metamorphoses* of Apuleius and is even more mannered and bizarre. The verse is mostly competent.

Martianus Capella seems to have indirect knowledge of Varro's *Disciplinarum libri IX* and of his theological works. Pliny, Solinus, Aquila Romanus, and perhaps Aristides Quintilianus are among his immediate sources. Fulgentius owes something to him, and the cultural influence of his encyclopaedia was immense down to the late middle ages. Numerous manuscripts survive: there are commentaries by Johannes Scotus Erigena, Dunchad, and Remigius of Auxerre.

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CAPE MAY, a city of New Jersey, U.S., at the southern tip of the state, was named for the Dutch explorer Cornelius May (Mey) who visited there in 1623. It is one of the oldest beach resorts in the nation, although authorities disagree as to the date the tourist trade began. In the 1850s the Mount Vernon, accommodating 2,000 guests, was the largest hotel of its kind in the U.S. It was later destroyed by fire. Cape May clientele, mainly from the South, included Stephen Decatur, Henry Clay, Franklin Pierce, and Abraham Lincoln. Henry Ford raced on the beach in 1903 and sold a car to Daniel Focer, a local resident, who later received the nation's first franchise for a Ford agency. Many tree-lined streets are reminiscent of a rural village. On the boardwalk is Convention Hall where concerts and dances are held during the summer season. The Cape May lighthouse, a plant which extracts magnesite from sea water, and a U.S. Coast Guard base are outside the city. The dunes provide vantage points for observing bird migrations along the Atlantic flyway. The permanent population in the 1970s was about 4,000.

Under the name Cape Island the settlement was incorporated as a borough in 1848 and chartered as a city in 1851. The name was changed in 1869. (E. R. D.)

CAPE OF GOOD HOPE (CAPE PROVINCE, KAAPPROVINSIE) is the largest of the four provinces of the Republic of South Africa, its area being 278,380 sq.mi. (721,001 sq.km.) or 59% of that of the republic. Its coastline forms the western, southern, and eastern boundaries. The northern boundary lies along the Orange River in the west and the Nossob and Molopo rivers in the middle. In the northeast the province is divided rather irregularly from the Transvaal, the Orange Free State, Lesotho, and Natal.

Physical Features.—Physiographically the major part of the province lies on the South African Plateau (*see* SOUTH AFRICA, REPUBLIC OF: *Physical Geography: Physiography*), the Great Escarpment being most prominent along the Cape-Lesotho border where the Drakensberg rises to over 9,000 ft. (2,700 m.). Farther west the highest part of the escarpment is the northern part of the Sneeuwberge (Snow Mountains) where the Compass Berg, a dolerite peak, rises to 8,215 ft. (2,504 m.). In the southern and southwestern part of the province the folded mountain region provides some of the finest scenery in the continent. Although the highest parts of the folded mountains in the south do not reach 7,700 ft. (2,400 m.) the valleys are deeply cut between the ranges and the topography is extremely rugged. In the river valleys of the Little Karroo, intensive cultivation is practised under irrigation. In the Great Karroo Basin, which lies between the folded mountains and the Great Escarpment, the main areas of cultivation are the irrigated valleys of the Sundays and Great Fish rivers in the eastern part of the basin, to the south of Graaff-Reinet and Cradock.

In the coastal zone of the south and southwest two comparatively flat areas have a winter rainfall sufficient for wheat growing. To the east of the folded zone and the Great Karroo Basin, the eastern Cape Province is a moderately dissected part of the marginal zone between the plateau and the coast. The many rivers rising in the plateau edge provide narrow alluvial terraces suitable for cultivation but, especially in the Transkei (the marginal zone northeast of the Great Kei River), these valleys are generally too steep and rugged for more than strip cultivation.

In the north of the province the course of the Orange River forms the main feature. Above the Aughrabies Falls the valley is wide and open, and fairly large tracts can be irrigated; below the falls the course of the river is for the most part troughlike, and little irrigation is possible.

Climate.—The outstanding climatic features are associated with the great range of temperature and the seasonal variation of rainfall. Mean January temperatures vary from below 65° F (18.3° C) in the west coastal zone to between 65° and 70° F (18.3° and 21.1° C) in the south coastal area and on the higher parts of the plateau, over 75° F (24° C) in the Great Karroo Basin, and more than 85° F (30° C) in the Lower Orange River Basin. Mean July temperatures vary from less than 45° F (7.2° C) on the southern part of the plateau to over 60° F (15.5° C) in the southeastern coastal zone. The average duration of frost ranges from more than 180 days in the southern part of the plateau to an almost complete absence in the coastal areas. The highest mean absolute range of temperature (over 80° F [26.6° C]) is found on the west central part of the plateau.

Rainfall varies from the summer rainfall of the eastern area of the province to the winter rainfall of the west and southwest. Along the south coast is an area of all-season rainfall with monthly averages of two to three inches, and in the interior a narrow corridor of rainfall with no special seasonal incidence separate the winter and summer types. Mean annual rainfall totals vary from probably over 100 in. (2,540 mm.) in some parts of the Cape Ranges (*e.g.,* Wemmers Hoek) to less than 4 in. (101.6 mm.) in the west coastal zone and in the Lower Orange River Basin. In the summer-rainfall area the highest averages (above 40 in. [1,016 mm.]) occur on the Drakensberg and Amatola mountains and in the eastern coastal zone. The greatest contrasts occur in the folded mountains where it is common for the ranges to have an annual rainfall exceeding 60 in. (1,524 mm.) and the adjacent valleys in the rain shadow less than 10 in. (254 mm.).

In the summer reliability of rainfall is highest in the southeast of the province (75%) and lowest in the west (30%); in winter the reliability is greatest in the south coastal zone (60%) and least in the northeast (30%).

Vegetation.—Climatic distributions are closely related to the vegetation. In the winter-rainfall area vegetation is sclerophyllous, resistant to the intense dryness of the hot summer months. There is little tree growth except in very moist localities, although some exotic pines do well when nursed over the early stages. In the summer-rainfall region the area of lowest rainfall (below five inches) is desert with only succulent vegetation or other types specially protected against the continual aridity. The area with 5 to 15 in. (127 to 381 mm.) of rain is largely occupied by karroo shrubs which have root systems and fine leaves adapted to withstand long periods of drought. Many of these bushes provide excellent browsing for sheep and goats. In areas having over 15 in. (381 mm.) of rainfall the karroo vegetation tends to give place to grass that in the lower parts of the province is associated with tree growth, forming savanna. In the few humid areas, such as the eastern part of the south coastal zone and on the Hogsback and Amatola mountains, there are considerable areas of natural forest.

Animal Life.—After European occupation, the fauna changed greatly. Formerly the larger antelopes and quaggas roamed the plains in countless thousands and the large carnivores were numerous. The lion appears to have been found everywhere except in the south coastal zone. The elephant, rhinoceros, and hippopotamus were almost universally present, as the farm names testify, but now it is only in the mountains and the unoccupied areas that leopards (sometimes called tigers in South Africa) and baboons may be found. Jackals are common in most areas and are hunted continually by the sheep farmers. Small buck are found wild in some localities, but the larger buck are confined to the reserves. A few of the Knysna elephants still roam the southern forests where they are protected, but lions, rhinoceroses, and giraffes no longer exist in the province.

Game Reserves.—Four national parks are situated in the province: the Kalahari Gemsbok National Park in the north; the Addo Elephant National Park in the southeast; the Bontebok National Park in the extreme south; and the Mountain Zebra National Park near Cradock. A department of nature conservation is responsible for conserving flora and fauna and many nature reserves have been proclaimed.

Population and Administration.—When the Union was formed (1910), the population of the province was about 2,500,000. Census results in 1960 were: total 5,360,234; Bantu 3,011,080; Coloureds 1,329,921; whites 1,000,768; Asians 18,465. The estimated total population in 1967 was 6,199,634, comprising Bantu 3,441,869; Coloureds 1,609,112; whites 1,128,425; Asians 20,228. (*See* also SOUTH AFRICA, REPUBLIC OF: *Population,* and AFRICA: *Ethnography* [*Anthropology*]: *Southern Africa.*)

The chief towns are on the coast, including the provincial capital, Cape Town, and the ports of Port Elizabeth and East London (*qq.v.*). The largest inland centre is Kimberley (*q.v.*). Uitenhage, Paarl, Worcester, Grahamstown (*qq.v.*), and Queenstown are other towns with populations exceeding 25,000. The remaining towns are small and are mostly service centres, railway junctions, or pleasure or health resorts. Most of the smaller towns have a rectangular layout with a central square or marketplace. Streams directed into furrows along the streets, which may be lined with trees, assist in keeping them cool in summer.

Administration.—An account of the relations of the provinces to the central government, and of the judicial system, is given under SOUTH AFRICA, REPUBLIC OF. In 1960 the province was divided into 108 magisterial districts. For local government there were 95 divisions, each with a divisional council; 155 municipalities; and a number of village management boards and local boards. These local government bodies are under the legislative control of the Provincial Council and their local responsibilities are defined by provincial ordinances.

The annual expenditure of the Provincial Council in the mid-1960s was more than R172,500,000, the main items being education, hospital services and public health, and roads and bridges. The main items of taxation included provincial income tax, licences, companies tax, and tax on persons. There was a sizable subsidy from the government.

Education.—For whites in the province in the mid-1960s there were 1,200 schools. For Asians and Coloureds, there were about 1,700 schools and for Bantu education about 2,800 schools of which the majority were government or government-aided. The enrollment of about 420,000 included 285,000 lower primary pupils, 105,000 higher primary, 13,000 secondary, and 2,500 teacher-training and vocational-training students. In the nongovernment schools there were about 12,000 pupils. The whole Bantu educational system was transferred in 1958 from the Ministry of Bantu Administration and Development to the Department of Bantu Education.

Six universities are situated in the province: the University of Cape Town with mainly English-speaking students; the University of Stellenbosch with mainly Afrikaans-speaking students; Rhodes University at Grahamstown (English-speaking); and the University of Port Elizabeth (a bilingual institution serving both English- and Afrikaans-speaking students). The University College of Fort Hare for Xhosa-speaking students is situated near Alice. The University College of the Western Cape, Bellville, near Cape Town, is an English- and Afrikaans-speaking institution for Coloureds.

ECONOMY

Agriculture.—In western Cape Province the main crop is wheat, grown under natural conditions of winter rainfall. The two most important areas are the Swartland, lying between the folded mountains and the coastal sand veld from Bellville in the south to Het Kruis in the north, a distance of about 90 mi.; and a second area known as the Rûens ("ridge lands") in the Caledon and Bredasdorp districts. The annual wheat production of the province is between 4,000,000 and 5,000,000 bags (of 200 lb.). Oats and barley are subsidiary crops. In the eastern part of the province the main crop is maize ("mealies"), which is grown where the summer rainfall exceeds about 20 in. (508 mm.) and which yields about 2,000,000 bags annually.

The province produces grapes, deciduous tree fruits, and citrus fruits. Grapes are grown mainly in the southwest, both under natural conditions of rainfall and under irrigation. Wine grapes form the bulk of the crop; table grapes are grown mainly for export. The chief deciduous tree fruits, grown mainly in the winter-rainfall areas within a 100-mi. radius of Cape Town and Mossel Bay, are apples, pears, plums, peaches, nectarines, and apricots. Citrus fruits are grown mainly in the Olifants River Valley in the west and in the Sundays River Valley in the east. Both deciduous and citrus fruits are important export crops.

Virginia tobacco of the Orinoco type is grown in the Oudtshoorn and Gamtoos regions and relatively small quantities of Turkish tobacco in the southwestern winter-rainfall area. The production of chicory in the coastal regions of the Alexandria, Bathurst, and Albany districts varied between 18,100,000 lb. (1963) and 42,484,000 lb. (1966), fluctuating greatly with the rainfall.

Excluding the well-watered southwest, the areas of most intensive cultivation in the province are irrigated lands. In the 1960s the largest schemes (of over 20,000 ac. [over 8,093 ha.]) were the Vaal-Hartz scheme to the north of Kimberley where about 55,000 ac. (22,000 ha.) were irrigated by water from the Vaal River; the Orange River Valley (from Buchuberg Dam to

Kakamas) where about 48,000 ac. were under irrigation; the Great Fish River, where numerous small schemes had a total area of about 44,000 ac.; the Kammanassie River near Oudtshoorn with 23,000 ac.; the Sundays River scheme below Lake Mentz Dam with 23,000 ac.; and the Olifants River scheme in the west with 21,000 ac. In most of these areas the main crops were fruit and lucerne (alfalfa), but cotton growing was increasing in the Orange River Valley. The Orange River irrigation and hydroelectric scheme was expected to increase agricultural productivity by irrigating some 750,000 ac. (303,500 ha.) of the arid lands in the north. It was expected to take 30 years to complete at a cost of more than R400,000,000.

Forestry is important in the southwestern and southern coastal areas and in the adjacent ranges. State-owned natural forests extend to nearly 500,000 ac. (202,330 ha.) but are strictly protected because of former overexploitation. The rapid development of afforestation in the mid-20th century resulted in plantations exceeding 300,000 ac. of which approximately 90,000 ac. were of hardwoods (mostly eucalyptus and wattles) and about 230,000 ac. (93,070 ha.) were of softwoods (conifers). The annual volume increment of wood was between 80 and 280 cu.ft. per acre.

In the southwestern part of the province there is little livestock except for dairy herds. In the eastern summer-rainfall area the veld is suitable for cattle and most of the 4,000,000 head of cattle in the province in the mid-1960s were located there. In the drier middle interior, where the karroo type of vegetation flourishes, were most of the 24,000,000 sheep and about 4,000,000 goats of the province. Of the sheep about 20,000,000 were of the wooled type, mainly merinos; about 1,500,000 were karakuls. Ostriches are still bred on some farms in the Oudtshoorn area.

Fisheries.—About nine-tenths of the fish caught and marketed in South Africa come from Cape waters. The main shoal fish are the pilchard (*Sardinops ocellata*) and the maasbanker or horse mackerel (*Trachurus trachurus*), the catches being about 300,000 tons annually. Trawled fish include the Cape hake (*Merluccius capensis*)—about 60,000 tons a year—and much smaller catches of other fish, including the Agulhas sole (*Austroglossus pectoralis*). Line fisheries land annually about 30,000 tons, by far the most important item being the snoek (*Thyrsites atun*). An important inshore catch is the crayfish or rock lobster (*Jasus lalandii*). Annual exports of fish and fish products from the province in the 1960s were valued at about R16,000,000. Whaling is carried on from Saldanha Bay. Annual catches were about 1,500 whales (sperm and baleen), and the value of oil and other products about R1,200,000.

Mining.—The most valuable mineral found in the province is the diamond, which occurs in the volcanic pipes of the Kimberley area and as alluvial stones in river terraces. To 1960 the value of diamonds produced in the province was over R788,000,000, with an average annual output in the 1960s of about R24,000,000. Among the base minerals the most valuable is the "Cape blue" (crocidolite) asbestos found to the north of Prieska, the annual output being about 70,000 tons valued at about R10,000,000. Manganese from the Gamagara Hills near Postmasburg realizes about R8,000,000 annually for 700,000 tons of ore. Copper is mined in the Okiep area in Little Namaqualand, the annual output of blister copper being about 60,000 tons. Other minerals are of small value.

Manufactures and Trade.—Manufacturing is concentrated in the western Cape and Port Elizabeth areas, which together account for approximately four-fifths of the net value of manufacturing output. The East London area is a distant third. The major power stations in the province are in the western Cape, Port Elizabeth, and East London areas. Industries include foundries, engineering works, saw- and grain mills, distilleries and wineries, and the manufacture of many kinds of consumer goods. Port Elizabeth is the major automobile assembly centre in the country.

The principal exports from Cape Town are maize and fruit. Cargoes landed are mainly fuel oil, timber, and railway material, besides general cargoes. From Port Elizabeth the more important cargoes shipped are wool, citrus fruit, ores, and other minerals.

HISTORY

The Dutch East India Company.—In 1652 Jan van Riebeeck or Riebeek landed at De Kaap (Cape Town) with instructions from the Dutch East India Company to organize a refreshment station for ships en route between Holland and Batavia. He was directed to build a fort, to plant a garden, and to keep on good terms with the natives (Hottentots and Bushmen) so that they would barter cattle. Throughout its rule, the company clung to its primary objective, namely, the development of the Cape as a supply depot. Any colonial development was subordinate to company policy, and the diffusion of pioneer farmers eastward to the Great Fish River and beyond took place in spite of official plans. The company never outgrew the mercantilist spirit of the 17th century. To the end of its rule, navigation laws were enforced, local industries prohibited, and freedom of trade proscribed. Up to a point the interests of the Cape and those of the company coincided. The company gave reasonable security, provided ammunition and basic necessities, fostered the production of wine and corn, encouraged first the barter, then the farming of cattle and sheep, and periodically sponsored experimental crops. But the net result was that economic enterprise in the Cape was tied to the fortunes of a monopolistic and, in the 18th century, corrupt and declining company. When the company abandoned Mauritius to the French (1710) and failed to consolidate the move to seize Delagoa Bay from the Portuguese (1721–30), the Dutch lost the opportunity to command the western shores of the Indian Ocean.

The duel between England and France for domination in India emphasized the strategic importance of the Cape. During the American Revolution the English were forestalled and the French occupied the Cape between 1781 and 1784. During the French Revolutionary Wars the position was reversed. In 1794 the company, which had declared no dividend since 1782, went bankrupt, while the Netherlands, torn between pro-French and pro-Orangist factions, were attacked by the armies of republican France. The exiled prince of Orange authorized the British occupation of the Cape under a treaty made in 1788. In reality the occupation was a legitimate piece of naval strategy effected with political discretion.

The century and a half of company rule (1652–1795) left a permanent impress on South Africa. Granted its handicaps, its achievements were considerable. By 1795 Cape Town was an attractive garrison town, with an estimated population of 5,000 Europeans and 10,000 of other races. It was the centre of government and the hub of society and commerce. Beyond the Cape flats, the garden province of the western Cape was only beginning to take shape. Stellenbosch had been made the centre of a new district by Simon van der Stel (1679–99). In the Breede Valley, Swellendam, on the advice of Baron van Imhoff, had become a third district for local government in 1746. The Berg Valley was fairly thickly settled, and the company had supervised the granting of freeholds, often with conditional clauses stipulating in some cases one-tenth of the corn grown, in others the planting of trees. The most decisive venture in this area had been launched when, on Dec. 31, 1687, the first shipload of Huguenot refugees had sailed from Holland to be settled in the new Stellenbosch district. Their total number is estimated at less than 200, roughly one-sixth of the free burgher (*i.e.*, nonofficial) European population in the Cape at the end of the 17th century. They proved industrious agriculturalists and laid the foundations of Cape viticulture, though the first good wines seem to have been made at Constantia by Willelm Adriaan van der Stel (1699–1707). There were the Groote Kerk in Cape Town, a church at Stellenbosch, another at Swellendam. In the 18th century new churches were built at Paarl, Roodezand (Tulbagh), and at Zwartland (Malmesbury).

It has been argued that the policy of close settlement exemplified by Stellenbosch should have been adhered to and enforced. With it local government could have been effectively developed, cultural contacts would have been richer, a school system other than that in the lee of the churches would have been practicable. By contrast, in 1795 about 20,000 Europeans were scattered over a vast area, stretching at least 300 mi. N of Cape Town and 600 mi. E. In 1786 Graaff-Reinet was founded, as J. van Plettenberg (governor 1771–85) had fixed a frontier at the Great Fish River. But in 1795, though there was a church at Graaff-Reinet, the buildings were still rough mud and thatch. There was no effective control of the Boers (estimated population 4,262 in 1795) in and beyond this new colonial outpost. In brief, north and east of Swellendam there were colonists but no colony. To the north there was no defined frontier. Bushmen contested every water hole and spring (from 1774 onward ruthless commandos slaughtered them by the hundreds); Hottentots and Griquas, where not serving in the colony, were retreating; but detribalized marauders, often provided with firearms and sometimes guided by renegades, raided from a no-man's-land. To the east the trekboers (*trekboeren*), isolated physically by poor communications and intellectually by lack of schools, lived the life of pastoralists, bound together by common hardships, a common faith, and resentment of all official interference. Frontier life was precarious and made harsher by the ease with which slaves and apprentices could be acquired and discarded. At his best the frontier Boer developed stamina, courage and dignity, a love of the land, and a habit of local cooperation on commando and on trek, liable to turn as quickly against a government as against an enemy. As the Xhosa peoples were moving southward, and as their society also depended on land and cattle, it seems probable that, but for the trekboer, the frontiers of some future Bantu confederacy might have marched with Swellendam.

Whether or not the policy of close settlement with commercial apartheid, which the company vigorously reiterated in decrees against the cattle barter in 1677, 1727, 1739, 1770, 1774, 1780, and 1794, was sound in theory, in practice it was impossible. Many things militated against it. A limited and erratic market, where good crops caused a glut and poor harvests acute hardships, discouraged intensive agriculture in a country whose climate and soil remain a challenge. By contrast, as the Hottentots broke up, withdrew, and were shattered by the smallpox epidemics of 1713 and 1755, cattle farming was a safer venture. The company needed fresh meat, and though the farmers had to move far in quest of grazing, the animals could be driven back to market on the hoof. A policy of monopoly excluded the burghers from commerce or industry; geography largely dictated the alternative lines of expansion. The company, it would seem, unwittingly fostered this slow-motion trek by the systematizing of loan-place tenure in 1714. Large farms, of which the average size was 6,000 ac., could be "rented" on annual renewable licence. Though tenure was insecure, land was plentiful, and the company checked the licences rather than the leases. Farmers moved from one pasturage to another, and every adult male came to regard a loan-place farm as his right, as well as to confuse possession with legal title. Thus, by decree, the company sought to prevent clashes with the natives; by its land tenure, it facilitated the trek to the east; by its failure to construct effective frontier control or local government, it continued to command but ceased to direct.

Throughout, the company had been frustrated in part by its own economic policy and often by the ambiguous conduct of its own officials. Burgher opposition to its policy, until the last quarter of the 18th century, had been mainly economic in impulse, isolated, and not sustained in impetus. However, the American Revolution in 1776 (the first ship flying the Stars and Stripes entered Table Bay in 1784) and the speculation which preceded the French Revolution, as well as the party struggles of the 1780s in the Netherlands, gave a new emphasis to burgher demands. The burgher petition of 1779 was sent over the heads of company officials direct to the states-general in Amsterdam. It demanded not merely economic relief but a share in the making and administering of known laws—in brief, a constitution. Characteristically, the burghers demanded also liberty to flog their own slaves. Since the governorship of M. P. de Chavonnes, (1714–24) the policy of assisted white settlement had been abandoned and the importing of slaves, restrained in the 17th century, had increased. As the number of slaves increased in proportion to the white population, not only was the slave code stiffened, but social instinct recoiled from the miscegenation hitherto, though prohibited, not uncommon. It seems also that the large numbers of detribalized Hottentots and free persons of colour in the western Cape suffered a reflex diminution of status, though the company recruited Hottentots to defend the colony in 1793.

What is significant is that the generation which was to experience first the British occupation and then, in 1814, formal cession by Holland to England had begun to formulate a claim to share in the government. This was not the rural nihilism of the trekboer but the active political consciousness of a people who, as far back as 1706, had coined the word "Afrikaner" to distinguish the South African burgher, born in the land, from the alien official class. The officials of the Castle still wrote High Dutch and the services of the church were conducted in that language; but the average burgher spoke a local variant from which Afrikaans was to develop. The seeds of Afrikaner nationalism, though slow to germinate, are to be sought in the generation that preceded the British occupation.

This was true in the western Cape. It was true also in the frontier areas of the east, and though the life of the trekboer was very different from that of the western farmer, traditions were common and families interrelated. In the western areas the challenge to white occupation had come from the Bushmen and the Hottentots. By 1795 neither Bushmen nor Hottentots were a serious military danger; on the contrary, 90% of the Hottentot population of the Cape lived in the three western districts of Cape Town, Stellenbosch, and Swellendam. There was a social but no longer a military frontier. In the late 18th century, however, as the trekboers pushed eastward seeking new land and immunity from company control, they encountered the forward drift of the Xhosas. Bantu social customs were based on cattle, their tribal structure on land. In the last quarter of the 18th century, at a time when the death of their paramount chief Palo had exposed them to internal confusion, the Xhosas crossed the Great Fish River along its entire length and two societies, one white, one black, alike in that each was a cattle-farming community, clashed on a frontier that neither respected. Van Plettenberg toured all the eastern districts as far north as modern Colesberg and agreed with some petty chiefs that the Great Fish River should be the boundary. The treaty was ignored by both sides. In 1779 armed clashes developed into a major war (the first so-called Kaffir War) and forced the Xhosas back beyond the Great Fish. In 1789 (in the second Kaffir War) Chief Ndhlambi crossed the Great Fish River again and diffused his men over the Zuurveld, to the fury of the Boers. Fury was impotent since H. C. Maynier, secretary at Graaff-Reinet, disapproved of the trekboers and oversimplified the native question. He allowed Ndhlambi to stay but, in bland ignorance of native custom and society, reserved the property rights of Europeans.

While the Cape government evacuated Swellendam to concentrate on peninsular defense and turned its back on the eastern frontier, the Xhosas plagued one another, some Boers crossed the Great Fish, and a few dabbled in intratribal conflicts. Finally the Xhosas united to rend the Boers and made a desert of the farms between the Kowie and Zwartkops rivers. Again partly from conviction, partly from impotence, Maynier, now officially landdrost but with no armed support from the Cape, came to terms with the Xhosas after an abortive campaign. The sequel was significant. First Graaff-Reinet (led by A. van Jaarsveld and J. C. Trigardt) and then Swellendam revolted against the company. They elected their own officials and adopted the tricolour flag. In June 1795 Swellendam summoned a national assembly to cover a frontier secession. In the same month British warships anchored off Table Bay.

With rebellion on a chaotic frontier, pro-Orangist sentiment strong in the Castle, and inadequate manpower, A. J. Sluysken (1793–95) could put up no strong resistance. In September 1795 he signed a favourable capitulation and the British, in view of the recent alliance between Holland and France, took possession.

The First British Occupation, 1795–1803.—From 1795 to 1803 Great Britain was interested in the Cape only as a naval base and maritime junction. Few changes were made in the structure of government and Roman-Dutch law was recognized. Monopolies were abolished, whaling encouraged, trade to the east thrown open and, so far as war allowed, British goods freely imported. Adequate salaries were paid to officials and judges and though the highest posts were held by the British administration, there was no official purge. But colonial problems were thrust on the administration by the confusion in Graaff-Reinet which, having submitted in November 1795, revolted when Van Jaarsveld was arrested for forgery and again in 1801 because the third Kaffir War terminated on the basis of the unsatisfactory *status quo*. The establishment of a garrison point at Fort Frederick (Port Elizabeth) was directed to secure Algoa Bay rather than to police the Zuurveld. In February 1803, under the Treaty of Amiens, the Cape was retroceded to Holland, now styled and organized as the Batavian Republic.

The Cape Under the Batavian Republic, 1803–06.—The Batavian administration thrust its policy on the colony, which was to be reformed in accordance with French revolutionary ideals. The ideas of the governor, Gen. J. W. Janssens, and of Commissary J. A. de Mist were humane and their approach methodical. Several effective steps were taken. New districts were created at Tulbagh and Uitenhage; the Moravians at Genadendaal were encouraged; the missionary J. T. van der Kemp was established at Bethelsdorp, in the hinterland of Algoa Bay, to rally and civilize the Hottentot remnants in the eastern districts. Hottentot labour was to be registered and contracts observed by both parties. The frontier was defined and expanded in the northwest. Clearly the Batavians meant to govern as benevolent despots. They proposed religious toleration and secular education. Above all they meant to control frontiers and frontier folk. This, with sustained crisis on the eastern frontier and the truculent self-sufficiency of Graaff-Reinet, which wanted gunpowder rather than government, brought the colony to the edge of revolt. From this attempt to revolutionize society, the Cape was reprieved by the second British occupation in January 1806. Throughout the Napoleonic Wars Holland was the ally of France, and in their course the British conquered the entire Dutch colonial empire. Under the general settlement at Vienna in 1814 Great Britain relinquished most of its colonial conquests but retained the Cape and part of Guiana.

British Colonization and the Great Trek.—Theoretically the British might have evacuated the Cape in 1814. In practice, from 1806 administration was handled on the assumption that the "conquest" of that year would probably be permanent. The slave trade, legally abolished in 1807, was progressively suppressed. In 1834 slaves, as elsewhere, were emancipated subject to a period of apprenticeship. Free settlers were encouraged, frontiers were held and expanded, while even before the discovery of diamonds in 1867 the successful introduction of wool farming, of crossbred Angora goats, which launched the mohair industry, and the improvement in horse breeding (the company had exported horses to India as early as 1769) had led to steady economic expansion. The improvement in road communications (Montagu Pass, Mitchell's Pass, Bain's Kloof, 1848–53), the expansion of shipping in Cape Town, Port Elizabeth, and Durban, the removal of commercial restrictions, and, after 1854, the promise of railways made, in spite of financial depression in the late 1820s and the shock of frontier wars, for a general leavening of prosperity and fostered the growth of urban life. The Cape offered a career open to talent and enterprise. There was virtually free emigration from the European continent as well as from Great Britain.

During 1836 and 1837, Boer farmers, mainly from the eastern districts, launched the Great Trek and systematic emigration by ox wagon across the Orange River, away from British rule. It is estimated that in the decade after 1836 about 14,000 farmers abandoned the Cape to become the Pilgrim Fathers of the High Veld and to found republics in the Free State and the Transvaal. The trek is the axial point in South African history, an exodus remarkable less for its size than for its significance. In part it was the acceleration of leisurely progress toward the open veld. In part it was the fulfillment of dreams that had crystallized in the abortive republics of Graaff-Reinet and Swellendam in 1795. But in the main it had a coherence and spontaneity arising from revulsion from British rule. Though frontier Boers and frontier British settlers made common cause in criticizing frontier policy, only a few British abandoned the colony. Though each trekker family had its private goal, the trek was a quasi-nationalist move out of what threatened to become a house of bondage.

British rule at the Cape had begun cautiously but systematically. In structure the administration, subject to veto from the home government, was autocratic. It was not until 1825, when the unpopularity of Lord Charles Somerset (1814–26) forced the issue, that an advisory council was associated with the governor; a nominated legislative council and executive council followed in 1834. From the beginning local affairs were more closely supervised, and frontier posts and magistracies multiplied even in the first decade. In 1811 Alexander Du Pré, earl of Caledon, instituted circuit courts. These, among other things, could hear Hottentot as well as European complaints against the violation of Caledon's ordinance of 1809 as amended by Sir John Francis Cradock (1811–14) in 1811, which had sought to enforce master-and-servant contracts. The first circuit in 1812 acquired notoriety, partly because some frivolous charges were brought, chiefly because legal protection was effectively extended to Hottentots. In 1815, at Slachter's Nek, F. Bezuidenhout, having defied a summons for two years, was shot while defending himself from arrest by a European officer and Hottentot soldiers. His brother and friends launched a republican revolt, sought, in vain, the armed assistance of Chief Gaika, and tried, also in vain, to raise the frontier. The rebellion was suppressed, 32 rebels were banished from the frontier and 5 executed. Legally Somerset's action was correct and politically it was in accord with current practice, but the fact remains that Slachter's Nek stands in Boer legend as an example of British tyranny and *lèse-majesté* against the white man.

The early governors strove to face problems frankly. In the western Cape, schools were sponsored and new churches opened. The Dutch Reformed Church alone opened ten new churches between 1824 and 1829 and built up its synodal structure. Currency reform in 1826 caused considerable hardship, but with the development of banking and credit facilities this necessary preliminary laid the basis of future stability. The coincidence of currency reform and the progressive loss of preference for Cape wines in the home market (1825, 1831) meant that the emancipation of the slaves, against whom (as a species of property) mortgages were held, hit the Western Province severely in 1834. Compensation was inadequate, and payable only in London. Many, even if admitting the wisdom of the measure, resented the penury which resulted, as also the incorrect analogies drawn from West Indian conditions. In the main though, adjustment was easier in the western Cape, where closer settlement made for closer contact, and, after 1828, a free press provided a safety valve. The main difficulties lay on the frontier. To the north, annexation up to the Orange between Ramah and Bethulie in 1824 gave some stability, as did also the settlement of Bastards and Griqua in missionary-sponsored communities round Klaarwater, Campbell, and Philippolis. Missionary enterprise, begun in the 18th century under the company at Genadendaal, founded settlements for Bushmen, for Hottentots, and among the Bantu. Most denominations and most countries were represented in a fumbling drive to civilize the coloured races, and what coordination the movement had it received from John Philip (*q.v.*), the general superintendent of the London Missionary Society. The missionaries' objectives were sound, their methods uncertain, their resources inadequate, and, in the colony, their critics legion. Of their devotion, there is little doubt. They were, moreover, welcome. Their approach to frontier questions coincided in the main, especially between 1825 and 1842, with that of the Colonial Office and with underinformed opinion in Great Britain.

The crux of the issue lay mainly in eastern frontier districts. Cattle farming on primitive lines, with poor grazing and erratic rainfall, demands vast cattle runs and elastic tenure, whether the farmers are European or Bantu. The economy of both groups was primitive. There was no scientific breeding, no fencing, no adequate herding. The company had sought in vain to hold the Great Fish River as a frontier in its last 20 years. Neither in

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VIEW OF PORT ELIZABETH, CAPE OF GOOD HOPE, SHOWING THE CAMPANILE MEMORIAL TO THE BRITISH SETTLERS WHO LANDED THERE IN 1820

1789 nor in 1799 had the Xhosa been cleared from the Zuurveld. In 1812 (fourth Kaffir War) Cradock with ruthless efficiency drove Ndhlambi and 20,000 followers over the Great Fish. Forts at Cradock and Grahamstown, as well as the older one on Algoa Bay, were planned to hold this line. As a solution, it was faulty. The Great Fish often dries up, making a highway instead of a barrier, and in its lower reaches it is covered on both banks by thick bush. It became increasingly an imaginary line. When Ndhlambi was driven back he came into conflict with Gaika and, in 1820, defeated him in a bloody battle at Amalinde Flats (near King William's Town). Aided then by the prophet Makana, he launched a counteroffensive to recover his land. In this, the fifth Kaffir War, Grahamstown bore the brunt, and the Great Fish frontier was restored, with the difference that the land between the Great Fish and the Keiskama was to be a neutral belt, with a military station and fort at Fort Willshire. This was trespassed upon by both sides, especially inland in the Tyumie Valley, where Gaika settled.

It was partly to hold the Zuurveld that about 4,000 settlers were assisted by the British government to settle in what later became the district of Albany. After great hardships, accentuated by official ineptitude, they established themselves in the Zuurveld, though many craftsmen gravitated to the new towns at Grahamstown and Port Elizabeth (formerly Fort Frederick). Their paper, the *Grahamstown Journal,* became the acknowledged mouthpiece of frontier opinion, both Boer and British. Both groups demanded security from cattle raids on the frontiers and the European settlement of the neutral belt into which the overcrowded Xhosa cautiously expanded. When, in 1828, ordinance 50 ended the pass system for Hottentots built up on the regulations of Caledon and Cradock, there was a general outcry. Henceforward no special regulations governed free persons of colour, and the Hottentots drifted from the farms six years before the mooted emancipation of the slaves in 1833.

Between 1828 and 1838 the whole trend of British policy in the Cape was often unpopular with the settlers and anathema to the Boers. After 1831, in accordance with the theories of E. G. Wakefield (*q.v.*), crown land would be put up for auction. Expansion to the east was barred, expansion to the north was growing more difficult, labour was scarce, and the price of new farms was rising. A series of droughts meant stock losses and also stimulated Xhosa cattle-raiding parties. The establishment of a new Supreme Court in 1827 had been associated with the use of English instead of Dutch as the official language. The familiar jurisdiction of landdrost and heemraden gave place after 1828 to magistrates and civil commissioners. Thus to frustration was added a sense of alienation. True, some autonomy was given to the east by the appointment of a lieutenant governor; but the first holder, Andries Stokenstrom, an administrator of vigour and imagination, was dubbed a negrophilist and the label stuck. The emancipation of the slaves in 1833 hit the Eastern Province as a psychological rather than an economic shock, which became more profound when, in 1834, a proposed vagrancy law to check the Hottentot drift was disallowed by Britain. Already in 1834 *commissie* treks went ahead, one northwest, one north, one northeast, to spy out prospects of escape. The sixth Kaffir War (1835) delayed action on their reports; and the Boers, Piet Retief (*q.v.*) conspicuous among them, helped to save the frontier. Victory seemed to offer the prospect of new farms in the ceded territory between the Great Fish and the Great Kei. But when the governor, Sir Benjamin D'Urban (1834–38; *q.v.*), failed to convince the colonial secretary, Lord Glenelg, either of the legitimacy or of the advisability of annexing the territory to the Cape, the Boer felt he had everything to lose, including his whole standard of values, if he remained in the colony. The reversal of D'Urban's frontier policy was not the cause, but the final incident, which provoked the Boers resolutely to abandon the colony and everything associated with it. Fifty-seven years old, Retief had experienced the whole gamut of change. He saw no life that he cared to live save in a new land, and his departure (February 1837) was the signal for the main exodus. With the trekkers went the whole complex of ideas of the traditional trekboer, hardened by antagonism to the ideas and practices of the new era. The British, accustomed to a society where equality of legal rights in no sense connoted social equality, failed to appreciate that the different structure of Boer society, where all white men were peers, made it impossible for them to conceive legal equality for "free people of colour" apart from the nightmare of social equality.

The Colony From 1837 to 1854.—Within a few years the Great Trek had revolutionized the political structure of southern Africa. Natal was annexed by Great Britain in 1843 and was administered from the Cape until 1856. By the terms of the Cape of Good Hope Punishment Act (1836) criminal jurisdiction extended to latitude 25° S, but failing either civil or military apparatus of government, it was a dead letter. In 1852 the independence of the Transvaal (*q.v.*) was recognized; in 1854, after six years of experimental control, the independence of the Orange Free State (*q.v.*) was recognized, and Great Britain's direct political responsibilities in southern Africa were limited to the Cape and to Natal. Nevertheless, from 1847 the governor of the Cape was also high commissioner for South Africa, for nothing could alter the political and military fact that Great Britain was *de facto* the paramount power. The Cape and Natal controlled the markets for republican goods, so that isolationism would in any event have been impracticable. Moreover, however shakily, the new republics had turned the flank of the Bantu.

Events in the Free State were always likely to have repercussions across the Drakensberg in Natal and in the no-man's-land between the Cape and Natal, as the European states were like the walls of a dam restraining a series of potential Bantu floods. Theoretically the Bantu tribes were all separate; in practice news passed freely between, for instance, Pondoland and Basutoland, and they were informed of the attitude of the frontier press. The risk of a concerted native convulsion was always within the bounds of possibility. Shrewd observers saw that the economic and political interests of the four South African communities could not be completely severed. It was therefore unfortunate that doctrinaire theorists in Great Britain, reinforced by an understandable clamour in Parliament for economy, led Great Britain in 1852 and 1854 to abdicate from the legal power that should legitimately have gone with paramountcy by recognizing the independence of the republics.

In the Cape, the trek left no obvious vacuum. The European population of the Cape in 1832 is estimated to have numbered 66,000. In 1854, partly by natural increase, partly by immigration, it had increased to 140,000. Systematic colonization from Great Britain was encouraged and many soldiers, having completed their service, settled in the colony. The territory of the colony was substantially enlarged when Sir Harry Smith (1847–52; *q.v.*) completed annexation up to the Orange River. After the War of the Ax (1846) he also annexed Victoria East and the land between the Great Fish and the Keiskama.

Three things characterized the development of the Cape during this period: the rapid growth of sheep farming and wool production as a new staple; the new approach to frontier issues marked by the crown's annexation of Kaffraria after the War of the Ax; and the successful demand for a representative assembly. Sporadic but unsuccessful attempts had been made by the company in the 18th century to breed sheep for wool and isolated experiments had been made by individual farmers for some time, but sheep farming for wool first became general in the Eastern Province, mainly because of the enterprise of British settlers.

The practice of enumerating a series of Kaffir wars, 1779, 1789, 1799, 1812, 1819, 1835, 1846, 1850, 1858, 1877, though sanctioned by convention, to some extent hides the problems which they indicate. The fact that the Xhosas many times outnumbered the Europeans, although the latter had superior military resources, together with the clash of race, has obscured the fundamental nature of the dispute. Many perished on both sides, and tension was almost as great in time of peace as in time of war. The colonists were embittered by repeated losses; others, speculators as well as farmers, were covetous of land. To peaceful settlement, however benevolent, by the colonial authorities in London, there were two handicaps: first, the length of the frontier and the nature of the terrain, which made it impossible to patrol (the Xhosas used the tactics that the commandos were to adopt later); second, ignorance of Xhosa tribal institutions and land tenure, which every European onslaught made more chaotic. Until about 1846 the object was to exclude the Xhosas from the colony, leaving the task of civilization to missionaries. With this went the experiment, based on misleading Indian analogies, of concluding *status quo* treaties with the miscalled states beyond the frontier. The prototype was the treaty with Andries Waterboer (1834; *see* GRIQUALAND EAST AND GRIQUALAND WEST). Similar treaties were concluded with the Gaikas, the Ndhlambis, etc., immediately after the war of 1835; with Adam Kok and Moshesh in 1843; and with Pondoland in 1844.

In the case of states on the immediate frontier, the treaties thrust duties on the chief which tribal structure made it impossible to perform. After the war of 1835 the treaties gave eight years of uneasy peace. Both sides settled between the Great Fish and the Great Kei, and Fort Victoria in 1844 was established in the heart of native territory. Twice the treaties were somewhat arbitrarily revised, and there were constant clashes of patrols before the War of the Ax. The Xhosas then launched a counterrevolution which swept missionaries, traders, farmers, and soldiers over the frontier. The government's counterattack was terrible, but even so it proved physically impossible to drive the Xhosas behind the Great Kei. The chiefs were therefore dispossessed and planted on locations interlaced with white settlement, and Kaffraria was annexed to the crown.

Reaction came in 1850, when even the Hottentots of the Kat River settlement (hitherto a buffer settlement south of the Winterberg), as well as the Xhosas, attacked the colony, starting with massacre on an unprecedented scale in the Tyumie Valley. Three years of fighting saw the Xhosas stripped of most of their cattle (at least 55,000 head were taken) and metaphorically penned into congested locations. There was one last flash when, in 1857, Nonquase the prophetess persuaded the tribes to burn their crops and kill their stock as a sacrificial preparation for the destruction of the white people. Though Sir George Grey (*q.v.*) took remedial steps, Sandile's tribe dropped, by famine and dispersal, from 105,000 to 37,000 in a few months. The way was thus cleared by race suicide for the planting first of the so-called German legion in Kaffraria, then of German peasants on the coastward side. By 1860 there were about 6,000 Europeans and 53,063 natives. Their interspersal and the initial overcrowding of the locations, despite the benevolent intentions of Grey, who wanted to civilize through the tribal structure, made this Ciskei area a rural slum and handicapped the working of native institutions.

Parallel with economic development and with new ventures in frontier stabilization had gone considerable political development. A representative element was introduced into local government. In 1837 Beaufort West became the first town to elect a board of commissioners. Others rapidly followed. Churches developed greater institutional autonomy. The Dutch Reformed Church was emancipated from political control in 1843. The Anglican Church developed rapidly after the creation of the bishopric of Cape Town in 1848, to be followed by new sees at Pietermaritzburg (Natal) and Grahamstown in 1853. A free press and a growing though still inadequate school system helped to make informed public opinion, which, if undisciplined, was strong enough to avert the proposed introduction of convict labour in 1849. The Eastern Province, which had its own lieutenant governor, demanded administrative autonomy and clamoured for separate representation. Great Britain was chary of granting representative government, lest the sequel be the revocation of the principle of legal equality or even an irresponsible frontier policy. But in 1853, with the latest Kaffir War over, Kaffraria annexed to the crown, and the Orange River sovereignty abandoned, the legitimate demands were met. The Cape Constitution Ordinance of 1853 set up a bicameral legislature. In the legislative council (the upper house) there were eight members for the Western and seven for the Eastern Province. In the legislative assembly (lower house) no attempt was made to balance the voting strength of the provinces, but as the electoral districts were then arranged, the Western could outvote the Eastern by two. High property qualifications were demanded for membership of either house, but the franchise for the lower house, based on property rather than colour, though it favoured the Europeans, did not exclude free persons of colour.

The Advent of Responsible Government.—In 1854 Great Britain had sought to cut its liabilities by giving up the Orange River sovereignty and concentrating on Natal and the Cape. Although some officials at the Colonial Office saw southern Africa as a unit, public policy toward the colonies inclined to the ideas of the Manchester school. Like the Wakefield Radicals, this group of theorists believed sincerely in the educative discipline of self-government wherein the Cape, which now had representative but not responsible government, lagged behind the other colonies. Unlike the Radicals, the Manchester school did not believe in imperial coordination. They emphasized that Great Britain's colonies, especially South Africa and New Zealand, were the cause of heavy expenditure, whereas their economic significance was slight. Thus they favoured the acceleration of constitutional and fiscal responsibility, the reduction of military expenditure, and, to that end, a conservative imperial policy. In April 1859 Great Britain therefore rejected the federative proposals of Sir George Grey and ignored the fact that the fragmentary structure of southern Africa was an economic handicap and a political danger.

When, in 1856, Natal was constituted as a crown colony, there were eight political units in southern Africa: in diminishing order of stability, the Cape, Natal, Kaffraria, the Orange Free State, the South African Republic, Zoutpansberg, Lydenburg, and Utrecht. That the Transvaal coalesced and survived under M. W. Pretorius was hardly the result of imagination or forethought on Great Britain's part. In Basutoland and Griqualand West, however, in the interests alike of the Cape and of Natal, Sir Philip E. Wodehouse (1862–70) was compelled to act. The clash between Moshesh and the Orange Free State was dangerous in two ways. Already Nehemiah, son of Moshesh, was on the eastern side of the Quathlamba Mountains, while Molapo and Moshesh commanded the main passes over the Drakensberg into Natal. An overwhelming Basuto defeat would lead to their dispersal either into Natal, always harassed by fear of the Zulu, or into the Cape, where the colonial Xhosas, as in the early 19th century, would be caught between two pressures. Furthermore, Kreli, paramount chief of the eastern Xhosas, held the strategic key to the native territories between Kaffraria and Natal. Kreli was in touch with Moshesh, with the Pondos, and with the Tembus around Umtata. Any victory secured or any defeat sustained by Moshesh would have repercussions in the Cape and in Natal. Because of this, Wodehouse, while refusing to arbitrate in the Klip River dispute (*see* Transvaal), promised Pretorius to arbitrate the Basuto line if requested by Moshesh. In 1864 he modified the first treaty of Aliwal North (1858), arbitrating at J. H. Brand's request. In 1868, when after three years of war the Free State had won a victory which Brand could not consolidate and Moshesh dared not accept, Wodehouse annexed Basutoland and in 1869 the Free State *volksraad*, with only one dissentient, ratified the second treaty of Aliwal North. In 1871 Basutoland was annexed to the Cape, to revert to crown protection in 1884. Thus British policy was once again committed to responsibility north of the Orange and west of the Drakensberg.

Much the same issues were involved in the disputes beyond the Cape boundary north of the Cape and west of the Orange Free State. The claims of Pretorius in 1868 threatened to disrupt the Batlaping and Barolong, hitherto intact under British missionary guidance, and, what was vitally important, to cut across the trader-missionary road to the interior. Seven years earlier, in the Vaal-Hartz-Orange area, the migration of Adam Kok from Philippolis to Griqualand East had left behind a tangle of claims north of the Vetberg line and on both sides of the Vaal. The chief disputants were Waterboer, coached by David Arnot, and the Orange Free State, which in 1861 had purchased the lands of Adam Kok (*see* Orange Free State; Griqualand East and Griqualand West).

Confusion threatened chaos when diamonds were discovered first at Hopetown in 1868, then in the dry diggings (site of the future Kimberley) in 1870. Disorder and conflicting jurisdictions were of more than local significance because the traffic in spirits and guns now available to migrant native labourers threatened to kindle and arm native unrest. It was clear that control of diamond areas would restore the waning economy of the Cape, but neither that nor the treaty links with Waterboer were so decisive as the threat to security. In 1871 the Keate Award resolved the Transvaal boundary dispute. In the same year Sir Henry Barkly (1870–77) annexed Griqualand West, which the Cape, however, declined to accept until 1880.

Piecemeal annexation added to difficulties in the Cape, where the granting of representative institutions imposed on the high commissioner in his capacity of governor the ambiguity of a double role. For his actions as high commissioner he was answerable to the Colonial Office; yet such steps as Grey's policy in Kaffraria and the subsequent annexation of Kaffraria to the Cape (1865), the dispatch of Cape police to Basutoland, and the fate of Griqualand West could not be determined without the connivance of the Cape assembly, and there was the risk of deadlock between the upper and lower houses and between the two houses and the irresponsible official executive, as well as between either or both and the Colonial Office. Grey's tenure of office coincided with a period of relative prosperity when the home government was prepared to spend fairly lavishly both on the imperial garrison and on the development of Kaffraria; and Grey himself did much to enrich the cultural life of the colony.

In the 1860s the threat of the diversion of shipping routes when the Suez Canal should be opened hung over a colony hit by drought, by changes in the wool market, and by the general tightening of credit that followed the American Civil War and the outbreaks of war in Europe. Economic stagnation retarded the development of railways and telegraphs; government debt increased (it stood at £1,420,000 in 1870); and Great Britain was with difficulty dissuaded from hasty garrison withdrawals like those in New Zealand. Depression was accentuated by awareness of frontier threats, further advance in the Transkei was prohibited (1865), and Kaffraria —the heyday of imperial grants departed—was incorporated in the Cape (1865). Within the colony, the Eastern Province clamoured for separation on the analogy of Natal. With wool as the staple and the traffic at Port Elizabeth expanding, it claimed that it could be self-supporting; and it hoped to increase its own weight by the inclusion of Kaffraria (which, however, the Kaffrarians, headed by J. G. Sprigg, opposed).

Tension was such that Wodehouse, who met the Parliament of 1864 in Grahamstown and established there a two-judge court for the Eastern Province, toyed with instituting "Jamaica" reforms and restoring official autocracy. Even such enthusiasts as J. C. Molteno (Beaufort West) hesitated to urge full responsible government on a fractious, stagnant, and well-nigh bankrupt colony. Sir Henry Barkly took advantage of returning prosperity to encourage Molteno's move for responsible government. The move failed in 1871, but in 1872 a bill to institute responsible government was introduced with a parallel measure to equalize representation of the two provinces. In December 1872 Molteno built up the first cabinet government in the Cape and wisely sought to make it truly representative in the major provincial groups.

The Cape From 1872 to 1902.—Between 1854 and 1872 there had been more than a little danger that parties in the Cape would follow a territorial alignment of the Western Province versus the Eastern Province, with the Kaffrarian group under Sprigg holding a balance of power. Molteno, the first premier of the colony (1872–78), did much to avert this by the electoral law of 1874, which divided the colony into electoral circles. Molteno also worked to give the Cape full responsibility for its own affairs. Two complementary factors made this difficult to achieve: in the first place the governor of the Cape was also, until 1901, high commissioner, and his actions as such were determined mainly by the home government; in the second place, as Sir Michael Hicks Beach (secretary of state for colonies, 1878–80) was to explain, "the peculiar conditions of the Colony" as well as the political structure of southern Africa were held to make responsible government subject to special limitations. Molteno raised both issues. He was critical of the federation dispatch of the 4th earl of Carnarvon which, when it arrived in June 1875, included without official consultation the proposed separate representation of the Eastern Province. He further claimed that the Cape should control its own forces on the Cape side of the Great Kei in the Kaffir War of 1877. On the other hand, the high commissioner, Sir Bartle Frere (1877–80), treated the war as part of a native resurgence that constituted an imperial problem, not solely a Cape frontier question. Molteno was dismissed and the dismissal was endorsed by the Cape Parliament.

Molteno's successor, Sprigg (1878–81), was prepared to work for federation with a colonial initiative. By 1880, however, Zululand had been conquered and the Transvaal was preparing armed resistance against the annexation of 1877. Sprigg's federation motion was defeated, though his government managed to hold out a few months longer.

The whole picture of Cape politics had altered, substantially because British annexation of the Transvaal had roused the antagonism of the Afrikaner groups in the Cape. A revival of journalism, the formation of farmers' associations from 1873 onward, the founding of the Genootskap van Regte Afrikaners in 1875—all signs of a cultural renaissance of Afrikaner tradition—assumed a political significance with the formation of the Afrikander Bond in 1879. This movement was a popular political muster of democratic and race-conscious nationalism. Its object was to unite the Afrikaans-speaking people throughout southern

Africa in a national republic. It helped to determine the Cape elections of 1879, to defeat Sprigg's federation motion, to drive him from office, and to replace him successively by T. Scanlen (1881–84) and T. Upington (1884–86). The cleavage in the Cape had been widened by British policy in the Transvaal and by S. J. P. Kruger's propaganda, but three factors served to conceal it.

First, the convention of London in 1884, while suppressing overt mention of suzerainty, defined the external relations of the Transvaal, so that for about a decade, though there was often acrimonious dispute, fundamental issues of principle were avoided. Second, J. H. Hofmeyr weaned the Bond from its extremism and converted it into a party structure for purely Cape ends. Situations reminiscent of the Italian techniques of *trasformismo* resulted, from the moment when C. J. Rhodes (*q.v.*) and Hofmeyr first cooperated to drive Sprigg from office in 1881. Governments ruled by grace of the Bond even when Hofmeyr was not in office. In 1882 Dutch as well as English was allowed in addressing either house, and Dutch was permitted as the medium of instruction in certain grades of Cape schools; two years later it was enacted that parliamentary bills and papers should be in both languages, and Dutch was given parity with English in the magisterial courts. The retrocession of Basutoland to crown government was the main reason for Scanlen's fall, and the imperial—as distinct from colonial—annexation of Bechuanaland was the operative reason for the more formal alignment between Hofmeyr and Rhodes. The third factor that helped the growth of a moderate but enterprising colonial party was the governorship of Sir Hercules Robinson (1881–89), who, not yet caught up in Rhodes's financial undertakings, understood the colonial point of view more clearly than anyone else since Grey.

In the Cape there were three main political groups. On the extreme right was a section of the British, organized in the Imperial League and kindred groups, which favoured the imperial connection as necessary and, in patches, were not averse to open conflict with the Transvaal and revenge for the British defeat by the Transvaal Boers at Majuba. On the extreme left was that section of the Afrikaners who saw in the Transvaal their spiritual home and in Kruger their Moses. In the centre were grouped Rhodes and Hofmeyr. Rhodes, when he was not representing his own ideas and the financial projects which could translate dreams into reality, stood avowedly for something nearer to Cape imperialism than to colonialism (he introduced the Glen-Grey Act as a "Bill for Africa"). He wanted the Cape to fit itself to lead South Africa by closing its ranks within and taking a wider view of its potentialities. This side of his policy was closely related to that of Hofmeyr, who deprecated accentuating differences between two European races confronted with a common future and sought to secure the maximum of colonial self-determination by federal cooperation with other South African states under the necessary protection of the British crown.

Meanwhile the diamond fields had made possible the rapid expansion of railways and telegraphs (the existing 63 mi. had been bought from private ownership for the colony by Molteno). This in its turn put the colony in a favourable position to profit from the quickening of commerce that was to follow the opening of the Rand gold fields in 1886. At that time the colony already had three trunk lines: one to Colesberg, one to Kimberley, and one to Aliwal North. Unwisely it rebuffed Kruger's proposal for customs negotiation, but it concluded a customs agreement with the Orange Free State in 1888 and a railway agreement in 1889.

In 1891 the Cape line reached Bloemfontein from Colesberg (extended to Pretoria in 1892), while the Kimberley line, sponsored by Rhodes, reached Vryburg. Once the extension thence to Mafeking was completed, two routes lay open if the Cape was to be linked by rail with the territories of Rhodes's newly chartered British-South Africa Company (1889) in the north. One lay along the western margin of the Bechuanaland Protectorate where Rhodes eventually, in 1895, negotiated with Joseph Chamberlain, the new secretary of state for the colonies, the purchase of the ill-fated railway strip, outside but nevertheless contiguous to the western frontier of the Transvaal. The better route lay across the Transvaal. But Kruger wished to have an independent railway system through Portuguese East Africa to Delagoa Bay. This was the nearest port and had the unique advantage of being free from British control. In 1889 he concluded with the Free State political and economic alliances which threatened the balance of power in South Africa. By 1895 his railway policy, which culminated in the drifts crisis (August–November 1895; *see* TRANSVAAL), had alienated what was almost a national body of opinion and the Cape sponsored and endorsed the protest of the imperial government. On Nov. 7 Kruger reopened the drifts.

At the same time fear of foreign intervention (and the evidence is clear that this was contemplated after the German annexation of South-West Africa) led to successive annexations of territory both by the crown and by the colony. Though Basutoland was returned to crown control in 1884, Griqualand West was incorporated in the Cape in 1880; and in 1895 the Cape, at the instigation of Rhodes, took over the crown colony (as distinct from the protectorate) of Bechuanaland. For Rhodes, this kept the path to Rhodesia open; for the colony, it brought back under its rule the many farmers who had trekked to farm there. Even more decisive were annexations on the east coast, over which the crown proclaimed a coastal protectorate in 1885. The native territories between Natal and the Great Kei River were progressively absorbed into the Cape. Griqualand East was annexed in 1879, followed by the Pondoland coast in 1884, by Tembuland and Galekaland in 1885, and by the rest of Pondoland in 1894. This confronted the Cape with a challenge, since its social frontiers were now within its political borders, and the proportion of native to European population was greatly increased. In spite of some agitation the established principle of equal franchisal qualification for all races was not touched, but steps were taken to avert premature swamping by blanket voters.

In 1887 the franchise was extended to newly annexed areas with the proviso that communal tenure of property could not qualify individuals for the vote. In 1892 qualifications for the franchise were raised and a simple education test was imposed. Parallel with this compromise between Cape realism and Cape liberalism went a constructive attempt to work out administrative policy for native territories. The Transkei was rather simpler to face than the Ciskei, where European and native settlement had been deliberately interspersed and tribal structure weakened by war. In 1883 it was decided that native civil law should be recognized. This put magisterial authority behind tribal tenure and marriage customs. In the Glen-Grey Act Rhodes made a comprehensive attack on the Transkei problem. Detailed for one area, the act was designed on lines which might apply throughout a hypothetical union and beyond. Individual tenure, subject to quitrent and inalienable without the consent of the governor of the Cape, was instituted, and provision was made for the natives to share in local self-government. This was not only the greatest legislative achievement of Rhodes, but the most constructive invention in native administration in a century of conflict.

More could have been done but for the Jameson Raid (*see* JAMESON, SIR LEANDER STARR) at the end of 1895, which not only split the Rhodes-Hofmeyr grouping but fanned extremism on both sides. The congratulatory telegram sent by the German emperor William II to Kruger alarmed the British Foreign Office far more than Rhodes's complicity in the raid shocked Chamberlain—who, it would seem, came near to being accessory before the fact. The Transvaal Boers were now convinced that Great Britain had deliberately surrounded the Transvaal as a prelude to annexation on the pattern of 1877, and that British insistence on the integrity of Swaziland, even if under a Transvaal protectorate, was part of the same design. Afrikaners everywhere saw in the Transvaal the only hope for the survival of Afrikaner ideals. In the Cape, while many of the Bond were critical of Krugerism on points of detail, and many, after the arrival of Alfred Milner (*q.v.*) in 1897, strove to avert conflict as tension mounted over the *uitlanders* in the Transvaal, it was nevertheless clear that armed conflict would have serious repercussions in the colony. Sprigg, prime minister since Rhodes's resignation (January 1896), hoped that federation could still be brought about by the nebulous Progressive Party, which counted itself heir to the best in Rhodes's program.

But Sprigg could do no more than fight a losing rearguard action in the assembly. In the election of 1898, conducted in mounting tension, although Rhodes returned to the field, the Bond and its allies carried the day. Sprigg resigned on a vote of censure and was succeeded by W. P. Schreiner (1898–1900), the parliamentary leader—but not the puppet—of the Bond.

Schreiner faced a difficult role with imperturbable integrity and, in the most bitter of all Cape parliaments, was loyal to his obligations as a minister of the crown. His hopes of keeping the colony out of the war were as futile as his repeated attempts to avert by compromise the outbreak of war between Great Britain and the Transvaal. When war began, the fact that revolts against the British were mainly limited to the north and west of the Cape districts was chiefly due to Schreiner, who was, however, overthrown by a schism in his own cabinet when he accepted the British demand that rebels should be disfranchised. His fall made way for another Sprigg cabinet, which passed emergency legislation before Parliament was prorogued *sine die*. Except when J. C. Smuts's commandos swept within 30 mi. of Cape Town, the heart of the colony was relatively untouched by war; but refugees from both sides flocked to the Cape and most families had relatives fighting. (*See* also South Africa, Republic of; South African War.)

From Vereeniging to the Union.—Through all the vicissitudes of his administration Milner had clung to his initial purpose of bringing about a closer union of the southern African countries—if necessary, by asserting British paramountcy beyond challenge. With the occupation of Bloemfontein and Pretoria in 1900 he counted the war as won, though in fact the period of the commandos was still to come. He seriously considered suspending the Cape constitution rather than face in the Cape the possible obstruction of those whose compatriots he had defeated in the north. This plan of reducing the Cape to the status of the defeated republics was rebuffed by Chamberlain, contested by Sprigg, and snuffed out by the colonial conference in London.

The Parliament therefore met in August 1902 and duly passed the necessary act of indemnity, but Sprigg's hold on the assembly was slight and, after defeat on a motion to examine sentences passed when the colony had been under martial law, he dissolved it. In the 1904 election, partly because the former rebels had not yet worked out their five-year disfranchisement, the Progressives under Jameson won a slender and illusive victory. This Jameson hoped to consolidate by a necessary redistribution of seats (effected in 1906) on a more systematic population basis that would not sacrifice the voting strength of the towns to that of the rural areas. This was regarded by some as sharp practice, since, they said, the British parties were stronger in the towns and the Bond stronger in the country. This was broadly true but not the whole picture. Many of the Bond were liberals, and many Afrikaners had business interests which gave them a stake in the economic integration of southern Africa. Conversely, many British farmers shared the rural demand for the protection of farming interests, and not all were either liberal or enlightened. The Cape parties could thus rise above cutthroat politics, which might have been fatal to intercolonial cooperation. Moreover, whereas many Afrikaners had been hard hit by the war, all alike felt the slump which saw Cape revenues shrink, in spite of Jameson's efforts, from £12,000,000 in 1904 to £7,000,000 in 1908.

In September 1907 the Progressives were defeated in the first postwar election in which former rebels could vote. Jameson's government had offered assistance to Natal during the Bambata rebellion and had cooperated fully in the customs and railway conventions and in the intercolonial Native Affairs Commission. The axis of political power, however, lay on the Rand; the grant of responsible self-government to the Transvaal and to the Orange River Colony had shifted the fulcrum of political initiative beyond the Orange River; and the moderation of such men as Smuts could not conceal the fact that the leaders of the former republics were Afrikaner in social and political outlook. As federation of any kind could only become practical with the connivance of the north, the defeat of the Progressives in the Cape paved the way for the only kind of political integration that the Transvaal was prepared to accept. It swung the pendulum from federation to union.

Jameson was succeeded in February 1908 by J. X. Merriman (1908–10), whose South African Party was the old Bond in a new guise, calculated to secure the support of the moderates among the British colonials but unlikely to make the general acceptance of the Cape franchise a condition of cooperation with the Transvaal, which had already adopted an all-white franchise. Merriman favoured union rather than federation—and the closer the better. He was persuaded by Sir John Henry de Villiers (chief justice of Cape Colony) to leave tactics to Smuts, who moved resolutions of procedure to be followed at the intercolonial railways and customs conference of 1908. The ensuing National Convention met successively at Durban, at Cape Town, and at Bloemfontein. The absence of Hofmeyr and Schreiner, both keen federalists, made it fairly easy to override Natal prejudice against union; and the proposal of the high commissioner, Sir Walter Hely-Hutchinson (1901–10), that in the Union property, not race, should, as in the Cape, determine the franchise, was neither firmly pressed nor generally acceptable. The one thing that the Cape delegates would not abandon was the nonracial franchise within the Cape. This, together with equal language rights throughout the Union, was entrenched by the safeguarding clause that it could be altered only by a two-thirds majority of both houses, assembly and senate, sitting in joint session. In 1910 the Cape had 51 members in the lower house; and though the provision for periodical redistribution of seats after census meant that the relative preponderance of the Cape in the lower house was to shrink, if the Cape remained solid for the franchise, the entrenched clause could not be touched without violating the constitution.

The provincial status of the Cape was identical with that of other provinces, and the sovereignty of the Union Parliament over provincial activities, even though they lay within the provincial sphere allotted by the constitution, was clearly established. Federal union had long been the thesis of Cape journalists and politicians of divergent views on other issues, although union at the time and in the manner in which it came was very substantially the architecture of the northern colonies. That the Parliament of the Union should meet in Cape Town was fitting acknowledgment that the Cape, more than any other colony, had forged the parliamentary traditions of the subcontinent.

The history of the Cape Province from 1910 is merged in that of the Union of South Africa (from 1961 Republic of South Africa). Two of the Union's major problems, however, the preservation of the structure of Bantu society and the non-European franchise, were especially serious in the Cape (*see* South Africa, Republic of: *History*).

See also references under "Cape of Good Hope" in the Index.

Bibliography.—M. Whiting Spilhaus, *South Africa in the Making 1652–1806* (1966); L. M. Thompson, *The Unification of South Africa: 1902–1910* (1960); L. Marquard, *The Story of South Africa*, 2nd ed. (1963).

(W. A. Ml.; R. J. Da.)

CAPE PROVINCE: *see* Cape of Good Hope.

CAPERCAILLIE (Capercailzie), a name derived from the Gaelic and applied to the largest of the old-world grouse (*q.v.*), *Tetrao urogallus*.

The species is widely, though intermittently, distributed on the continent of Europe, from Lapland to the northern parts of Spain to Turkistan, but is always restricted to pine forests, which alone afford it food in winter. Hunted to extinction in the British Isles by about 1785, it was reintroduced into Scotland, from Sweden, in 1837.

The male, known as the mountain cock or cock of the woods, is remarkable for his large size, often reaching 34 in. in length and 12 lb. or more in weight; dark glossy plumage; shaggy metallic green breast; and rounded tail. The hen is much smaller, with mottled-brown upperparts and a reddish-brown breast. During the characteristic courtship ceremonies in the spring, the polygamous cock performs for the assembled hens: he struts about the clearing, spreading his wings and voicing a peculiar cry; frequently he mounts to the topmost bough of a tall tree and challenges all rivals by extraordinary sounds and gestures; the combat takes place on the ground in the presence of the waiting hens. In earlier times the capercaillie population suffered great losses because of the unsportsmanlike behaviour of hunters who shot them while they were absorbed in courtship.

The hen nests on the ground, laying from seven to nine or more yellowish eggs. Soon after they are hatched, the young are able to fly; toward the end of summer, from feeding on the fruit and leaves of the bilberries and other plants, they are of a size and flavour fit for the table. With the first heavy snowfalls they resort to the trees where they feed on the pine leaves. The capercaillies' flesh, under this diet, rapidly acquires a distasteful flavour of turpentine.

The Siberian capercaillie (*T. parvirostris*), a darker species with a longer, more graduated tail, lives in northeast Asia. Hybrids are frequently produced between the capercaillie and related birds —the black grouse (*Lyrurus tetrix*), red grouse (*Lagopus scoticus*) and pheasant (*Phasianus colchicus*). (G. F. Ss.; X.)

CAPERNAUM (in the Douai version of the Bible, Capharnaum), an ancient city on the northwestern shore of the Sea of Galilee in Israel, identified with the ruined site at Tell Hum, was Jesus' second home and, during the period of his life, a garrison town (Matt. viii, 5 ff.), an administrative centre (John iv, 46) and a customs station (Matt. ix, 9). Jesus chose his disciples Peter, Andrew and Matthew from Capernaum. It was the scene of many of his miracles, and in its synagogue he delivered many of his discourses. Its fame did not prevent the complete disappearance of the name and a long dispute over its location. Two identifications were advanced—Tell Hum, about 2½ mi. W. of the Jordan river's entry into the lake, and Khirbet al Minyeh, 2 mi. W. of Tell Hum. Excavations were begun at Tell Hum in 1905 by Heinrich Kohl and Carl Watzinger; they were completed by the Franciscans, who established its identification with Capernaum beyond doubt. Minyeh has also been excavated and has proved to be of the early Arabic (Omayyad) period.

The remains of a synagogue have been uncovered and partially restored. It was a rectangular building (57 x 75 ft.), oriented to the north. It was entered by three doors from a platform on the south side. Built of white limestone, its walls were ornamented outside with pilasters. An open court with covered porticoes on three sides extended the entire length of the east side. In the interior a stylobate, 1 yd. wide, raised 2½ in. from the floor and based on the south wall, ran parallel to the walls and divided the synagogue into a nave, two aisles and a transept. It supported seven columns with Corinthian capitals on each of its long sides with two additional columns between nave and transept, 16 in all. Above the aisle and transept was a gallery of Doric columns. Above each set of columns was a richly ornamented entablature. The lintels of the door had been surmounted by a frieze from which the figures forming part of the design have been obliterated. This synagogue, though an early example of its type, dates from the 2nd–3rd century A.D., but an older synagogue dating from the time of Christ may well be buried beneath its foundations.

See G. H. Dalman, *Sacred Sites and Ways*, Eng. trans. (1935); E. L. Sukenik, *Ancient Synagogues in Palestine and Greece*, pp. 7–21 (1934). (J. S. I.)

CAPERS, the unexpanded flower buds of *Capparis spinosa* (family Capparidaceae), prepared with vinegar for use as a pickle. The caper plant is a trailing shrub, belonging to the Mediterranean region, having handsome flowers of a pinkish white, with four petals, and numerous long, tassellike stamens. The leaves are simple and ovate, with spiny stipules. The plant is cultivated in Sicily and the south of France. Capers are valued according to the period at which the buds are gathered and preserved. The finest are the young tender buds called "nonpareil." Other species of *Capparis* are similarly employed in various localities.

CAPET, the name—derived from the specific designation of Hugh Capet (*q.v.*)—not only of the French royal house "of the third race" (the first being the Merovingian dynasty, the second the Carolingian) but also of the many other sovereign princes of Europe descended in the male line from the Capetian kings of France. The founder of the house was Robert the Strong (*q.v.*), count of Anjou and Blois, whose two sons were both crowned king of the Franks: Eudes in 888 and Robert I in 922. Robert I's son, Hugh the Great, effected a restoration of the Carolingians in 936, but in 987 the claim of the next Carolingian heir was ignored, an Hugh the Great's son Hugh Capet was elected king.

In France the 13 kings from Hugh Capet to the infant John I who succeeded one another from father to son, and John I's tw uncles, Philip V and Charles IV (d. 1328), are designated as th Capetians "of the direct line." They were followed by the 1 Capetian kings of the house of Valois. Of these, seven kings (fron Philip VI to Charles VIII) succeeded from father to son, afte whom Louis XII began the house of Valois-Orléans, continued i the branch of Valois-Orléans-Angoulême (five kings from Franci I to Henry III) until 1589. Then the Capetians of Bourbon succeeded. For these and for the house's subsequent accession to othe sovereignties, *see* Bourbon. (*See* also France: *History*.)

The duchy of Burgundy (*q.v.*) was also held by branches o Capetians separate from the French royal line: first, until 100 by two sons of Hugh the Great; then, from 1032 to 1361, by 1 dukes (from Robert I, brother of Henry I of France, to Philip c Rouvre); and finally, from 1363 to 1477, by four Valois duke (from Philip the Bold, a son of John II of France, to Charles th Bold, who left only a daughter, the duchess Mary).

Three Capetians were emperors of Constantinople between 121 and 1261: Peter of Courtenay, grandson of Louis VI of France, an his sons Robert and Baldwin II.

Capetians of the first Angevin line were descended from Charle of Anjou, a brother of Louis IX of France. Charles in 1266 wo the kingdom of Naples (*q.v.*), in which he was succeeded by fou kings and two queens of his blood (from Charles II to Joan II until 1435. His great-grandson Charles Robert (Carobert), moreover, was crowned king of Hungary (*q.v.*) in 1310 as Charles but the latter's successor Louis (d. 1382) left only daughters.

The second separate Angevin (Valois) line of Capetians fu nished five counts of Provence (*q.v.*) from Louis I, brother c Charles V of France and count from 1382, to Charles (d. 1481).

Apart from its periods of union with France or with the Bourbo titles, Navarre (*see* Navarre, Kingdom of) had three Capetia kings from 1328 to 1425, of the house of Evreux: Philip II grandson of Philip III of France and count of Evreux, Charles I and Charles III. Capetians descended from Louis VI's so Robert, count of Dreux, furnished not only a line of counts o Dreux (1132–1377) but also 11 dukes of Brittany (*q.v.*), fron Peter Mauclerc to Francis II, between 1213 and 1488. *See* als Alençon, Ducs d'; Artois; Orléans, Ducs d'.

CAPE TOWN (Kaapstad), the legislative capital of the R public of South Africa, and capital of the Cape of Good Ho province, is situated at the northern end of the Cape peninsula. narrow strip of land 32 mi. long whose southernmost point is th Cape of Good Hope on the South Atlantic. The metropolita population in 1951 was 577,648 (city 441,209) and in 1960 wa 807,211 (305,155 Europeans, fairly evenly divided between tho of Dutch and British descent, and 502,056 Africans, Cape Coloureds and Asians). Civic affairs are administered by the Cap Town city council of 45 members and a wide range of municipa services is provided.

The city consists of a central business area with a chain o suburbs stretching out in three directions. The central area i bounded to the south by the flat-topped Table mountain (*q.v.*) 2 mi. long and rising to about 3,570 ft., and to the east by subsidiary peaks. Reclamation from Table bay carried out betwee 1935 and 1945 added another 360 ac. known as Roggebaai ("th Foreshore") to the central area. This work also provided for th 290-ac. Duncan dock and the Sturrock graving dock (complete in 1945); this is one of the largest in the southern hemisphere, bein 1,149 ft. long with a width of 156 ft. and an entrance depth o 40 ft. at low water. These docks, together with the older Victori basin, provide harbour facilities comparable to other internationa ports.

The main street is Adderley street (named for C. B. Adderley an English member of parliament, who in 1849 successfully oppose the establishment of a convict settlement on the Cape), to whic was added an extension known as the Heerengracht running seaward across the reclaimed area. Running south from Adderle street is Government avenue, a splendid thoroughfare lined by oa trees and closed to vehicular traffic. Greenmarket square, the original centre of the town, is to the west of Adderley street, and a little farther west is Riebeeck square, originally an outspan, or place where oxen were unyoked. A large rectangular space known as the Grand parade, used as a parking lot and for market stalls, lies east of Adderley street.

The suburbs fall into three groups. The marine suburbs stretch along the coast to the west and south of the city to Bakoven; those to the south extend southward along the eastern side of Table mountain to Kalk bay, 17 mi. from the city; the northern suburbs lie along the main route inland. There are a number of other large separate municipalities outside the city limits.

Public Buildings and Amenities.—The oldest building in Cape Town is the castle. Situated near the Grand parade, it dates from 1666 and replaced the original wood and mud fort begun in 1652, soon after the arrival of Jan van Riebeeck. Most of its bricks were imported from the Netherlands; the stone comes from Table mountain. The castle was formally inaugurated by Gov. Johan Bax on Nov. 25, 1677. At that time, the waters of Table bay came almost to the ramparts.

The Dutch Reformed church (*Groote Kerk*) in Adderley street is the oldest and largest church of the denomination in South Africa. It was begun in 1699 but all that remains of the original building is the bell tower. Eight former Dutch governors of the Cape are buried in the church. There are Anglican (St. George's, still incomplete) and Roman Catholic (St. Mary's) cathedrals.

The city hall (1905) is situated on Darling street but after 1960 it was replaced by a modern municipal centre on Roggebaai. The general post office, a tall building completed in 1942, occupies an entire block.

Opposite the public gardens on Government avenue are Government house, internally one of the handsomest buildings in South Africa, the houses of parliament, and the South African National gallery. On the western side is the South African Public library, founded in 1818 as a free government-supported institution. Its nucleus was a collection of 5,000 books left by Joachim von Dessin in 1761. At the top of the botanical gardens is the South African museum, the oldest in the country, dating from 1825. Its collection of Bushmen figures is unique, casts having been taken from living bodies.

In Greenmarket square the Michaelis collection of 17th-century Flemish and Dutch paintings is exhibited in the Old Town house, originally the Burgher Watch house (1755), a fine example of colonial Dutch architecture. Other well-preserved buildings are the 18th-century Koopmans de Wet house in Strand street, which contains furniture, china and glassware of the same period, and the Martin Melck house. The old supreme court building, originally a slave market, adjoins the Groote Kerk, at the top of Adderley street. After the abolition of slavery in 1835, it housed the supreme court and is now used as government offices.

About three miles east of the city centre stands the observatory (1827–28), one of the most important in the southern hemisphere. South of the observatory, in the suburb of Rondebosch, the Groote Schuur estate of several thousand acres, was permanently reserved for the nation by Cecil Rhodes. The name literally means "great barn," for the early settlers of the Dutch East India company established a cattle station there in 1657. On this site on the slopes of Devil's peak, Groote Schuur, the official residence of the prime minister, was rebuilt in the Dutch colonial style after a fire in 1896.

Higher up the hill lies the University of Cape Town which achieved its present status in 1918, having been known as the South African college from its beginning in 1829. Student enrollment exceeds 5,000; there are faculties in arts, science, commerce, edu-

COURTESY OF THE INFORMATION SERVICE OF SOUTH AFRICA

AERIAL VIEW OF CAPE PENINSULA SHOWING (CENTRE) CAPE TOWN SURROUNDED BY TABLE MOUNTAIN. DEVIL'S PEAK IS ON THE LEFT, LION'S HEAD AND LION'S RUMP (SIGNAL HILL) ON THE RIGHT cation, engineering, architecture, law, medicine, music (including ballet) and social science. Three other features of note on or near the Groote Schuur estate are the Rhodes memorial; Mostert's mill, a perfectly restored example of 18th-century Dutch work dating from 1796; and the national botanical gardens at Kirstenbosch. These gardens, founded in 1913 and reserved for the native flora of South Africa, are situated on the eastern slopes of Table mountain and cover about 1,200 ac. extending to the summit.

The municipal public gardens, which occupy 14 ac. of the site of the 17th-century vegetable gardens of the Dutch East India company, are situated west of Government avenue and contain 8,000 kinds of trees, flowers and plants. The Claremont public gardens are noted for exotic trees and shrubs. Other open spaces are Wynberg park, on the slopes of Wynberg hill, the Green Point common, the Rondebosch common and de Waal park.

Transport.—Two main transport systems serve the city and its suburbs. The government-owned suburban electric railway runs from Cape Town station, Adderley street, through the southern suburbs to Simonstown, with branches to the Cape Flats areas. Buses and trolley buses serve the metropolitan area. A feature of the city is the Table mountain cableway which takes visitors to the summit and provides a magnificent view of the city and its surroundings.

Cape Town is the southern terminus of the national railway system. Through train services connect with all parts of South Africa, Rhodesia and its neighbouring territories. In the early 1960s a new station was erected on Roggebaai. The D. F. Malan airport near Bellville, 12 mi. E.S.E. of the city, though not an international airport, is the southern terminus for South African air services.

Cape Town is the chief passenger and mail port of the nation and the nearest to Great Britain. It is the principal port of shipment for gold, diamonds and citrus and deciduous fruit.

Industries and Trade.—Situated near fertile farm lands, Cape Town has as its leading industry the processing of foodstuffs, such as jams, tinned fruit and vegetables, fish and its by-products (vitamin oil and fertilizer), dried fruit and processed cereals. There is an extensive export trade in these goods, as well as in wine and spirits. Second is the clothing industry which provides employment to about 18,000 workers (mainly Coloured). There is also an increasing development in the manufacture of plastics and leather goods. The city is the second largest industrial area in South Africa. Its chief imports are raw materials for the country's industry and manufactured articles.

As a tourist resort Cape Town is popular with visitors from both inland and overseas, its Mediterranean type of climate and scenic beauty being the chief attractions.

History.—Ever since Bartolomeu Dias in 1488 and Vasco da Gama in 1497 rounded the Cape of Good Hope, Table bay has been a place of call for ships passing to India and beyond. Water and food could be obtained and mail left under marked "post office" stones, to be picked up by ships bound for Europe. The first permanent white settlement was begun in April 1652 by Jan van Riebeeck who had been sent by the Dutch East India company to build a fort and establish vegetable gardens for ships bound for the East Indies. By the end of the 17th century, the town had already taken shape. The gardens and the castle which replaced the fort were surrounded by streets lined with warehouses, taverns and the houses of officials of the company. The style of living was similar to that of the Netherlands, then at the height of its prosperity, but the climate caused the Dutch architecture to be considerably modified.

As a result of the Napoleonic Wars, the British were in control of the Cape from 1795–1803, when it was returned to the Netherlands. It was, however, again annexed by the British in 1806. The emancipation of the slaves in 1833 and the opening of the Suez canal in 1869 were severe blows to the town's prosperity. However, the discovery of diamonds in 1867 and of gold in 1886 had a revitalizing influence. It became the capital of South Africa in 1910.

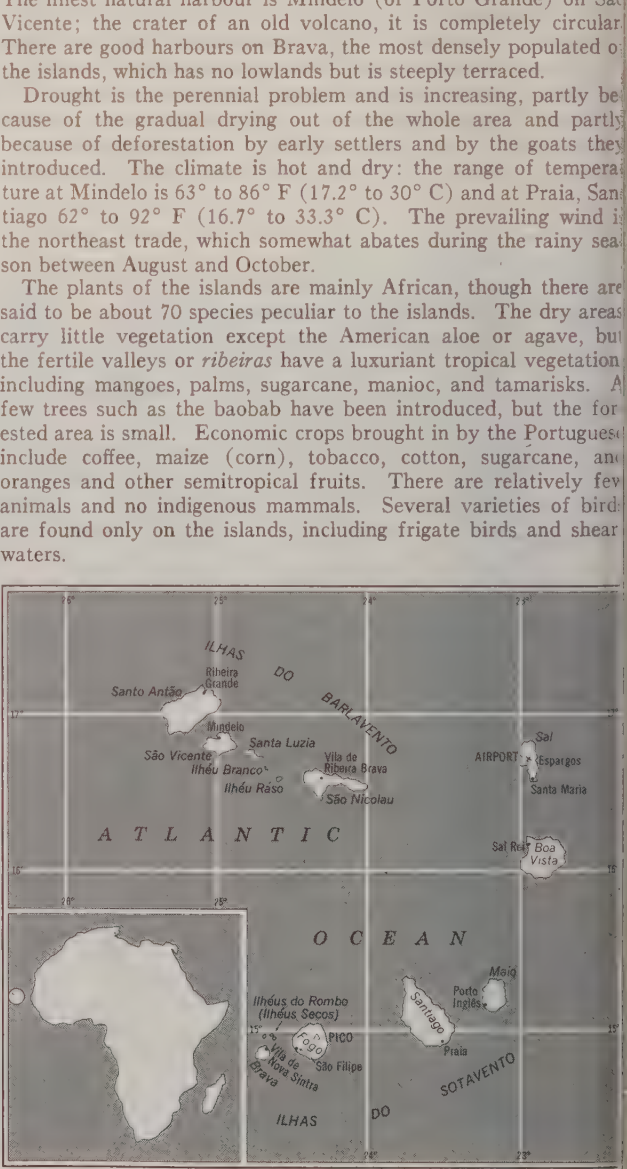
See also the *History* section of CAPE OF GOOD HOPE and SOUTH AFRICA, REPUBLIC OF; and references under "Cape Town" in the Index. (M. E. H.)

CAPE VERDE ISLANDS (ARQUIPÉLAGO DE CABO VERDE), a Portuguese overseas province, forming a crescent-shaped archipelago off the West African coast ranging from 370 to 535 mi. (595 to 861 km.) W of Cape Verde (Dakar, Senegal). There are nine inhabited and several small uninhabited islands, with a tota area of 1,557 sq.mi. (4,033 sq.km.). They fall into two groups: the Northern or Windward Islands (Ilhas do Barlavento): Boa Vista, Sal, São Nicolau, Santa Luzia, São Vicente, and Sant Antão, with the islets of Branco and Raso; and the Southern o Leeward Islands (Ilhas do Sotavento): Maio, Santiago (Sã Tiago), Fogo, Brava, and the Ilhéus do Rombo (Ilhéus Secos).

Physical Geography.—The islands are volcanic in origin an mostly mountainous and rocky. Sal, Boa Vista, and Maio, the islands nearest Africa, are flat except for a few sandy and saline hills. The highest mountain is Pico (9,281 ft. [2,829 m.]), on Fogo Island. Its volcano was frequently in eruption in the 16th and 17th centuries, but was quiescent from 1857 to 1951. Earthquakes have been recorded, the last severe eruption being in 1847 The coastlines are mostly rocky and dangerous, and Boa Vista has reefs and sandbanks, and dunes on the east coast. Santo Antão, the largest island in the northern group, has no adequate harbour The finest natural harbour is Mindelo (or Porto Grande) on Sã Vicente; the crater of an old volcano, it is completely circular. There are good harbours on Brava, the most densely populated o the islands, which has no lowlands but is steeply terraced.

Drought is the perennial problem and is increasing, partly because of the gradual drying out of the whole area and partly because of deforestation by early settlers and by the goats they introduced. The climate is hot and dry: the range of temperature at Mindelo is 63° to 86° F (17.2° to 30° C) and at Praia, Santiago 62° to 92° F (16.7° to 33.3° C). The prevailing wind i the northeast trade, which somewhat abates during the rainy season between August and October.

The plants of the islands are mainly African, though there are said to be about 70 species peculiar to the islands. The dry areas carry little vegetation except the American aloe or agave, bu the fertile valleys or *ribeiras* have a luxuriant tropical vegetation including mangoes, palms, sugarcane, manioc, and tamarisks. A few trees such as the baobab have been introduced, but the forested area is small. Economic crops brought in by the Portugues include coffee, maize (corn), tobacco, cotton, sugarcane, an oranges and other semitropical fruits. There are relatively fe animals and no indigenous mammals. Several varieties of bird are found only on the islands, including frigate birds and shearwaters.



CAPE VERDE ISLANDS OFF WEST AFRICAN COAST, SHOWING MAJOR CITIE AND SETTLED AREAS

The People.—When discovered in 1456 or 1460, the islands were uninhabited. The first Portuguese *donatários* (territorial proprietorships) brought in Africans to work their plantations, and after the discovery of America the islands became a collecting point for the slave trade. Mulatto strains predominate, and there is a Cape Verdean Creole language known as *língua crioula,* which is basically a local simplification of Portuguese.

In the late 1960s, the population reached 250,000 of whom 70% were mulattos and only a few thousand whites. The decade of the 1940s saw a significant population decline as a result of drought and emigration, but since 1949 population growth has been rapid, in spite of continuing emigration. Recent emigration has been mainly to other Portuguese territories in Africa, and to Portugal and the United States.

Because rough seas separate the islands that constitute the Cape Verde archipelago, their inhabitants developed their own dialects, customs, and individuality. Although Roman Catholicism is the official religion, a shortage of priests has meant the survival of largely animist customs. The islands have a native song and dance called the *morna,* best described as "a Negro spiritual without the religion."

The area and population of the principal islands are shown in the table (*see* below.)

History.—The date of the islands' discovery has been much disputed; it is possible that they were visited in 1456 by the Venetian captain Alvise Ca D'a Mosto (*q.v.*). In 1460, however, it is certain that Diogo Gomes (*q.v.*) and António da Nola sighted and named Maio and São Tiago (Santiago). The archipelago was granted by Afonso V (*q.v.*) of Portugal to his brother, Prince Ferdinand, and in 1466 its inhabitants received the monopoly of the Guinea slave traffic. In 1470 the archipelago reverted to Prince Manuel, by whose accession to the throne in 1495 it finally became part of the royal dominions.

Its importance and wealth grew with the development of the slave trade. Slaves were brought in to cultivate the land. Portuguese settlers increased. In 1532 the first bishop was consecrated and in 1595 the first governor-general was appointed. The wealth of Ribeira Grande, the former capital, caused it to be attacked twice (1585 and 1592) by Sir Francis Drake (*q.v.*), unsuccessfully by the Dutch, and finally by the French in 1712, which led to its abandonment. With the decay of the slave trade (finally abolished in 1876) and the increase in drought, the history of the islands became one of recurrent drought and famine, a situation made worse by corruption and maladministration.

The end of the 19th century saw some improvement; the islands' position on the great trade routes between Europe and South America and South Africa led to the opening, first of a coaling station at Mindelo and later of a submarine cable station (1875). Also, the islanders began to emigrate to the United States, particularly from Brava. The money they sent home played a large part in the islands' economy. After World War I, however, reduction in shipping and the introduction of a quota policy for immigration into the United States caused a further decline in prosperity, somewhat arrested by loans from the Portuguese government for relief and development.

Administration and Social Conditions.—The islands form a single overseas province of Portugal, administered by a governor assisted by a Government Council and a partially elected Legislative Council. The capital is at Praia on Santiago. The chief town in the northern group is the port of Mindelo on São Vicente. The islands are divided for administrative purposes into 12 *concelhos* (districts) and 31 *freguesias* (parishes). Juridically, they depend upon the Appeals Court of Lisbon. The islands form a diocese under the jurisdiction of Lisbon.

Area and Population of Principal Islands

Island	Area* (sq. mi.)	Population (1960 census)	Chief town
Boa Vista	239	3,309	Sal Rei
Brava	25	8,646	Vila da Nova Sintra
Fogo	184	25,457	São Filipe
Maio	104	2,718	Porto Inglês
Sal	83	2,626	Santa Maria
Santa Luzia	13	uninhabited	—
Santo Antão	301	34,598	Ribeira Grande
São Nicolau	132	13,894	Vila da Ribeira Brava
Santiago	383	88,940	Praia
São Vicente	88	21,361	Mindelo

*1 sq. mi. = 2.59 sq.km.

Several nationalist movements exist which intend to remove Portuguese control. These have headquarters in Guinea, Senegal, and the United States, but no local activities have begun. The most successful group, the African Party for the Independence of Guinea and Cape Verde (PAIGC), is led by a Cape Verdean agronomist, Amilcar Cabral, and includes Cape Verde in its frame of reference.

In culture, social life, local administration, and the tax system, the Cape Verdes resemble mainland Portugal. In the mid-1960s, primary school enrollment exceeded 31,000 and secondary enrollment 2,000. The literacy rate of 25% is highest of all Portuguese African territories.

The Economy.—Agriculture, mainly subsistence, forms the livelihood of more than 80% of the islanders. The Cape Verde Islands are constantly threatened by the scarcity of water, though in the rainy years the land shows high productivity. After 1948 a start was made in water research and irrigation, but erosion remains a major problem. The forested area of the archipelago comprises only 2 to 3% of the total area, but reforestation has begun, partly to increase the water supply. The main crops are bananas, coffee (*arabica*), grown at an elevation of 1,000 to 4,000 ft. (305 to 1,220 m.), maize (corn), the basic food crop of most of the inhabitants, and *purgueira* or physic nut, sugarcane, castor beans, broad beans, potatoes, and peanuts. Some islands are particularly suitable for fruit growing, especially for tropical and Mediterranean varieties, but lack of transport prevents their commercial development. There are a few small factories that produce canned and otherwise preserved fish, sugar, biscuits and other foodstuffs, hats, shoes, cotton goods, soaps, dyestuffs, and cigarettes. Salt is an important product in Sal, Maio, and Boa Vista. Pozzolana (a volcanic rock used in preparing hydraulic cement) is mined in the islands and is an important export. In addition to the normal trade of imports for local consumption and the exports of goods locally produced, there is a considerable import of liquid fuels to be supplied to ships. Canned tuna fish, other fish, bananas, salt, peanuts, pozzolana, water supplied to ships, coffee beans, hides, potatoes, and *purgueira* are the chief exports.

Communications are poor. In the mid-1960s there were about 870 mi. (1,400 km.) of roads, a third of which were on Santiago. Espargos, on Sal, the most important airport in the archipelago, provides a control base for the neighbouring Atlantic region. Mindelo, in spite of the competition from Las Palmas of the Canary Islands and Dakar, is frequently visited by large ships because of its excellent position in the Atlantic. Improvements are being carried out on the harbours. Telegraphic communications are by submarine cables and radiotelegraph stations.

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(A. A. G. P.; M. A. SA.)

CAPGRAVE, JOHN (1393–1464), English chronicler, theologian and hagiologist, whose life of St. Katharine deserves more praise than it has received, was born at Lynn, in Norfolk, on April 21, 1393. He became a priest, took the degree of D.D. at Oxford, where he lectured on theology, and subsequently joined the order of Augustinian hermits. Most of his life he spent in the house of the order at Lynn, of which he probably became prior; he was certainly provincial of his order in England, which involved visits to other friaries, and he made at least one journey to Rome, the wonders of which are described in *The Solace of Pilgrims* (ed. by C. Mills, 1911). He died on Aug. 12, 1464.

Capgrave was an industrious writer, though his works seem to have been mainly compilations from other authors or free translations. The majority are theological works in Latin—biblical commentaries, lectures, sermons, treatises and lives of saints, mostly lost. He also wrote a history in honour of Henry VI, of little historical value. In English he wrote a *Chronicle of England* (from the creation to 1417, cut short by his death) of which the latter part has some independent value; the *Lives* of St. Augustine and of St. Gilbert of Sempringham in prose; an unprinted life of St. Norbert and the life of St. Katharine, both in rhyme royal. This last work is didactic but with some dramatic energy of debate, and in vigorous verse. Much of Capgrave's work was produced for patrons, from kings and Humphrey, duke of Gloucester, to abbots and ordinary gentlewomen, and illustrates the literary tastes and circumstances of the time.

The huge Latin collection of the lives of English saints, the *Nova Legenda Angliae* (printed 1516 and 1527; ed. C. Horstman, 1901), attributed to him in the 16th century, was at most rearranged by him at one stage of its development.

Bibliography.—F. C. Hingeston edited the *Chronicle* and the *Liber de Illustribus Henricis* for the "Rolls Series" (1858) and published an English translation of the latter. *The Life of St. Katharine* was published by the Early English Text Society in 1893 and *The Lives of St. Augustine and St. Gilbert* in 1910. (D. S. B.)

CAP-HAÏTIEN (locally Le Cap), called Cap Français when Haiti (*q.v.*) was a French colony and the town gained renown as the "Paris of the Islands," is the capital of Nord *département*. Pop. (1950) 24,423. United States ships used its excellent harbour during the dispute with France (1798–1800) and during the American Civil War.

Haitian and French troops razed it in 1802. Henri Christophe rebuilt much of it, but an earthquake in 1842 and a hurricane in 1928 destroyed many historic buildings. The modernization of its harbour enabled it to handle about 11% of Haiti's imports and exports.

It is the trade centre for the Plaine du Nord (mainly bananas, pineapples, coffee, sugarcane, cacao). Many tourists use the adjacent airport and the paved road from Port-au-Prince for excursions from Le Cap to the palace of Sans-Souci and the fortress La Citadelle. Cap-Haïtien is the most picturesque city in Haiti.

(R. W. Ln.)

CAPHARNAUM: *see* Capernaum.

CAPILLARY ACTION: *see* Circulation of Blood; Plants and Plant Science; Surface Tension.

CAPILLARY TUBE, a tube of small dimensions in which the effects of surface tension (*q.v.*) in liquids become conspicuous and may be approximately measured. When a small-bore glass tube is inserted in a vessel of water which wets the glass, the surface tension of the water film adhering to the glass on the inside of the tube draws water up in the tube above the level of the surrounding liquid outside.

If the liquid is mercury, which does not wet but has a tendency to draw away from a glass surface, the mercury is depressed within the tube a very definite distance below the level at which it stands in the outside vessel. Various porous solids whose structure consists of small-bore tubes show these phenomena in varying degrees. In anatomy, the capillaries are the most minute blood vessels.

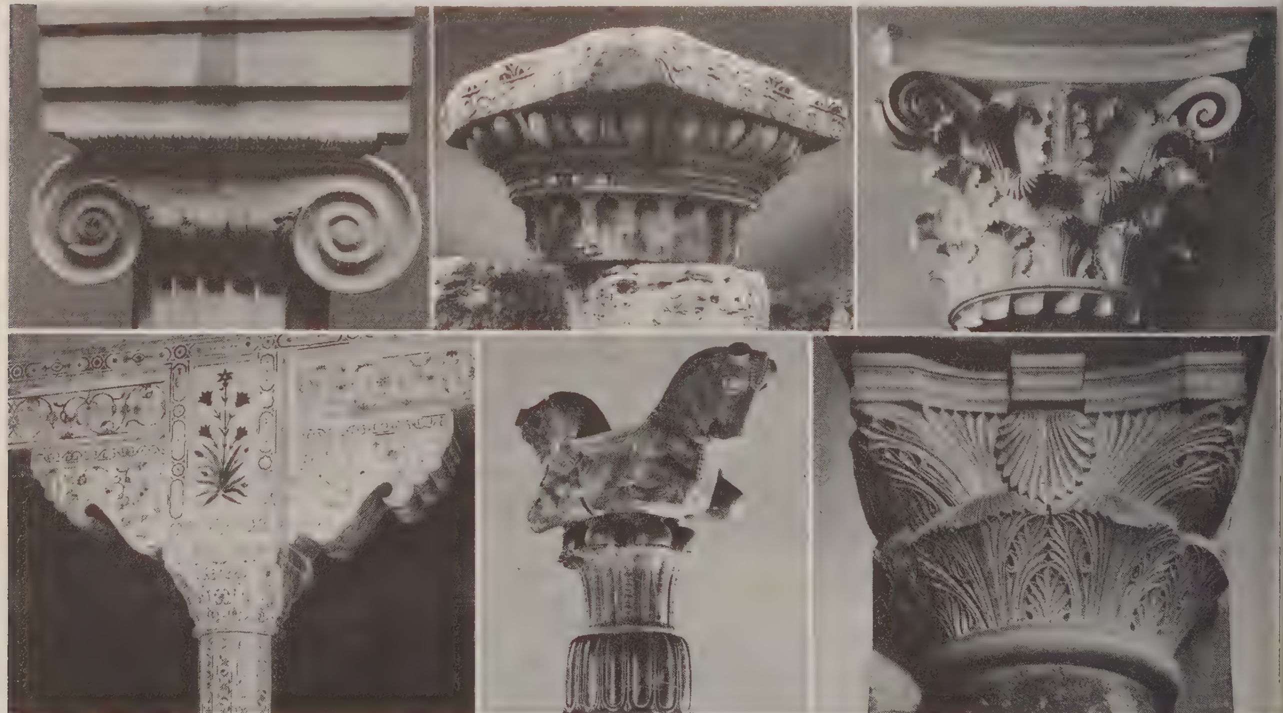
See Circulation of Blood: *The Blood Vessels.*

(H. B. Lm.)

CAPITAL, in architecture, is the crowning member of a column, pier, anta, pilaster or other columnar form. It marks the top of the vertical rise of the shaft and provides a transition to the horizontal or arched members above. Usually wider at the top than the bottom, it provides better bearing for the superstructure as well as a visual accent. In the classical styles the capital is the part that most readily distinguished the order.

In simple form a capital may be no more than a wooden block placed on the top of a post. Square in plan, this form is called an abacus (*q.v.*) and is an important part of many capitals. An oblong block or billet, placed with its greatest dimension parallel to the beam above, is another simple form. Shaping the ends of such a block has produced laterally spreading forms of capital. These primary shapes have been elaborated by multiplication of parts, addition of moldings (*q.v.*), and the use of ornament of floral, zoomorphic or other inspiration.

In many early buildings in which the plans indicate that columns were used, the employment of capitals can only be surmised. Sec-



BY COURTESY OF (TOP LEFT) THE TRUSTEES OF THE BRITISH MUSEUM, (BOTTOM LEFT) INFORMATION SERVICE OF INDIA, (BOTTOM CENTRE) THE ORIENTAL INSTITUTE; PHOTOGRAPHS, (TOP CENTRE FOTOTECA UNIONE ROMA, (TOP RIGHT) ÉCOLE FRANÇAISE D'ATHENES, (BOTTOM RIGHT) THAMES AND HUDSON, LONDON

REPRESENTATIVE CAPITALS

(Top row) Greek Ionic (restored), Temple of Artemis, Ephesus, Greece, 4th century B.C.; Roman Doric, Arch of Augustus, Roman Forum, originating in the 6t century B.C.; Greek Corinthian, Temple of Athena Alea, Tegea, Greece, 4th century B.C.; (bottom row) Indian Saracenic, Agra Fort, India, 17th century; Persia double bulls (restored), Persepolis, Iran, early 5th century B.C.; Italian Romanesque, Cathedral of Santa Maria, Nardo, Italy, 13th century ondary evidence derived from representations on small objects and persistent traditions in vernacular architecture, however, is sufficient to indicate their use at an early date in Egypt and Mesopotamia. Primitive abacus capitals were known in both places. Small huts shown in reliefs from Ur, from the third millennium B.C., show decorated imposts and it is likely that similar ornaments were used on columns, the bases and shafts of which have been found. Two kinds of stone capital have been found in the stepped-pyramid complex at Sakkara (*c.* 2780–2680 B.C.); both apparently followed prototypes in perishable material. One was a saddlelike shape suggesting bent reeds or leaves; the other an upturned bell derived from the papyrus plant. Later Egyptian architecture used capitals derived from other plant forms such as the palm and lotus, as well as simple abacus capitals. Anthropomorphic and aedicular designs also appeared on Egyptian capitals. In Mesopotamia there is evidence of the use of capitals with paired volutes or spirals. Capitals with volutes rising vertically from the centre appear on a stele of Nabupaliddina, 870 B.C., and in a relief from Khorsabad, *c.* 742–705 B.C. Volute capitals seem to have been known in Hittite architecture in Anatolia. In Achaemenid Persia very elaborate capitals combining multiple volutes, plant forms and zoomorphic elements were created. Minoan civilization in Crete used principally capitals composed of an abacus above a bulbous ring, suggesting the Greek Doric. Others had rectangular boxlike forms with decorated faces.

The Greeks in their systematic development of columnar architecture created some of the best known forms. The Doric capital consisted of a square abacus surmounting a round form with an egg-shaped profile, called the echinus; it was usually related to the shaft below by several narrow ridgelike moldings. The Ionic, probably related to the volute capitals of western Asia, had a pair of horizontally connected volutes inserted between the abacus and echinus. The Corinthian was basically an abacus supported on an inverted bell surrounded by rows of stylized acanthus leaves. Roman capitals were generally similar to the Greek. In addition to standardizing Greek forms, the Romans added the Tuscan, a modified form of the Doric, and they created the Composite by combining Ionic volutes with the Corinthian bell shape. More elaborate Roman capitals sometimes included representational elements with the conventionalized foliage.

Islamic capitals for the most part followed late classical and Persian types. The nonrepresentational bias of Muslim art encouraged development of abstract forms derived from repetition of small moldings and multiplication of miniature squinches. In India, China and Japan some form of bracketed capital was used most frequently. Bell shapes, either upright or inverted, often decorated with lotus motifs, were employed, especially in India. A combination of these types with additional ornamental features characterized the most elaborate Indian capitals.

Capital design in medieval Europe generally stemmed from Roman sources. More massive forms were used as they more frequently carried arched rather than trabeated construction. Byzantine capitals in general had less relief and showed a tendency toward closed or basketlike form. The simplest transition from round base to square top produced cubiform or cushion capitals, sometimes with scalloped faces. This type was used in the Romanesque period along with others derived from simplified treatment of the Roman Corinthian. Grotesque animals, birds and other figurative elements were added. Historiated capitals with religious themes were frequent, especially in French Romanesque. At the beginning of the Gothic period exotic features tended to disappear in favour of simple stylized foliage and crockets. Greater naturalism marked 13th-century capitals, particularly in France. A combination of geometric moldings was characteristic of English Gothic. In the later middle ages the importance of the capital tended to decrease because of a reduction in scale and emphasis.

Classical forms were revived in the Renaissance. While variation in detail appeared in the early Renaissance, the High Renaissance achieved a standard of correctness close to the best examples of antiquity. The baroque saw some further efforts toward variety, but in general the ancient model was followed, with a preference for the Corinthian. Attempts to invent new orders during the Renaissance and the succeeding classic revival met with little success.

The revival styles of the 19th century encouraged the use of many older forms of capital with varying degrees of archaeological correctness. Near the close of this period new techniques of construction in steel and reinforced concrete were developed. The framed nature of this construction differed radically from the bearing relationship of the past and made visible capitals redundant. The feeling that capitals were structurally false led to a conscious effort to avoid their use in much 20th-century design. In some designs in reinforced concrete, however, the top of the column is spread to provide better integration with the floor slab, producing a mushroom column in which the funnellike shape has both the appearance of a capital and real structural purpose.

See GREEK ARCHITECTURE; INDIAN ARCHITECTURE; ORDER; ROMAN ARCHITECTURE; *see* also references under "Capital" in the Index.

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CAPITAL, EXPORT OF. An export of capital is a transfer of funds from one country to another. It need not entail a physical transfer of currency or of capital goods. What is transferred is command over purchasing power, which residents of the capital-exporting country put at the disposal of residents of the capital-importing country. The funds may be provided by private individuals, companies, banks, governments, or international organizations and may be put at the disposal of any of these. The motives for such movements include: provision of temporary credit to finance international trade; speculation (*i.e.,* the purchase or sale of a currency in anticipation of a rise or fall in its price); the earning of interest or dividends in excess of those which can be earned at home; support or influence of a foreign country or government; and the like. An important gain for the capital-importing country is often command over goods or services not otherwise available to it.

Various attempts have been made to categorize capital movements. They have been divided, for example, into stabilizing and destabilizing, depending upon whether they tend to restore or move away from equilibrium in a country's balance of payments; autonomous or induced, depending upon whether they initiate or follow changes in other items in a country's balance of payments; and normal or abnormal, depending upon whether they run from a capital-rich to a capital-poor country, or vice versa. The most usual division, however, is between short- and long-term movements.

Short-term capital movements are those embodied in credit instruments maturing in less than one year. The most significant of these instruments prior to 1914 was the sterling bill of exchange, used to finance international trade. After the 1920s, the bulk of short-term capital movements occurred through changes in bank deposits, often effected through cabled orders. The 1960s saw the growth of a new credit instrument, the Euro-dollar balance, which represents dollar deposits in European banks. Long-term capital movements are those embodied in credit instruments without maturity, or which mature in a period longer than one year, and normally include newly issued foreign bonds, existing securities, government loans, and direct investment, where ownership of equity securities in a foreign corporation carries with it control of the company.

An important factor in recent decades has been government export of capital, which takes place through specially created institutions such as the Export-Import Bank of Washington or the Development Loan Fund of the Agency for International Development, through the payment of reparations, and through transfers of foreign aid for reconstruction or for economic development. A number of intergovernmental institutions were established after

World War II, including the International Monetary Fund (*q.v.*), which makes credits of three to five years available to countries suffering from payments imbalances; the International Bank for Reconstruction and Development (*see* BANK FOR RECONSTRUCTION AND DEVELOPMENT, INTERNATIONAL), the Inter-American Development Bank, the Asian Bank and the African Development Bank, which made capital available for economic development; and the United Nations Special Fund for Development. After 1960 the leading financial countries established a series of ad hoc arrangements for supporting each other's currencies when they were under speculative attack. Sometimes referred to as the Basel Agreement, after the first such arrangements worked out at the Bank for International Settlements in Basel, Switz., in March 1961 to defend the pound sterling, they were also dubbed the "swap network," since they involved credit swaps between central banks.

Private short-term capital movements are generally associated with the finance of merchandise trade. Official short-term capital movements, on the other hand, usually result from disequilibria in national balances of payments. Private long-term capital movements are motivated by the chance of higher earnings abroad, and are also a means of avoiding trade restrictions by manufacturing in foreign facilities. Governmental and intergovernmental capital movements of a long-term nature have been associated with war reparations, with reconstruction and economic development, and especially with the attempt to replace the private international capital market, which, after the 1929 collapse of foreign lending, was unable to discharge its useful function of transferring capital from rich countries with excess savings to poor countries with investment opportunities.

History of Capital Movements.—In the 19th century London was the world's leading capital market. From 1820 to 1848 there was a substantial flow of long-term capital from London to continental Europe. The bulk of this took the form of long-term lending through foreign bonds issued in London, but there was some movement of business capital associated with the transmission to Europe of the technology developed in Britain in the Industrial Revolution, especially in railroad and locomotive construction and in iron and steel. After the revolutions of 1848 British interest in lending to Europe declined, and substantial capital flows took place to the dominions, the colonies, and the United States. The risks of capital export to the colonies were reduced by British government guarantees, which brought the return on loans down to the level of domestic issues. The flow of capital abroad alternated in the business cycle with investment at home. In the view of some observers, the capital outflow was so large as to handicap industrial development in Britain, diverting abroad capital which could have been put to effective use at home. Another interpretation holds that foreign lending through bonds that qualified as safe trustee investments was not really competitive with the need for equity capital in new, risky industries in Britain.

The Continent continued to rely on foreign lending even after British capital exports had been diverted to the Empire and the United States. In France the *banque d'affaires* was developed by the Pereire brothers after 1851, and undertook industrial lending in Germany, Austria, Spain, and Italy. After the successful flotation of the French *rentes* needed to pay the Franco-German War indemnity of 5,000,000,000 fr. in 1871, investment bankers engaged in a wave of new issues. Savings drawn from peasant holdings were pumped into loans to Russia and the Balkan governments, which defaulted on them in World War I.

The dominant short-term instrument for capital export was the sterling bill of exchange that financed much of the world's trade. Capital movements through this instrument responded to changes in the Bank of England's rediscount rate. A reduction of the rate made it more profitable to finance trade through London, hence encouraging a capital outflow. An increase in the rate induced foreigners drawing bills on London to hold them to maturity rather than to discount them in London and remit the proceeds, thus reducing the outflow of capital through sterling bills and encouraging an inflow. So sensitive became the response of short-term capital to interest-rate changes that the Bank of England was able to adjust its international payments through short-term capital movements, with only limited gold flows.

The 5,000,000,000-fr. indemnity exacted by Prussia from France in 1871 was initially transferred through offsetting gross capital flows. French capitalists sold their holdings of foreign securities to buy the new franc *rentes,* and the French government thus obtained the foreign exchange needed, along with certain amounts of gold, to pay the German government. A subsequent export surplus enabling French lenders to reconstitute their portfolios of foreign securities constituted the net real transfer. The success of the payment later induced the French to insist on German reparations payments after World War I.

The Interwar Period.—World War I depleted the strength of the British economy and built up that of the United States, which assisted its Allies during and immediately after the war by substantial transfers of real resources that gave rise to inter-Allied war debts. While the United States renounced any claim on Germany for reparations, France and Britain counted on the receipt of reparations from Germany to enable them to pay their debts to the United States. French occupation of the Ruhr in 1923, in an effort to collect what had been agreed to at Versailles, led to German hyperinflation, the collapse of German government finance, and a new settlement under a commission presided over by Charles G. Dawes. The settlement provided for a new loan to Germany to be issued in New York in 1924 and the resumption of reparation payments on a reduced scale. The success of the Dawes loan encouraged issuance of foreign bonds in the New York market, especially for German and Latin-American account. Tighter interest rates after the middle of 1928, when the rising New York stock market absorbed large amounts of call money, brought the movement to a halt. German borrowers shifted from bonds to bank loans for a time, but in 1930 their difficulties in continuing to borrow through short-term credits led to a new attempt to reorder reparation payments through the Young Plan. The Bank for International Settlements was established to effect transfers of reparations. In 1931, however, a moratorium was declared on payments of reparations and war debts. The moratorium was planned to last a year, but payments were never resumed. Short-term bank loans to central Europe were frozen in so-called Standstill Agreements, and written off during the depression.

The international bond market failed to revive during the 1930s. Many governments defaulted because the fall of commodity prices and the low level of trade made it impossible to maintain debt service. In retrospect, it was clear that the New York investment community had floated many bond issues of dubious quality. Large-scale movements of liquid funds took place from country to country in search of safety regardless of discount rates. So-called "hot-money" movements from Europe to the United States took place despite the imposition of exchange controls in central Europe; these became acute in the spring of 1937 when there was fear that the United States might lower the price of gold (raised in 1934 from $20.67 an ounce to $35 an ounce), and they reached flood proportions during the Munich crisis in 1938 and after the Stalin-Hitler pact in 1939. In the absence of adequate private funds, a number of countries established official bodies to help finance trade. These included the Export Credit Guarantees Department in Britain and the Export-Import Bank of the United States (*q.v.*). Private capital movements did not cease entirely. Two-way private movements took place in direct investment, as some firms sold off foreign subsidiaries and repatriated the proceeds while others continued to establish foreign affiliates to take advantage of particular opportunities. On the whole, however, the export of capital dried up or was blocked off, and often it was perverse, *i.e.*, from poorer to richer countries, in search of safety and to escape taxation or confiscation.

Postwar Planning.—During World War II it was recognized that the postwar world would require substantial movements of capital, initially for reconstruction and ultimately for economic development. Despairing of a revival of an adequate private capital market, governments contemplated keeping foreign-exchange controls to limit private flows together with the establishment of

TABLE I.—*Selected Items from the United States Balance of Payments*
(annual averages, $000,000)

Item	1919–21	1922–29	1930–33	1934–40	1941–45	1946–49	1950–54	1955–59	1960–64	1965–67
Balance on goods and services and private remittances	2,865	733	319	565	7,394	4,288	1,405	2,096	4,977	4,509
Government unilateral transfers and capital	−928	28	14	−28	−8,445	−3,631	−2,564	−2,344	−3,141	−3,688
Short-term capital inflow (outflow [−])										
U.S. Private	*	−150	177	151	−15	−61	−143	−274	−1,276	−303
Long-term capital inflow (outflow [−])										
U.S. direct investment	−120	−283	−128	14	27	−337	− 677	−1,356	−1,867	−3,329
U.S. other private	−317	−586	117	125	−108	−10	−256	−815	−1,353	−868
Foreign Investment in U.S.	−166	242	58	152	−81	−71	233	476	693	1,956
Short-term capital inflow (outflow [−])										
Foreign	*	211	−670	627	740	30	1,077	1,465	1,634	1,475
Gold sales (purchases [−])	−167	−78	−25	−2,134	392	−640	609	279	955	614

*Figures not available.
Source: Calculated from Office of Business Economics, U.S. Department of Commerce, "Balance of Payments of the United States, 1919–1953," *Survey of Current Business* (July 1954) and subsequent annual estimates.

several new intergovernmental bodies to achieve the desired movements.

At Bretton Woods, N.H., in 1944, a preparatory commission laid the basis for the International Bank for Reconstruction and Development to make long-term capital available, and the International Monetary Fund to finance short-term imbalances in international payments. These two institutions were preceded by the United Nations Relief and Rehabilitation Administration (UNRRA). The cancellation of United States wartime assistance under lend-lease agreements was offset to a degree by the sale of surplus military property abroad on low-interest 28-year loans, and by military relief furnished to liberated territories and to enemy countries. The capital of the Export-Import Bank was also increased by $3,000,000,000 in 1945 to make intergovernmental loans for reconstruction.

The resources provided in these various ways proved insufficient. The United States made a substantial loan to Britain under the $3,750,000,000 Anglo-American Financial Agreement of 1946. The theory was that if Britain could be helped to recovery she would assist other countries in the Commonwealth and elsewhere with their problems. This became known as the "key-currency" doctrine, under which help was provided first to countries that played a strategic role in world trade and payments. A condition of the British loan was that the United Kingdom make sterling convertible within a year. This was done, but the conversion of foreign holdings of sterling, and the outward movement of British capital, especially to the dominions, drew down British reserves rapidly. After six weeks convertibility was given up and the key-currency doctrine temporarily abandoned. For a while a piecemeal approach to European problems was undertaken. Finally the Marshall Plan brought a substantial transfer of assistance, largely through grant rather than government loans (*see* EUROPEAN UNITY).

Various attempts were made to restore private capital movements. The Marshall Plan, or European Recovery Program, provided for government guarantees of private investment. Later, under the development assistance programs of the Economic Cooperation Administration, the Mutual Security Program, and the Agency for International Development, the Eisenhower administration sought to shift some of the burden of economic development to private enterprise by exhortation and to a limited extent by government guarantees.

Direct investment by business enterprises was substantial immediately after the war, initially largely in petroleum products and subsequently in iron ore. In oil, investment took place not only in petroleum production in the Middle East, Venezuela, Canada, Libya, Nigeria, Australia, and other countries, but also in the refining and distribution facilities, largely in Europe, necessary to convert crude oil into consumer products.

The Resurgence of Private Capital Movements.—The private long-term capital market that collapsed in the early 1930s had not been altogether wiped out. Canadian bonds sold in substantial amounts to institutional investors in the United States, since they were not thought of as foreign. But it proved impossible up to 1958 to float new issues for many other countries, with the special exception of Israel. Beginning in the 1950s, however, private investment began gradually to take an interest in Europe.

Investment in Europe began largely as direct investment by business firms attracted by a rapid growth in European incomes after the conclusion of the Marshall Plan in 1952. To some extent these investment opportunities were attributable to the integration of the European economy under the European Coal and Steel Community (1950) and the European Economic Community (the so-called Common Market, established under the Rome Treaty of 1957). Part of the inducement to direct investment was that firms outside the Common Market (France, the German Federal Republic, Italy, Belgium, the Netherlands, Luxembourg) were placed at a disadvantage as against those located inside. However, direct investment also took place in the "Outer Seven" of the European Free Trade Association (Austria, Denmark, Norway, Portugal, Sweden, Switzerland, and the United Kingdom), indicating that perhaps the opportunities were there anyway and had not been explored because United States firms were concentrating on postwar investment needs at home. In some industries, such as chemicals, the timing of U.S. direct investment in Europe could be linked to the 1954 recession, which prompted the realization that the major need for capital at home had been satisfied and that there were brilliant opportunities for investment in Europe.

A divide in the postwar recovery of Europe was marked in 1958, when the French franc was devalued and the pound sterling was made convertible. Led by the new Common Market institutions, such as the European Investment Bank, European borrowers turned to the New York bond market to sell long-term bonds for the first time in nearly 30 years. While the annual average of direct investment by United States firms doubled from 1950–54 to 1955–59, as shown in Table I, other private long-term lending, largely in bonds, went from $256,000,000 annually to more than three times that amount. By 1960–64 the annual average in this category amounted to $1,353,000,000. Foreign investment in the

TABLE II.—*International Investment Position of the United States in Selected Years, 1914-67*
(in $000,000,000)

Item	1914	1919	1930	1939	1946	1955	1967
United States investments abroad	3.5	7.0	17.2	11.4	18.7	44.9	122.3
Private	3.5	7.0	17.2	11.4	13.5	29.0	93.3
Long-term	3.5	6.5	15.2	10.8	12.3	26.7	81.4
Direct	2.6	3.9	8.0	7.0	7.2	19.3	59.3
Portfolio	.9	2.6	7.2	3.8	5.1	7.4	22.1
Short-term	*	.5	2.0	.6	1.3	2.4	11.8
United States government	—	—	—	—	5.2	15.9	29.0
Long-term	—	—	—	—	5.0	15.2	23.5
Short-term	—	—	—	—	.2	.7	4.4
Foreign investment in the United States	7.2	4.0	8.4	9.6	15.9	29.6	69.6
Long-term	6.7	3.2	5.7	6.3	7.0	12.6	32.0
Direct	1.3	.9	1.4	2.0	2.5	4.3	9.9
Portfolio	5.4	2.3	4.3	4.3	4.5	8.3	22.1
Short-term assets	.5	.8	2.7	3.3	8.9	17.0	37.7
United States net creditor position	−3.7	3.0	8.8	1.8	2.8	15.3	52.7
Net long-term	−3.2	3.3	9.5	4.5	10.3	29.3	72.9
Net short-term	− .5	− .3	− .7	−2.7	−7.4	−13.9	− 21.5

*Figures not available.
Note: Data for various years not wholly comparable.
Source: *Survey of Current Business*, p. 15 (Aug. 1956), and subsequent annual estimates.

United States also expanded, and accumulation of dollar balances took place on both private and official account. By 1959 the balance of payments of the United States was substantially in deficit as measured by gold losses and inflows of foreign short-term capital. Net claims of the United States on the rest of the world continued to rise, however, as shown in Table II. It is particularly interesting to see that, within the rise in total net United States assets, long-term net claims rose but short-term net obligations rose as well, though to a lesser extent.

There is considerable debate over the extent to which the gold losses and foreign accumulation of short-term balances represented a serious disequilibrium in the U.S. balance of payments because of "excessive foreign lending" and the failure to develop an export surplus in goods and services to match the net capital outflow on long-term account. Another explanation is that the situation resulted from the interplay of national capital markets with different degrees of monopoly and with different liquidity preferences, and hence different attitudes toward long-term lending. As emphasized in separate studies of European capital markets by the European Economic Community and the Organization for Economic Cooperation and Development, European capital markets are fragmented by habit and regulation; those markets with low interest rates, namely Switzerland and the Netherlands, limit both the numbers of foreign borrowers and the amounts that can be obtained in individual loans, while in other markets, notably the German, French, and Italian, long-term interest rates are high and short-term rates low because of the aversion of savers to long-term debt instruments and the desire by borrowers to be funded over extended periods. This gave long-term borrowers an incentive to turn to the New York market. If European savers had been interested in holding dollar balances, they could have offset the long-term lending of the U.S. As it happened, European savers preferred to hold domestic balances, so that the long-term dollar balances borrowed by their countrymen ended in the hands of banks and central banks, where they counted as surplus in European accounts and deficits in the accounts of the U.S.

The Euro-Dollar and Euro-Bond Markets.—Some of these balances were held not directly in the United States but through the Euro-dollar market. This institution grew up in the late 1950s and early 1960s more or less by accident. Regulation Q of the Federal Reserve System, limiting the amount of interest that could be paid on time deposits in the United States, did not apply to foreign deposits, so that London banks offered to accept dollar deposits and relend them to New York at rates slightly above the New York limits. In addition, certain holders such as the Soviet foreign trading organizations preferred to hold their dollar balances in London free from intervention by the United States authorities. With the passage of time a substantial market grew up in Euro-dollars and European currencies held outside the jurisdiction of the country using the currency.

In 1963 United States authorities, concerned by what they regarded as excessive lending through the New York bond market, imposed an interest-equalization tax, equivalent to about a 1% increase in interest on a 15-year bond, in an effort to halt the selling of foreign dollar bonds in New York. The tax was not passed until 1964 but took effect retroactively to July 1963. The legislation provided for an amendment applying the tax to long-term bank lending if European borrowers shifted from bonds to bank loans, as they appeared to be doing while the legislation was under consideration. The amendment was applied in December 1964. In February 1965 Pres. Lyndon B. Johnson instituted a voluntary credit-restraint program, applied to 400 corporations and extended to an additional 500 corporations the following November. On Jan. 1, 1968, the voluntary program was replaced by a mandatory credit-restraint program, based on an executive order under the 1917 Trading with the Enemy Act, which set limits on funds that could be invested abroad, depending upon the area. Canada was exempted from the interest-equalization tax, along with the less-developed countries, and Japan received an exemption for amounts up to $100,000,000 annually.

United States corporations were not forbidden to invest abroad, but merely to export capital from the United States. Under the mandatory program, moreover, they were required to repatriate specified percentages of profits earned abroad, depending upon the part of the world they were earned in. Companies were free, however, to borrow abroad for the purpose of investing there. This opening led to the rapid development of Euro-dollar bonds, sold in Europe for dollars by United States companies for the purpose of raising funds for foreign investment. Investors in the United States could purchase these securities only on payment of the interest-equalization tax. Many of these bonds were debentures convertible under certain circumstances into the equity shares of the issuing company. Of course, to the extent that foreign investors sold existing holdings of United States securities in order to buy the Euro-dollar convertible debentures or Euro-dollar bonds, there was an outflow of capital from the United States. Thus, so long as the capital markets of the United States and Europe were joined by unregulated trade in United States securities owned in Europe, it would be difficult, if not impossible, to control the outflow of capital from the United States. The substantial expansion in direct investment recorded in Tables I and II, however, took place before the application of the mandatory restraint program of Jan. 1, 1968.

Speculative Capital Movements.—The 1930s had been dominated by speculative movements of short-term funds seeking to anticipate changes in exchange rates. In the post-World War II period such movements occurred largely in relation to the pound sterling, the German mark, and the French franc. The convertibility of the pound in 1958 was limited to current-account transactions in the balance of payments, *i.e.*, to transactions in goods and services, and to foreign holders. Domestic holders of sterling, however, found it possible to speculate against the pound sterling through the "leads and lags"; *i.e.*, by speeding up payments for imports and delaying receipts of payments for exports when it was thought that the pound might be devalued. In March 1961, when the German mark and the Dutch guilder were revalued upward by 5%, many private holders of sterling and dollars thought this might prove to be the first of two or more revaluations of the currency, and a large speculative movement occurred into Deutsche Marks. It was offset by German official purchases of sterling and dollars under the Basel Agreement of March 1961; the credits being later funded by the International Monetary Fund. This operation inaugurated the "swap network" developed to counter private speculation.

The swap network was subsequently used to defend the Canadian dollar in June 1962, the Italian lira in February 1964, and the British pound on several occasions prior and subsequent to the devaluation of November 1967. Following that devaluation (from $2.80 to $2.40), serious speculation took place out of dollars into gold. It was finally halted by action of the central banks in refusing to sell gold to the private market, while trading among gold themselves at $35 an ounce. Subsequent to that decision, in which French authorities did not join, student and worker demonstrations in May–June 1968 in France led to speculation against the French franc (into Swiss francs and gold), and the swap arrangements were again invoked to defend a major currency.

National Reactions to Direct Investment.—While direct investment by business enterprises was considered to have certain advantages over long-term lending through bonds, the 1960s saw a rise of sentiment against it in a number of countries, notably France, Germany, Canada, and Australia. There was the fear that foreign corporations, mainly those of the United States, were becoming too powerful in the host countries. Some feared that enterprises run by United States citizens abroad might be required to follow United States policies in a variety of fields such as trade controls on shipments to mainland China and Cuba or antitrust laws and balance-of-payments measures. There was a general apprehension that the presence of foreign corporations made national economic life subservient to foreign economic interests in such areas as research and development, defense technology, economic planning, and monetary policy. Some of this was reminiscent of the populist sentiment in the U.S. agains dominance by Eastern business and financial interests. It was difficult to tell precisely what was feared and how the negative effects were expected to compare with the benefits of new technology and capital imports; perhaps the reaction was essentially nationalistic, reflecting a fear that the international corporation, with its capacity to allocate capital and resources worldwide, was a threat to the nation-state with its narrower domain.

International Financial Integration.—A sharp reduction in the costs of transport and communication, including the costs of assembling information needed for decisions in foreign economies, seemed to be working in the direction of international financial—as well as economic—integration. The European Economic Community was deliberately setting out on a course of economic and financial integration, leading to freer movement of labour and capital with a consequent narrowing of differences in wages and interest rates. The development of the Euro-dollar and Euro-bond market seemed to have had similar effects in linking North America and Europe, despite the steps taken to break the connections between the United States and European capital markets through the interest-equalization tax and the credit restraints. Such integration threatened the power of any country to operate an independent monetary policy. Tighter money would lead to capital inflows and undo the effects of restraint; monetary ease would tend to produce outflows and spread the effects abroad.

Financial integration thus had its costs in loss of monetary independence, as well as its benefits in greater capital mobility. If the costs were considered to outweigh the benefits, further steps would be taken to interfere with international capital movements, including control over foreign-owned securities in the United States, or possibly wider and more frequent fluctuations in exchange rates, which would increase the risks of international lending and borrowing. The benefits were currently limited to the developed countries, since the less-developed countries as a rule lacked access to private international capital markets and had to rely on governmental loans and foreign aid. If the benefits to the developed countries were to be retained, however, it would probably be necessary to alter the way in which balance-of-payments calculations were made and thus stop recording international financial intermediation (lending long and borrowing short) as a deficit in the balance of payments.

Some economists favoured the adoption by interested countries of a single form of long-term asset in common, their holdings of it varying as other items in the balance of payments produced surplus or deficit. Such a security might be United States government bonds, or the Special Drawing Rights (SDRs) worked out at the International Monetary Fund meeting at Rio de Janeiro, Braz., in September 1967. The gold shortage seemed to argue in favor of a capital asset based on credit as the balancing item in international payments. The alternative might be a fragmentation of the world capital market either through foreign-exchange controls or through a system of fluctuating exchange rates; this would follow if the benefits from international financial integration were not persuasive enough to overcome the difficulties of working out a common policy.

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(C. P. K.)

CAPITAL AND INTEREST. Capital is a word of many meanings. All its meanings, however, have something in common. They all imply that capital is a "stock" by contrast with income, which is a "flow." Capital may be broadly defined, therefore, as the set of economically significant elements in existence at a moment of time. The various concepts and definitions of capital revolve around the question of defining what is economically significant. In its broadest possible sense capital includes the human population; nonmaterial elements such as skills, abilities and education; land, buildings, machines, equipment of all kinds; and all stocks of goods—finished or unfinished—in the hands of both firms and households.

In economics the word capital is generally confined to "real" as opposed to merely "financial" assets. In the business world, the word usually refers to an item in the balance sheet which represents that part of the net worth of an enterprise that has not accrued through the operations of the enterprise. Different as the two concepts may seem, they are not unrelated. If all balance sheets were consolidated in a closed economic system all debts would be cancelled out, because every debt is an asset in one balance sheet and a liability in another. What is left, therefore, in the consolidated balance sheet, is a value of all the real assets of a society on one side, and its total net worth on the other. This is the economist's concept of capital.

Within the all-inclusive set of economically significant elements many useful subsets can be defined, and some authors have given the name capital to one or another of these subsets. There is, for instance, a distinction between goods in the hands of firms and goods in the hands of households, and attempts have been made to confine the term capital to the former. There is also a distinction between goods that have been produced and goods that are gifts of nature; attempts have been made to confine the term capital to the former, though the distinction is very hard to draw in practice. Another important distinction is between the stock of human beings (and their abilities) and the stock of nonhuman elements. In a slave society, of course, human beings are counted as capital in the same way as livestock or machines, and the value of slaves appears as an asset in the balance sheets of the slaveowners and is therefore part of the net worth of the nonslave element in society. In a free society each man is his own slave—the value of his body and mind is not, therefore, an article of commerce and does not get into the accounting system. In strict logic, persons should continue to be regarded as part of the capital of a society, but in practice the distinction between the part of the total stock that enters into the accounting system and the part that does not is so important that it is not surprising that many writers have excluded persons from the capital stock.

Another distinction, which has some historical importance, is that between circulating and fixed capital. Fixed capital is usually defined as that which does not change its form in the course of the process of production, such as land, buildings and machines. Circulating capital consists of goods in process, raw materials and stocks of finished goods waiting to be sold; these goods must either be transformed, as when wheat is ground into flour, or they must change ownership, as when a stock of goods is sold. This distinction, like many others, is not always easy to maintain. Nevertheless, it represents a rough approach to an important problem of the relative structure of capital; that is, of the proportions in which goods of various kinds are found. The stock of real capital exhibits strong complementarities. A machine is of no use without a skilled operator and without raw materials for it to work on.

Historical Background.—Although ancient and medieval writers were interested in the ethics of interest and usury, the concept of capital as such did not rise to prominence in economic thought before the classical economists (Adam Smith, David Ricardo, Nassau William Senior and John Stuart Mill). Adam Smith laid great stress on the role played by the accumulation of a stock of capital in facilitating the division of labour and in increasing the productivity of labour in general. He recognized clearly that accumulation proceeds from an excess of production over consumption. He distinguished between productive labour, which creates objects of capital, and unproductive labour (services), the fruits of which are enjoyed immediately. His thought was strongly coloured by observation of the annual agricultural cycle. The end of the harvest saw society with a given stock of grain. This stock was in the possession of the capitalists. A certain portion of it they reserved for their own consumption and for the consumption of their menial servants, the rest was used to feed "productive labourers" during the ensuing year. As a result, by the end of the next harvest the barns were full again and the stock had replaced itself, perhaps with something left over. The stock that the capitalists did not reserve for their own use was the "wages fund"—the more grain there was in the barn in October the sharper the competition of capitalists for workers, and the higher real wages would be in the year to come. The picture is a crude one, of course, and does not indicate the complexity of the relationship between stocks and flows in an industrial society. The last of the classical economists, John Stuart Mill, was forced to abandon the wages fund theory. Nevertheless, the wages fund is a crude representation of some real but complex relationships, and the theory reappears in a more sophisticated form in later writers.

The classical economists made a sharp distinction between three categories of income—wages, profit and rent; and identified these with three factors of production—labour, capital and land. Ricardo especially made a sharp distinction between capital as "produced means of production," and land as the "original and indestructible powers of the soil." In modern economics this distinction has become blurred. About 1870 a new school of economics developed, sometimes called the Austrian school from the fact that many of its principal members taught in Vienna, but better perhaps called the Marginalist school. The movement itself was thoroughly international, and included such figures as William Stanley Jevons in England and León Walras in France. The so-called "Austrian theory of capital" is mainly based on the work of Eugen Böhm-Bawerk (*q.v.*). His *Positive Theory of Capital* (1884) set off a controversy that has not yet subsided. In the Austrian view the economic process consisted of the embodiment of "original factors of production" in capital goods of greater or lesser length of life which then yielded value or utility as they were consumed. Between the original embodiment of the factor and the final fruition in consumption lay an interval of time known as the period of production. In an equilibrium population it can easily be shown that the total population (capital stock) equals the annual number of births or deaths (income) multiplied by the average length of life (period of production). The longer the period of production, therefore, the more capital goods there will be per unit of income. If the period of production is constant, income depends directly on the amount of capital previously accumulated. Here is the wages fund in a new form. Unfortunately, the usefulness of Böhm-Bawerk's theory is much impaired by the fact that it is confined to equilibrium states. The great problems of capital theory are dynamic in character and comparative statics throws only a dim light on them.

In many ways the marginalist school culminated in the work of three men—Philip H. Wicksteed in England, Knut Wicksell in Sweden and Irving Fisher in the United States. The last two especially gave the Austrian theory clear mathematical expression. Perhaps the greatest contribution of the Austrian theory was its clear recognition of the importance of the valuation problem in the relation of capital to interest. From the mere fact that physical capital produces an income stream there is no explanation of the phenomenon of interest, for the question is why the value of a piece of physical capital should be less than the total of future values that are expected to accrue from it. The theory also makes a contribution to the problem of rational choice in situations involving waiting or maturing. The best example is that of slowly maturing goods such as wines or timber. There is a problem here of the best time to draw wine or to cut down a tree. According to the marginal theory this is at the time when the rate of net value growth of the item is just equal to the rate of interest, or the rate of return in alternative investments. Thus, if a tree or a wine is increasing in value at the rate of 7% per annum when the rate of interest is 6% it still pays to be patient and let it grow or mature. The longer it grows, however, the less the rate of value growth, and when the rate of value growth has fallen to the rate of interest, then is the time to reap the fruits of patience.

The contributions of John Maynard (Lord) Keynes to capital theory are incidental rather than fundamental. Nevertheless, the "Keynesian revolution" had an impact on this area as on most others. The great contribution of Keynes is the recognition that the attempt to save does not automatically result in the accumulation of capital. A decision to restrict consumption is only a decision to accumulate capital if the volume of production is constant. If abstention from consumption itself results in a diminution of production, then accumulation (production minus consumption) is correspondingly reduced.

Theoretical Problems.—The theory of capital was not a matter of primary concern to economists in the mid-20th century, though some revival of interest was apparent in the late 1950s. Nevertheless, certain problems remain of perennial interest. They may be grouped as follows:

1. Problems involved in the measurement of a heterogeneous aggregate of goods. Real capital is a set of very heterogeneous items. The measurement of the total volume of real capital, therefore, involves a serious index number problem. A single measure of total real capital can be achieved only if there is an assumption of constant co-efficients of valuation by which each item can be expressed in a common denominator such as dollars. The problem is particularly complicated in periods of rapid technical change when there is change not only in the relative values of items but in the nature of the list itself. Only approximate solutions can be found to this problem and no completely satisfactory measure is possible. Nevertheless, approximate solutions are better than none. A related problem which has aroused considerable interest among accountants is that of accommodating the valuation of assets in balance sheets to changing price levels. In the conventional balance sheet the value of some items is based on their cost at an earlier period than that of others. When the general level of prices is changing this means that different items are valued in dollars of different purchasing power.

The problem is particularly acute in the valuation of inventory. Under the more conventional "FIFO" (First In, First Out) system, inventory is valued at the cost (purchase price) of the latest purchases. This leads to an inflation of inventory values, and therefore of accounting profits, in time of rising prices (and a corresponding deflation under falling prices) which may be an exaggeration of the long-run position of the firm. This may be partially avoided by a competing system of valuation known as "LIFO" (Last In, First Out), in which inventory is valued at the purchase price of the earliest purchases. This avoids the fluctuations caused by short-run price level changes, but it fails to record changes in real long-run values. There seems to be no completely satisfactory solution to this problem, and it seems wise to admit the fact that any single figure of capital value that purports to represent a complex, many-dimensional reality will need careful interpretation.

2. The second theoretical problem relates to the determinants of the rate of accumulation of capital; that is, of investment. It has been seen that investment in real terms is the difference between production and consumption. The classical economist laid great stress on frugality as the principal source of capital accumulation. If production is constant it is true that the only way to increase accumulation is by the reduction of consumption. Keynes shifted the emphasis from the reduction of consumption to the increase of production and regarded the decision to produce investment goods as the principal factor determining the rate of

growth of capital. In modern theories of economic development great stress is laid on the problem of the structure of production—the relative proportions of different kinds of activity. The advocates of "balanced growth" lay stress on the necessity for investment in a wide range of related and co-operative enterprises, public as well as private. There is no point in building factories and machines if the educational system does not provide a labour force capable of using them. There is also, however, a case to be made for "unbalanced growth," in the sense that growth in one part of the economy frequently stimulates growth in other parts. A big investment in mining or in hydroelectric power, for example, creates strains on the whole society which result in growth responses in the complementary sectors. The relation of inflation to economic growth and investment is an important though difficult problem. There seems to be little doubt that deflation, mainly because it shifts the distribution of income away from the profit-maker toward the *rentier* and bondholder, has a deleterious effect on investment and the growth of capital. In 1932, for instance, real investment had practically ceased in the United States. It is less clear at what point inflation becomes harmful to investment. In countries where there has been long continuing inflation there seems to be some evidence that the structure of investment is distorted. Too much goes into apartment houses and factories and not enough into schools and communications.

3. A third problem of the theory of capital is that of the period of production and the time structure of the economic process. This is a complex problem which cannot be solved by the simple formulas of the Austrian school. Nevertheless, the problem is a real one and there is still a need for more useful theoretical formulations of it. Decisions that are taken today have results extending far into the future. Similarly, the data of today's decisions are the result of decisions taken long in the past. The incompatibility of decisions is frequently not discovered at the time they are made because of the lapse of time between the decision and its consequences. The existing capital structure is the embodiment of past decisions and the raw material of present decisions. It is tempting to regard the cyclical structure of human history, whether the business cycle or the war cycle, as a process by which the consequences of bad decisions accumulate until some kind of crisis point is reached. The crisis (war or depression) redistributes power in the society, and so leads to a new period of accumulating, but hidden, stress. In this process, distortion in the capital structure is of great importance.

4. The fourth theoretical problem is that of the relation between the stocks and the flows of a society, or in a narrower sense the relation between capital and income. Income, like capital, is a concept capable of many definitions; a useful approach to the concept of income is to regard it as the gross addition to capital in a given period. In real terms this is practically identical with the concept of production. For any economic unit, whether a firm or an individual, income may be measured by that hypothetical amount of consumption that would leave capital intact. It should be observed that all the difficulties that arise in the measurement of a heterogeneous aggregate of capital arise also in the measurement of real income. Money income is the value of production at current prices. The total flow of income is closely related to both the quantity and structure of capital; the total real income of a society depends on the size and skills of its population, and on the nature and extent of the equipment with which they have to work. The most important single measure of economic well-being is per capita real income; this is closely related to the productivity of labour, and this in turn is closely related to per capita capital, especially if the results of investment in human resources, skills and education in the capital stock are included.

INTEREST

Historically, the concept of capital has been so closely bound to the concept of interest that it seems wise to take these two topics together, even though in the modern view it is capital and income rather than capital and interest that are the related concepts.

Definition and Concepts.—Interest as a form of income may be defined as income received as a result of the possession of contractual obligations for payment on the part of another. Interest, that is, is income received as a result of the ownership of a bond, a promissory note or some other instrument that represents a promise on the part of some other party to pay sums in the future. The obligations may take many forms. In the case of the perpetuity, the undertaking is to pay a certain sum each year or other interval of time for the indefinite future. A bond with a date of maturity usually involves a promise to pay a certain sum each year for a given number of years, and then a larger sum on the terminal date. A promissory note frequently consists of a promise to pay a single sum at a date some time in the future.

Rate of Interest.—If $a_1, a_2, \ldots a_n$ are the sums received by the bondholder in years $1, 2 \ldots n$, and if P_o is the present value in year O, or the sum for which the bond is purchased, the rate of interest r in the whole transaction is given by the equation

$$P_o = a_1(1+r)^{1} + a_2(1+r)^{-2} + \cdots + a_n(1+r)^{-n}$$

There is no general solution for this equation, though in practice it can be solved easily by successive approximation, and in special cases the equation reduces to much simpler forms. In the case of a promissory note, for instance, the equation reduces to the form

$$P_o = a_n(1+r)^{-n}, \text{ or } \log(1+r) = \frac{\log a_n - \log P_o}{n}$$

where a_n is the single promised payment. In the case of a perpetuity with an annual payment of a, the formula reduces to

$$P_o = a[(1+r)^{-1} + (1+r)^{-2} + \cdots \text{ to inf.}] = \frac{a}{r}$$

whence $r = \dfrac{a}{P_o}$

Thus if we had to pay $200 to purchase a perpetual annuity of $5 per annum, the rate of interest would be 2½%.

It should be observed that the dimensions of the rate of interest are those of a rate of growth. The rate of interest is not a price or ratio of exchange; it is not itself determined in the market. What is determined in the market is the price of contractual obligations or "bonds." The higher the price of a given contractual obligation, the lower the rate of interest on it. Suppose, for instance, I have a promissory note that is a promise to pay me $100 in one year's time. If I buy this for $100 now, the rate of interest is zero; if I buy it for $95 now the rate of interest is a little over 5%; if I buy it for $90 now, the rate of interest is about 11%. The rate of interest may be defined as the gross rate of growth of capital in a contractual obligation.

A distinction is usually made between interest and profit as forms of income. In ordinary speech, profit usually refers to income derived from the ownership of aggregates or assets of all kinds organized in an enterprise. This aggregate is described by a balance sheet. In the course of the operations of the enterprise, the net worth grows, and profit is the gross growth of net worth. Stocks, as opposed to bonds, usually imply a claim on the profits of some enterprise.

Changing Attitudes.—In ancient and medieval times the main focus of inquiry into the theory of interest was ethical, and the principal question was the moral justification of interest. On the whole, the taking of interest was regarded unfavourably by both classical and medieval writers. Aristotle regarded money as "barren" and the medieval schoolmen were hostile to usury. Nevertheless, there developed elaborate defenses for the taking of interest where it fulfilled a useful social function. Among the classical economists the focus of attention shifted away from ethical justification toward the problem of mechanical equilibrium. The question then became this: Is there any equilibrium rate of interest or rate of profit in the sense that where actual rates are above or below this, forces are brought into play, tending to change them toward the equilibrium? The classical economists did not provide any clear solution for this problem. They believed that the rate of interest simply followed the rate of profit, for people would not borrow or incur contractual obligations unless they could earn something more than the cost of the borrowing by investing the proceeds in enterprises or aggregates of real capital. They believed that the growth of capital itself would tend to reduce the rate of profit because of the competition of the capitalists. This doctrine is important in the Marxian dynamics in which the struggle of capital to avoid a falling rate of profit is an important factor, leading, for instance, to unemployment, foreign investment and imperialism.

Within the general framework of classical economics the work of Nassau William Senior deserves mention. He raised the question of whether profit or interest were "paid for" anything; that is, whether there was any identifiable contribution to the general product of society that would not be forthcoming if this form of income were not paid. He identified such a function and called it "abstinence." Karl Marx denied the existence of any such function, and argued that the social product must be attributed entirely to acts of labour, capital being merely the embodied labour of the past. On this view, profit and interest are the result of pure exploitation in the sense that they consist of an income derived from the power position of the capitalist and not from the performance of any service. Non-Marxist economists have generally followed Senior in finding some function in society that corresponds to these forms of income.

The marginalist school generally took the view that profit and interest were related to the marginal productivity of the extension of the period of production. Böhm-Bawerk assumed that "roundabout" processes of production would generally be more productive than processes with shorter periods of production; there is, that is to say, a productivity of "waiting" (to use the term of Alfred Marshall), and the rate of interest can then be seen as an inducement to the capitalist to extend the period of production. A low rate of interest leads to concentration on longer, more roundabout processes, and a high rate of interest on shorter, less roundabout processes. There is a limit, however, on the period of production imposed by the existing stock of accumulated capital. If we embark on a long process with insufficient capital, we will find that we have exhausted our resources before the end of the process and before the fruits can be gathered. It is the business of the rate of interest to prevent this, and to adjust the roundaboutness of the processes used to the capital resources available. The marginalists' theory of interest reached its clearest expression in the work of Irving Fisher. He saw an equilibrium rate of interest as determined by the interaction of two sets of forces: the impatience of consumers on the one hand, and the productivity of extending the period of production on the other.

J. M. Keynes brought a new approach to the whole problem. His liquidity preference theory of interest is a short-run theory of the price of contractual obligations ("bonds"), and it is essentially an application of the general theory of market price. If people as a whole decide that they want to hold a large proportion of their assets in the form of money, and if new money is not created to satisfy this desire, there will be a net desire to sell securities and the price of securities will fall. This is the same thing as a rise in the rate of interest. Conversely, if people want to get rid of money the price of securities will rise and the rate of interest will fall. This, then, is the theory of the "market" rate of interest, by contrast with the marginalists' theory, which concerns itself with whether or not there is a long-run equilibrium rate of interest. The controversy, therefore, between the liquidity preference theory which regards interest as a "bribe" to prevent people holding money rather than bonds, and the time preference theory which regards interest as a bribe to persuade people to postpone enjoyments to the future, can be resolved by placing the former in the short run and the latter in the long run.

Theoretical Problems.—The middle of the 20th century saw a considerable shift in the focus of concern relating to the theory of interest. Economists seemed to lose interest in the equilibrium theory and their main concern was with the effect of rates of interest as a part of monetary policy in the control of inflation. It was recognized that the monetary authority could control the rate of interest in the short run within wide limits. The controversy lay mainly between the advocates of "monetary policy" and the advocates of "fiscal policy." If inflation is regarded as a symptom of a desire on the part of a society to consume and invest more in total than its resources permit, it is clear that the problem can be attacked either by diminishing investment or by diminishing consumption. On the whole, the attack of the advocates of monetary policy is on the side of diminishing investment, through raising rates of interest and making it harder to obtain loans, though the possibility that high rates of interest may restrict consumption is not overlooked. The alternative would seem to be to restrict consumption by raising taxes. This has the disadvantage of being politically unpopular. The mounting concern with economic growth, however, has raised considerable doubts about the use of high rates of interest as an instrument to control inflation. There is some doubt whether high interest rates in fact restrict investment; if they do not, they are ineffective, and if they do, they may be harmful to economic growth. This is a serious dilemma for the advocates of monetary policy. On the other hand, it must be admitted that the type of fiscal policy that might be most desirable theoretically has received neither public support nor a political acceptability.

The problem of the ethics of interest is still unresolved in spite of many centuries of discussion; as long as we accept the institution of private property, the institution of securities, loans and a security market can hardly be denied usefulness. In the long historic process of inheritance, widowhood, gain and loss, by which the distribution of the ownership of capital is determined, there is no reason to suppose that the actual ownership of capital falls into the hands of those best able to administer it. Much of the capital of an advanced society, in fact, tends to be owned by elderly widows, simply because of the greater longevity of the female. There must, therefore, be some machinery in society for separating the control of capital from its ownership. Financial instruments and financial markets are the principal agency to perform this function. It might be argued that we could get along without contractual obligations (bonds), and therefore without interest as a form of income, if all securities took the form of stocks or equities. The case for bonds and interest, however, is the case for specialization. There is a demand for many different degrees of ownership and responsibility, and interest-bearing obligations tap a market that would be hard to reach with equity securities; they are also peculiarly well adapted to the obligations of governments. The principal justification for interest and interest-bearing securities, therefore, is that they provide an easy and convenient way whereby skilled administrators can control capital that they do not own, and the owners of capital can relinquish its control. Society has to pay a price for this arrangement and the price is interest.

There has been very little discussion of the problem of the socially optimum rate of interest. It could be argued that while interest has to be paid for a certain convenience there is no point in paying any higher price than we need to, and that hence the rate of interest should be as low as is consistent with the performance of the function of the financial markets. This position, of course, would place all the burden of control of economic fluctuations on the fiscal system, and perhaps we are not ready for this politically.

The ancient problem of "usury," in the form of the exploitation of the ignorant poor by moneylenders, is still important in many parts of the world. The remedy would seem to be the development of adequate financial institutions appropriate to all classes rather than the attempt to prohibit or even limit the taking of interest. The complex structure of lending institutions in a developed society—banks, building societies, land banks, co-operative banks, credit unions, and so on—is a tribute to the reality of the service that the lender provides and that interest pays for. The democratization of credit—that is, the extension of the power of borrowing to all classes in society—is one of the important social movements of the 20th century.

See Economics; Wealth and Income; *see* also references under "Capital and Interest" in the Index.

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CAPITAL GAINS, TAXATION OF. Strictly speaking, capital gains are gains realized from the sale or exchange of capital assets. Under federal income tax law in the United States all properties are, with certain exceptions, classed as capital assets. Personal securities, private residences and other properties held to yield income or for personal use are types of capital assets under the tax law. The main exceptions are properties used in the taxpayer's business, including stock in trade, depreciable property and land. However, if certain of the excepted properties are sold or exchanged with a resulting gain, the gain is treated by law as though it were truly a capital gain. The term is therefore used commonly to include any gain that is treated by law as a capital gain.

Capital gains have been taxed in the United States since the advent of federal income taxation, but after 1921 certain capital gains were afforded preferential treatment. There are several reasons for this special treatment. One is that it encourages the investment of risk capital. Another is the unfairness of taxing in a single year the full value of several years' appreciation. Accordingly, tax benefits are limited to long term gains; *i.e.,* those involving assets that the taxpayer has held for a specified period (after 1942 this period was six months). Other capital gains are short term, and, with some exceptions, are treated the same as ordinary income.

To compute the amount of a capital gain two things must be known: the value received for the asset and the taxpayer's adjusted basis therein. When a taxpayer acquires an asset he obtains a basis therein. Generally, if the acquisition is by purchase, the basis is cost; if by transmission at death, it is fair market value; if by gift, it is the donor's basis. This original basis may be adjusted upward to account for capital improvements or may be lowered to take depreciation into account. Thus, if a taxpayer buys a hotel for $1,000,000, adds capital improvements of $200,000 and over the years has had allowable depreciation of $300,000, his adjusted basis is $900,000. The amount of the capital gain is computed by subtracting the adjusted basis from the value received for the asset. In the example given, if the taxpayer sells the hotel for $1,500,000, the capital gain is $600,000.

If the taxpayer has held the hotel for more than six months and is an individual, only 50% of the gain, or $300,000, is subject to taxation. Furthermore, the maximum tax on the total gain cannot exceed a specified percentage, which for several years has been 25%. To individual taxpayers whose effective rates are below this maximum percentage, this ceiling is unimportant. But for taxpayers in higher brackets this limitation may effect substantial savings. Thus, in the example given, the maximum possible tax is 25% of $600,000, or $150,000.

By contrast, if the gain were ordinary income, the tax thereon to a single person, with no other income and no special deductions, would be approximately $470,000 at current rates.

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CAPITALISM, a term used to denote the economic system that has been dominant in the western world since the breakup of feudalism. Fundamental to any system called capitalist are the relations between private owners of nonpersonal means of production (land, mines, industrial plants, etc., collectively known as capital) and free but capital-less workers, who sell their labour services to employers. Under capitalism, decisions concerning production are made by private businessmen operating for private profit. Labourers are free in the sense that they cannot legally be compelled to work for the owners of the means of production. However, since labourers do not possess the means of production required for self-employment, they must, of economic necessity, offer their services on some terms to employers who do control the means of production. The resulting wage bargains determine the proportion in which the total product of society will be shared between the class of labourers and the class of capitalist entrepreneurs.

After penetrating the resisting framework of feudal society, the capitalist process gradually permeated the fabric of economic life and attained its classical form in the 19th century. Internal and external forces in the 20th century have transferred an increasing range of economic decisions from the private (capitalist) to the public (government) sector, and the resulting economic system is quite different from capitalism in either its early or its classical form. This article is organized according to the following outline of topics:

- I. Historical Development
    - 1. Origins of Capitalism
    - 2. Early Capitalism (1500–1750)
    - 3. Classical Capitalism (1750–1914)
    - 4. The Later Phase (Since 1914)
- II. Criticisms and Problems
    - 1. Allocation of Resources
    - 2. Employment of Resources
    - 3. Unemployment and Waste
    - 4. Exploitation and Inequality
    - 5. Concentration of Private Economic Power
    - 6. Public *v.* Private Sector
    - 7. The Future of Capitalism

I. HISTORICAL DEVELOPMENT

1. Origins of Capitalism.—Although the continuous development of capitalism as a system dates only from the 16th century, antecedents of capitalist institutions existed in the ancient world, and flourishing pockets of capitalism were present during the later middle ages. One strategic external force contributing to the breakup of medieval economic institutions was the growing volume of long-distance trade between capitalist centres, carried on with capitalist techniques in a capitalist spirit. Specialized industries grew up to serve long-distance trade, and the resulting commercial and industrial towns gradually exerted pressures which weakened the internal structure of agriculture based on serfdom, the hallmark of the feudal regime. Changes in trade, industry and agriculture were taking place simultaneously and interacting with one another in highly complex actual relations, but it was chiefly long-distance trade which set in motion changes that spread throughout the medieval economy and finally transformed it into a new type of economic society.

Flanders in the 13th century and Florence in the 14th century were two capitalist pockets of special interest. Their histories shed light on the conditions that were essential to the development of capitalism in England. The great enterprise of late medieval and early modern Europe was the woolen industry, and most of the business arrangements that later characterized capitalism developed in connection with long-distance trade in wool and cloth.

In Flanders revolutionary conflict raged between plebeian craftsmen and patrician merchant-manufacturers. The workers succeeded in destroying the concentration of economic and political power in the hands of cloth magnates, only to be crushed in turn by a violent counterrevolution that destroyed the woolen industry and brought ruin to both groups. A similar performance was repeated in Florence, which became one of the great industrial cities of Europe during the 14th century. Restless, revolutionary urban workers overthrew the ruling hierarchy of merchants, manufacturers and bankers, and were in turn crushed in a bloody counterrevolution. Thus both Flanders and Florence failed to perpetuate their great industries because they failed to solve the social problem arising from conflicting claims of small numbers of rich capitalists and large numbers of poor workers.

2. Early Capitalism (1500–1750).—By the end of the middle ages the English cloth industry had become the greatest in Europe. Because of the domestic availability of raw wool and the innovation of simple mechanical fulling mills, the English cloth industry had established itself in certain rural areas where it avoided the violent social strife that had destroyed the urban industries of Flanders and Florence. Although it was subject to many problems and difficulties, the English rural cloth industry continued to grow at a rapid rate during the 16th, 17th and 18th centuries. Hence, it was the woolen industry that spearheaded capitalism as a social and economic system and rooted it for the first time in English soil.

Productive use of the "social surplus" was the special virtue that enabled capitalism to outstrip all prior economic systems. Instead of building pyramids and cathedrals, those in command of the social surplus chose to invest in ships, warehouses, raw materials, finished goods and other material forms of wealth. The social surplus was thus converted into enlarged productive capacity. Among the historical events and circumstances that significantly influenced capital formation in western Europe in the early stage of capitalist development, three merit special attention: (1) religious sanction for hard work and frugality; (2) the impact of precious metals from the new world on the relative shares of income going to wages, profits and rents; and (3) the role of national states in fostering and directly providing capital formation in the form of general-purpose capital goods.

Capitalist Spirit.—The economic ethics taught by medieval Catholicism presented obstacles to capitalist ideology and development. Hostility to material wealth carried forward the teachings of the Christian fathers against mammonism. Saint Jerome said, "A rich man is either a thief or the son of a thief." Saint Augustine felt that trade was bad because it turned men away from the search for God. Down through the middle ages commerce and banking were viewed, at best, as necessary evils. Moneylending was for a time confined to non-Christians because it was considered unworthy of Christians. Interest on loans was unlawful under the anti-usury laws of both church and secular authorities. Speculation and profiteering violated the central medieval economic doctrine of just price.

Expansion of commerce in the later middle ages stirred controversies and led to attempts to reconcile theological doctrines with economic realities. In Venice, Florence, Augsburg and Antwerp—all Catholic cities—capitalists violated the spirit and circumvented the letter of the prohibitions against interest. On the eve of the Protestant Reformation capitalists, who still laboured under the shadow of the sin of avarice, had by their deeds become indispensable to lay rulers and to large numbers of people who were dependent upon them for employment.

The Protestant Reformation of the 16th and 17th centuries developed alongside economic changes which resulted in the spread of capitalism in northern Europe, especially in the Netherlands and England. This chronological and geographical correlation between the new religion and economic development has led to the suggestion that Protestantism had causal significance for the rise of modern capitalism. Without in any sense being the "cause" of capitalism, which already existed on a wide and expanding horizon, the Protestant ethic proved a bracing stimulant to the new economic order. Doctrinal revision or interpretation seemed not only to exonerate capitalists from the sin of avarice but even to give divine sanction to their way of life. In the ordinary conduct of life, a new type of worldly asceticism emerged, one that meant hard work, frugality, sobriety and efficiency in one's calling in the market place similar to that of the monastery. Applied in the environment of expanding trade and industry, the Protestant creed taught that accumulated wealth should be used to produce more wealth.

Acceptance of the Protestant ethic also eased the way to systematic organization of free labour. By definition, free labourers could not be compelled by force to work in the service of others. Moreover, the use of force would have violated the freedom of one's calling. Psychological compulsion arising from religious belief was the answer to the paradox. Every occupation was said to be noble in God's eyes. For those with limited talents, Christian conscience demanded unstinting labour even at low wages in the service of God—and, incidentally, of employers. It was an easy step to justify economic inequality because it would hasten the accumulation of wealth by placing it under the guardianship of the most virtuous (who were, incidentally, the wealthiest) and remove temptation from weaker persons who could not withstand the allurements associated with wealth. After all, it did not much matter who held legal title to wealth, for it was not for enjoyment. The rich like the poor were to live frugally all the days of their lives. Thus the capitalist system found a justification that was intended to make inequality tolerable to the working classes.

The Price Revolution.—Meanwhile treasure from the new world had a profound impact on European capitalism, on economic classes and on the distribution of income in Europe. Gold and silver from the mines of Mexico, Peru and Bolivia increased Europe's supply of precious metals sevenfold and raised prices two- or threefold between 1540 and 1640. The significance of the increased supply of money lay not so much in the rise in prices as in its effect on the social and economic classes of Europe. Landlords, the older ruling class, suffered because money rents failed to rise as rapidly as the cost of living. The more aggressive landlords raised rents and introduced capitalistic practices into agriculture. In England the enclosure movement, which developed with ever increasing momentum and vigour during the 17th and 18th centuries, encouraged sheep raising to supply wool to the expanding woolen industry. Among labourers, money wages failed to keep pace with the cost of living, causing real wages to fall during the price revolution. The chief beneficiaries of this century-long inflation were capitalists, including merchants, manufacturers and other employers. High prices and low wages resulted in profit inflation, which in turn contributed to larger savings and capital accumulation. Profit inflation and wage deflation created a more unequal distribution of income. Wage earners got less and capitalists got more of the total product than they would have received in the absence of inflation. Had the new increments of wealth gone to wage earners instead of to capitalists, most of it would have been consumed rather than invested, and hence the working classes of the 16th century would have eaten better, but the future would have inherited less accumulated wealth.

Mercantilism.—Early capitalism (1500–1750) also witnessed in western Europe the rise of strong national states pursuing mercantilist policies. (*See* MERCANTILE SYSTEM.) Critics have tended to identify mercantilism with amassing silver and gold by having a so-called favourable balance of exports over imports in trading relations with other nations and communities, but the positive contribution and historic significance of mercantilism lay in the creation of conditions necessary for rapid and cumulative economic change in the countries of western Europe. At the end of the middle ages western Europe stood about where many underdeveloped countries stand in the 20th century. In underdeveloped economies the difficult task of statesmanship is to get under way a cumulative process of economic development, for once a certain momentum is attained, further advances appear to follow more or less automatically. Achieving such sustained growth requires virtually a social revolution.

Power must be transferred from reactionary to progressive classes; new energies must be released, often by uprooting the old order; the prevailing religious outlook may constitute a barrier to material advancement. A new social and political framework must be created within which cumulative economic change can take place.

Among the tasks which private capitalists were either unable or unwilling to perform were the creation of a domestic market free of tolls and other barriers to trade within the nation's borders; a uniform monetary system; a legal code appropriate to capitalistic progress; a skilled and disciplined labour force; safeguards against internal violence; national defense against attack; sufficient literacy and education among business classes to use credit instruments, contracts and other documents required of a commercial civilization; basic facilities for communication and transportation and harbour installations. A strong government and an adequate supply of economic resources were required to create most of these conditions, which constitute the "social overhead capital" needed in a productive economy. Because the returns from them, however great, cannot be narrowly channeled for private gain, such investments must normally be made by the government and must be paid for out of public revenues.

Preoccupation with productive use of the social surplus led mercantilist commentators to advocate low wages and long hours for labour. Consumption in excess of bare subsistence was viewed as a tax on progress and therefore contrary to the national interest. Mercantilist society was not a welfare state; it could not afford to be. Luxury consumption was condemned as a dissipation of the social surplus. Restrictions on imports were directed especially at luxury consumption.

Opportunities for profitable private investment multiplied rapidly as mercantilist policy succeeded in providing the basic social overhead capital. Rather paradoxically, it was because the state had made such an important contribution to economic development that the ideology of *laissez-faire* could later crystallize. When that occurred, dedication to capital accumulation remained a basic principle of capitalism, but the shift from public to private initiative marked the passage from the early state of capitalism and the beginning of the next stage, the classical period.

3. Classical Capitalism (1750–1914).—In England, beginning in the 18th century, the focus of capitalist development shifted from commerce to industry. The Industrial Revolution (*q.v.*) may be defined as the period of transition from a dominance of commercial over industrial capital to a dominance of industrial over commercial capital. Preparation for this shift began long before the invention of the flying shuttle, the water frame and the steam engine, but the technological changes of the 18th century made the transition dramatically evident.

The rural and household character of the English textile industry continued only as long as the amount of fixed capital required for efficient production remained relatively small. Changes in technology and organization shifted industry again to urban centres in the course of the Industrial Revolution, although not to the old commercial urban centres. Two or three centuries of steady capital accumulation began to pay off handsomely in the 18th century. Now it became feasible to make practical use of technical knowledge which had been accumulating over the centuries. Capitalism became a powerful promoter of technological change because the accumulation of capital made possible the use of inventions which poorer societies could not have afforded. Inventors and innovators like James Watt (*q.v.*) found business partners who were able to finance their inventions through lean years of experimentation and discouragement to ultimate commercial success. Aggressive entrepreneurs like Richard Arkwright (*q.v.*) found capital to finance the factory type of organization required for the utilization of new machines. Wealthy societies had existed before capitalism, but none had managed their wealth in a manner that enabled them to take advantage of the more efficient methods of production which an increasing mastery over nature made physically possible.

Adam Smith's great *Inquiry Into the Nature and Causes of the Wealth of Nations* (1776) expressed the ideology of classical capitalism. Smith recommended dismantling the state bureaucracy and leaving economic decisions to the free play of self-regulating market forces. While Smith recognized the faults of businessmen, he contended they could do little harm in a world of freely competitive enterprise. In Smith's opinion, private profit and public welfare would become reconciled through impersonal forces of market competition. After the French Revolution and the Napoleonic wars had swept the remnants of feudalism into oblivion and rapidly undermined mercantilist fetters, Smith's policies were put into practice. *Laissez-faire* policies of 19th-century political liberalism included free trade, sound money (the gold standard), balanced budgets, minimum poor relief—in brief, the principle of leaving individuals to themselves and of trusting that their unregulated interactions would produce socially desirable results. No new conceptions of society arose immediately to challenge seriously what had become, in fact, a capitalist civilization.

This system, though well-defined and logically coherent, must be understood as a system of tendencies only. The heritage of the past and other obstructions prevented any full realization of the principles except in a few cases of which the English free trade movement, crystallised by the repeal of the Corn Laws in 1846, is the most important. Such as they were, however, both tendencies and realizations bear the unmistakable stamp of the businessman's interests and still more the businessman's type of mind. Moreover, it was not only policy but the philosophy of national and individual life, the scheme of cultural values, that bore that stamp. Its materialistic utilitarianism, its naive confidence in progress of a certain type, its actual achievements in the field of pure and applied science, the temper of its artistic creations, may all be traced to the spirit of rationalism that emanates from the businessman's office. For much of the time and in many countries the businessman did not rule politically. But even non-capitalist rulers espoused his interests and adopted his views. They were what they had not been before, his agents.

More definitely than in any other historical epoch these developments can be explained by purely economic causes. It was the success of capitalist enterprise that raised the bourgeoisie to its position of temporary ascendancy. Economic success produced political power, which in turn produced policies congenial to the capitalist process. Thus the English industrialists obtained free trade, and free trade in turn was a major factor in a period of unprecedented economic expansion.

The partition of Africa and the carving out of spheres of influence in Asia by European powers in the decades preceding World War I led critics of capitalism to develop, on a Marxist basis, a theory of economic imperialism. According to this doctrine, competition among capitalist firms tends to eliminate all but a small number of giant concerns. Because of the inadequate purchasing power of the masses, these concerns find themselves unable to use the productive capacity they have built. They are, therefore, driven to invade foreign markets and to exclude foreign products from their own markets through protective tariffs. This situation produces aggressive colonial and foreign policies and "imperialist" wars, which the proletariat, if organized, turn into civil wars for socialist revolution. Like other doctrines of such sweeping character, this theory of imperialism is probably not capable of either exact proof or disproof. Three points, however, may be recorded in its favour; first, it does attempt what no other theory has attempted, namely, to subject the whole of the economic, political and cultural patterns of the epoch that began during the long depression (1873–96) to comprehensive analysis by means of a clear-cut plan; second, on the surface at least, it seems to be confirmed by some of the outstanding manifestations of this pattern and some of the greatest events of this epoch; third, whatever may be wrong with its interpretations, it certainly starts from a fact that is beyond challenge—the capitalist tendency toward industrial combination and the emergence of giant firms. Though cartels (*q.v.*) and trusts antedate the epoch, at least so far as the United States is concerned, the role of what is popularly called "big business" has increased so much as to constitute one of the outstanding characteristics of recent capitalism.

4. The Later Phase (Since 1914).—World War I marked a turning point in the development of capitalism in general and of European capitalism in particular. The period since 1914 has witnessed a reversal of the public attitude toward capitalism and of almost all the tendencies of the liberal epoch which preceded the war. In the prewar decades, European capitalism exercised vigorous leadership in the international economic community. World markets expanded, the gold standard became almost universal, Europe served as the world's banker, Africa became a European colony, Asia was divided into spheres of influence under the domination of European powers, and Europe remained the centre of a growing volume of international trade.

After World War I, however, these trends were reversed. International markets shrank, the gold standard was abandoned in favour of managed national currencies, banking hegemony passed from Europe to the United States, African and Asian peoples began successful revolts against European colonialism, and trade barriers multiplied. Western Europe as an entity declined, and in eastern Europe capitalism began to disintegrate. The Russian Revolution, a result of the war, uprooted over a vast area not only the basic capitalist institution of private property in the means of production, but the class structure, the traditional forms of government, and the established religion. Moreover, the juggernaut unleashed by the Russian Revolution was destined to challenge the historic superiority of capitalist organization as a system of production within less than half a century. Meanwhile, the inner structure of west European economies was tending away from the traditional forms of capitalism. Above all, *laissez-faire*, the accepted policy of the 19th century, was discredited by the war and postwar experience.

Statesmen and businessmen in capitalist nations were slow to appreciate the turn of events precipitated by World War I and consequently they misdirected their efforts during the 1920s by seeking a "return to prewar normalcy." Among major capitalist countries, the United Kingdom failed conspicuously to achieve prosperity at any time during the interwar period. Other capitalist nations enjoyed a brief prosperity in the 1920s only to be confronted in the 1930s with the great depression, which rocked the capitalist system to its foundations. *Laissez-faire* received a crushing blow from Pres. Franklin D. Roosevelt's New Deal in the United States. The gold standard collapsed completely. Free trade was abandoned in its classic home, Great Britain. Even the classical principle of sound finance, the annually balanced governmental budget, gave way in both practice and theory to planned deficits during periods of depressed economic activity. Retreat from the free market philosophy was nearly complete in Mussolini's Italy and Hitler's Germany. When World War II opened in 1939, the future of capitalism looked bleak indeed. This trend seemed confirmed at the end of the war when the British Labour party won a decisive victory at the polls and proceeded to nationalize basic industries, including coal, transportation, communication, public utilities, and the Bank of England. Yet a judgment that capitalism had at last run its course would have been premature. Capitalist enterprise managed to survive in Great Britain, the United States, western Germany, Japan and other nations. Its remarkable show of vitality in the postwar world calls for a closer look at its long-range achievements and the internal working of the system.

Perhaps the most useful index of economic development is the increase in real output per capita (allowing for population growth and for price changes). In the United States over the 120-year period from 1839 to 1959, real gross national product per head increased, on an average, at $1\frac{3}{4}\%$ per year. At this rate, annual real income doubles every 40 years and increases sixfold in a century. In Great Britain the annual rate of increase of real output per head was slower than in the United States; from 1839 to 1959 it averaged approximately $1\frac{1}{2}\%$ per year. Assuming the relatively constant share of national income to labour which has prevailed in the past, a steady increase of from 1% to 2% in per capita real income would eventually eliminate poverty.

II. CRITICISMS AND PROBLEMS

Few observers are inclined to find fault with capitalism as an engine of production. Criticism usually proceeds either from moral or cultural disapproval of certain features of the capitalist system, or from the short-run vicissitudes (crises and depressions) with which long-run improvement is interspersed. Whatever its faults, historically the capitalist system has led the way from an age of scarcity to an age of potential abundance. Karl Marx, capitalism's most formidable critic, wrote in 1848 that capitalism ". . . in scarce 100 years has created more massive and more colossal productive forces than have all preceding generations together."

1. Allocation of Resources.—Leaving aside the moral and cultural aspects, we may approach the problems usually discussed in connection with capitalism through the economics of resource allocation and the economics of employment. Economic analysis of resource allocation within the private sector typically assumes a high degree of competition among firms in the same industry. In an industry with many buyers and sellers who are free to enter and to leave the industry, producers will tend to expand output to a point at which current price just covers the cost of producing an additional increment of output, and profits will tend toward a minimum. This hypothesis of pure competition with many buyers and sellers free to enter and to leave an industry suggests the best possible allocation of scarce resources resulting in maximum welfare.

Unfortunately, the conditions required for pure competition are seldom realized, except perhaps in the case of some agricultural commodities of a homogeneous nature produced by large numbers of farmers selling in national and world markets without government regulation. Since the latter part of the 19th century technological innovations have rendered progressively obsolete the assumption of pure competition in industry. Monopolistic competition and oligopoly are typical of a majority of markets in advanced capitalist countries, and in this context the allocation of resources departs from the optimum of pure competition. Government intervention aimed at restoring competition (antitrust policies) has proved generally ineffective for the simple reason that the potentialities of mass production can be fully realized only by firms that are beyond the size compatible with pure competition. (*See* COMPETITION, ECONOMIC.)

2. Employment of Resources.—Employment of resources, as distinguished from their allocation, is the second major division of economic analysis. According to the Keynesian theory of employment (*see* KEYNES, JOHN MAYNARD KEYNES), capitalist prosperity requires that current production exceed current consumption by substantial amounts because a sizable part of current income is saved, that is, not spent for current consumption. Because of this withheld income (saving) everyone cannot be employed to produce consumer goods because there would not be enough demand to buy back all the consumer goods produced at full employment. The gap between total income and total expenditure on consumption must be filled by production which is not for current consumption, *i.e.*, by some form of capital formation.

There exists, however, an organic connection between capital formation (production in excess of current consumption) and consumption because the ultimate purpose of capital formation is to increase consumption in the future. This connection imposes definite limitations on the amount of capital formation. Current levels of consumption output can be maintained indefinitely with no net capital formation, that is, with production equal to current consumption. Production can exceed current consumption only if consumption is expected to increase in the future. Moreover, today's success may contribute to tomorrow's failure—greater capital formation today lessens the need for it tomorrow. Abundance of wealth becomes a barrier to abundance of current production. A major boom like that of the 1920s is followed logically, within the capitalist framework, by a major depression like that of the 1930s. Further, the provision of current consumption out of past accumulations of wealth compounds the difficulties because it means that current consumption is in excess of current production, which is the opposite of the condition required for prosperity. Cyclical fluctuations in business since the Industrial Revolution, according to this theory, have resulted from periods of high capital formation and prosperity, followed by periods of low or negative capital formation and depression.

3. Unemployment and Waste.—In view of the foregoing analysis there exists no mechanism within the capitalist process to insure full employment. The strategic determinant of the volume of employment is the volume of capital formation, which in turn depends on expanding consumption and on fortuitous and historical conditions (such as inventions which lead to major new industries like railways in the 19th century and automobiles in the 20th century). New investment (capital formation) is important in the short run because it disperses income into the hands of consumers whose spending is necessary in order to keep existing productive capacity operating. In other words, a capitalist economy must always be adding new productive capacity if it is to keep its existing capacity in operation. This is another way of stating the accepted proposition that capitalism cannot stand still. It must either move forward or collapse. Stationary socialism would still be socialism, but stationary capitalism is a contradiction in terms. In the absence of a high rate of capital investment, unemployment mounts until the potentially rich community becomes so poor that all the income it produces is currently consumed.

Losses attributable to underutilization of labour and plant capacity are the most serious element in the indictment of capitalism on the score of waste. In the United States even during the prosperous 1920s unemployment ranged from 5% to 15% of the nonfarm labour force, according to W. C. Mitchell; during the 1930s unemployment ranged from 15% to 30% of the total labour force; and after World War II unemployment was often above 5% of the total labour force. In the United Kingdom unemployment in the years 1920 to 1939 was roughly parallel with that in the United States. After World War II, however, when Great Britain developed a "mixed" economy, unemployment did not exceed 5% and generally averaged much less.

4. Exploitation and Inequality.—Since the development of capitalism had profound cultural effects, to evaluate capitalism is to evaluate a civilization in all its aspects. The complexity of such a task is one reason why agreement is not to be expected. Another is that moral and cultural judgments presuppose moral and cultural standards that are matters of individual preference and beyond the range of scientific proof or disproof. All that can be done from a scientific standpoint is to establish the truth or falsity of such statements of fact as may enter into those judgments, and to point out the economic and cultural consequences to be expected from giving effect to them.

The role of exploitation in Karl Marx's assessment of capitalism is somewhat paradoxical (*see* MARX, KARL). Eager to set his "scientific" socialism apart from the "utopian" socialism of his predecessors, Marx appears to exonerate the capitalists of exploitation in the sense that workers are said to be cheated through underpayment for their services. Equivalents always exchange for equivalents in Marx's analysis. Wages received by workers are equal to the value of the labour power purchased by capitalists, and commodities are sold by capitalists at their value. The value of all commodities, including labour power, is determined by the socially necessary labour time required for their production. Labour power, however, is a unique commodity in that it is capable of producing values in excess of its own value. Hence, when the capitalist purchases labour power at its value, he appropriates to himself all the surplus value the worker is capable of producing by working longer than is required to produce his subsistence (wage).

What Marx really meant was that the labour market is a power market in which capitalists, possessing a monopoly of the means of production, have a power advantage over capital-less wage earners and therefore are able to appropriate the entire social surplus. While the notion of exploitation is clearly conveyed without being formally incorporated into the analysis, the theory of value and surplus value find their meaning in relation to Marx's leading proposition (which lends itself to empirical verification or refutation depending on the course of history) that capitalism as a system will break down because of contradictions associated, among other things, with the tendency for production capacity to outstrip consumption capacity. With the entire surplus value accruing to capitalists and being converted into expanding productive capacity and with the incomes of workers narrowly restricted by low wages, the stage is set for a falling rate of profit and for a deficiency of demand to keep the system operating. Consequently, cyclical movements of increasing extent will finally result in a crisis so severe that the capitalist system will collapse. Since exploitation of workers calls forth nothing but ethical disapproval, Marx makes it the basis for the inequality which disrupts the continuity of production and, according to him, results in ultimate breakdown.

Classical economists justified economic inequality on the ground that capital accumulation depended on the savings of the rich out of their wealth. However repugnant inequality was on moral grounds to liberal economists like John Stuart Mill, they were so greatly concerned for economic progress that they accepted inequality as a lesser evil. The ultra-liberal Mill opposed the personal income tax on grounds that it is a tax on savings and therefore an impediment to capital accumulation, which he considered necessary for economic progress.

Modern economic analysis, in keeping with its rejection of some capitalist preconceptions, does not accept so unreservedly as did classical economics the virtue or necessity of individual thrift. In conditions of unemployment, an increase in thrift has a depressing effect on demand and thus leads to a decrease rather than an increase in capital formation. If it is true that under modern conditions thrift frequently impedes rather than fosters the growth of wealth, the chief justification for inequality is open to question. While there may be social and psychological reasons for favouring some degree of inequality in income and wealth, in democratic societies the presumption would seem to favour limited inequalities. This democratic presumption finds expression in highly progressive death duties and income taxes. Death duties have gone far toward eliminating large family fortunes, which formerly could be passed intact from generation to generation. Despite numerous loopholes in tax laws, highly progressive income taxes have gone far toward socializing income without socializing income-earning property.

5. Concentration of Private Economic Power.—The evolution of economic collectivism, which was the fundamental premise of Marx and the basis of his theoretical and practical position, has accelerated in the 20th century under the stimulus of industrial technology and corporate organization. Accompanying the evolution of economic collectivism has been a revolution in the fundamental institution of capitalism—private ownership of the means of production. The prevailing but obsolete theory of private property stems from John Locke (*q.v.*), who justified private ownership of land and other means of production on the right of every man to the "labor of his body and the work of his hands." Locke said a man acquires property in land when "he hath mixed his labor with it." Locke's conception asserts active, functional control as a condition of property ownership.

With the growth of the modern corporation, ownership has become progressively separated from management of the means of production. In 20th-century America, characteristically, the owners of corporate shares are not managers and the managers are not owners. Separation of ownership from management has led to great concentration of power in the hands of nonowning managers, and has reduced nonmanaging shareholders to a functionless status similar to that of bondholders. Although the forms of private ownership remain, its substance has been revolutionized. Locke's concept of property represented the extension of the owner's personality into land or other objects, but there is nothing personal about giant corporations and the pieces of paper which represent shares of ownership in them. Nominal voting rights attach to common stock, but these rights have little meaning to the vast majority of shareholders. Managers rather than shareholders control corporation property, determine its use, and decide how much, if any, of the profits shall be paid out to the "owners."

Since World War II the rapid growth of pension funds, mutual investment funds, and insurance companies has led to further concentration of economic power and, in many instances, to the virtual disappearance of ownership in any meaningful sense. Pension funds, for example, invest heavily, for income purposes, in common stock of industrial corporations. Managers of pension funds with large blocks of voting shares in industrial corporations are in a position to exercise control over the policies of the industrial corporation. In one sense this development has reversed the early 20th-century trend toward de-concentration of share ownership, but it has done so only by rendering meaningless the concept of "ownership." For no one really owns the assets of a pension fund. Industrial workers have contingent claims to the income from pension funds after retirement, but they do not own the assets of the fund any more than do the shareholders or the managers of the corporation which places the assets in the pension fund. Pension fund trustees—mostly large banks in financial centres like New York—control the voting shares held in the pension fund, but the trustees are in no sense the owners of the industrial corporations whose policies they are in a position to control. What has emerged in the pension fund arrangement is a system of power without property, a system beyond property in the means of production, a "paraproprietal society," as one writer labeled it. Changes in property relations affecting capitalist means of production have been so fundamental as to raise the question whether the resulting system should continue to be called "capitalist."

Power without property has long been characteristic of political office, but it is a relatively recent phenomenon for economic management. In assuming some of the characteristics of political leaders, capitalist managers under big business parallel the position of managers of trusts and factories in the Soviet Union. Both hold power by virtue of office rather than of ownership. That power should follow management rather than ownership is perhaps inescapable in the conditions of modern large-scale technology and organization, whether the collectivism be of a private (American) or public (Russian) type. Nevertheless, in a democratic society massive concentration of power in the hands of a self-perpetuating oligarchy of corporation managers raises a host of questions, including how this power can be circumscribed and directed into channels where it will serve rather than threaten the general welfare.

By replacing market prices with administered prices of a monopolistic character, giant corporations have undermined the freely competitive market in numerous industries. Despite the creation of government agencies and other countervailing forces designed to curb extortionate practices, modern industrial capitalism operates in an altogether different world from that of the "sovereign consumer" of classical economics. Almost by definition the major decisions concerning production and distribution in a capitalist economy are made in the private sector, yet in the absence of strong competition there are no effective curbs on the power of corporate management. A. A. Berle described these corporation managers as "non-statist civil servants" and has suggested that a major abuse of power will bring government into the picture to remedy abuses, since the ultimate recourse of democratic society is to make all holders of power accountable to the people and their elected representatives. Thus far governments in capitalist countries have not attacked directly the greatest abuse of power by private management, the withdrawal from use of the socially necessary means of production in periods of depression. Probably the survival of capitalism lies in preventing, by indirect means such as monetary and fiscal policies, the conditions which lead to serious depression. A direct attack by government on this major abuse probably would mean the end of capitalism and the establishment of some form of government collectivism.

6. Public *v.* Private Sector.—The rationale of resource allocation under capitalism is that the people decide what should be produced (1) through the market forces of supply and demand operating within the private sector; and (2) by allocating from the private to the public sector, through taxes and bond issues, the resources the public believe should be in the public sector for schools, roads, defense, hospitals, urban renewal, public health, welfare and other public needs. The market theory of resource allocation within the private sector is the central theme of classical economics. The criterion for allocation between public and private sectors is formally the same as in any other resource allocation, namely, that the community should receive equal satisfaction from a marginal increment of resources used in the public and private spheres. Unfortunately, investment in the public sector yields no capturable monetary return similar to profit from private investment. As a result, the formal requirement of equal returns at the margin for private and public investment does not lend itself readily to operational testing. Nevertheless, many economists have asserted that there is substantial, perhaps overwhelming, evidence that total welfare in capitalist United States, for example, would be increased by a reallocation of resources to the public sector—more schoolrooms and fewer shopping centres, more public libraries and fewer automobiles, more hospitals and fewer bowling alleys. Affluence in the private sector, in this view, contrasts with parsimoniousness in the public sector.

Capitalism has a bias against the public sector for two reasons. First, all products and income accrue initially to the private sector while resources reach the public sector through the painful process of taxation. Public needs are met only by sufferance of consumers in their role as taxpayers, whose political representatives are acutely conscious of their constituents' tender feelings about taxation. That people know better than governments what to do with their income is a notion more appealing than the contrary one, that people get more for their tax money than for other types of spending. Only in acute national emergencies are public outlays likely to increase substantially.

Second, the pressure of private business to sell leads to the formidable array of devices of modern salesmanship which influence consumer choice and bias consumer values toward private consumption, whereas no similar pressures are marshaled on behalf of public needs. Under opulent capitalism, advertisers contrive all manner of means to sell gadgets that will satisfy the wants thus created. Hence, much private expenditure goes for wants that are not very urgent in any fundamental sense. The corollary is that many public needs are neglected because these superficial private wants, artificially generated, compete successfully for the same resources. Capitalist society, some argue, would be enriched by converting some of its persuasive salesmen into gifted school teachers.

A comparison of resource allocation to the public and private sectors under capitalism and under socialist collectivism is illuminating. In a collective economy all resources operate in the public sector and are available for education, defense, health, welfare and other public needs without any transfer through taxation. Private consumption is restricted to the claims that are permitted against the social product, much as public services in a capitalist economy are limited to the claims permitted against the private sector. In a collective economy public needs enjoy the same sort of built-in priority that private consumption enjoys in a capitalist economy. In the Soviet Union teachers are plentiful, but automobiles are scarce, whereas the opposite condition prevails in the United States. The percentage of national product going to education in the Soviet Union during the 1950s was twice that in the United States. Within this more generous Soviet allocation to education, a much higher proportion was devoted to mathematics, science and engineering in keeping with Soviet emphasis on rapid economic and scientific development.

Different resource allocations to private and public sectors reflect different economic structures. They also are major determinants of rates of economic growth. In the short run, resources withheld from private consumption can be allocated to capital formation. Under collective economic planning in the Soviet Union one-fifth to one-fourth of the total national product was invested in capital formation, with emphasis on heavy industry. After World War II, Soviet rates of industrial growth were from two to three times greater than in the United States, a more highly industrialized nation where capital formation constituted a much lower proportion of total national product. The strong arm of dictatorship is, of course, able to maintain high rates of investment at the expense of low levels of consumption. Yet with each succeeding year that heavy industry is expanded, the possibility of simultaneously increasing both consumption and heavy industry is enhanced. Thus consumption levels in the Soviet Union gradually rose even though they remained below the standards in advanced capitalist nations.

Many economists maintain that, in the long run, larger resource allocation to the public sector, especially in education, basic research, and investment in people generally, heightens the prospects for sustaining high rates of economic growth. Historically, changes in technology arising from scientific discovery and innovations have been much more important for economic growth than successive additions to existing types of capital assets. Scientific and technological advances in turn are functionally related to investment in human capital, which falls almost entirely within the public sector. Hence, the argument runs, an economy that is generous in its allocations to the public sector, wisely managed, has the potentiality of outstripping an economy that is sparing in its allocations to the public sector. In 1957 the dramatic Russian sputnik episode, which opened the space age, shocked the capitalist world. Economists pointed out that Soviet achievements in launching earth satellites and intercontinental ballistic missiles arose from the same source as its high rate of economic growth—a generous allocation of resources to the public sector. Capitalism's public poverty in the midst of private plenty, it was argued, created a social imbalance that impeded economic growth.

7. The Future of Capitalism.—Karl Marx was the first to formulate correctly the fundamental scientific question, namely, whether or not there are observable tendencies, inherent in the capitalist process as we know it, which, if allowed to work themselves out fully, would destroy the capitalist and produce the socialist system. The coexistence of capitalism and communism in the 20th century places the issue of the future of capitalism in a somewhat different perspective from that of Marx. Even if the apparent contradictions of capitalism have been overcome through fiscal, monetary and other anticyclical stabilization policies, the spectre of collectivism still hovers over the capitalist world both in terms of strong collectivist tendencies within contemporary capitalism and also in the high rates of economic growth in communist countries. The relative strength of the two systems in the latter decades of the 20th century may well turn on which type of economic system is capable of faster growth, with victory to the swifter. As noted above, communist Russia grew two or three times faster than capitalist America following World War II. Soviet successes in economic development, space exploration and military prowess were too impressive and persistent to be dismissed lightly and they made a strong impression on the uncommitted peoples in the populous underdeveloped areas of the world. The growing economic power of the Soviet Union enabled it to provide economic aid and technical assistance—items clearly in the public sector—to underdeveloped countries. Capitalism may continue to grow at 3% per year, but, some observers declared, if Soviet growth continues at 7%, the uncommitted peoples may prefer the collectivist to the capitalist type of economic organization. In this event, relative but not absolute decline would characterize the future of capitalism.

Predictions concerning the survival of capitalism are, in part, a matter of definition. One sees everywhere in capitalist countries a shifting of economic activity from the private to the public sphere. None of the five great events of the first half of the 20th century—World War I, the Russian Revolution, the great depression, World War II, and the Chinese revolution—were favourable to the future of capitalism. By the 1960s the process of transformation had gone so far that capitalist economies bore little resemblance to classical capitalism of the 19th century. Exigencies of technology, organization and development had suggested to many economists that in the future the public sector would occupy an expanding role in the mixed private-public economies still called capitalist. At the same time private consumption appeared destined to increase in communist countries. The two economic systems seemed to be drawing closer together by changes converging from both directions. Yet significant differences in the economic structures still existed. It seemed reasonable to assume that the society which invested more in people would advance more rapidly and inherit the future. In this important respect capitalism, in the eyes of some economists, labours under a fundamental but not inescapable disadvantage in competition with collectivism.

See also references under "Capitalism" in the Index volume.

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CAPITAL LEVY. The strict meaning of this term is a direct tax assessed simultaneously on the capital resources of all persons possessing taxable wealth in excess of a minimum value and paid at least partly out of capital resources. This definition excludes death duties because in any given year they are necessarily limited in application. Various taxes have been popularly included under the capital levy term, even though they were assessed on current incomes or though their burden did not exceed the taxpayers' capacity to pay out of current income. Thus the "special contribution" introduced by Sir Stafford Cripps in Great Britain in his 1948 budget was assessed on the basis of current incomes, but was popularly called a capital levy because in the case of higher incomes its burden, together with that of income tax and surtax, was in excess of 20*s.* in the pound, so that a number of taxpayers had to pay it out of capital. On the other hand, in a large number of instances during the interwar period and also after World War II the annual installments of taxes levied on capital assets were well within the taxpayers' capacity to pay them out of current incomes, because the payment was spread over long periods.

British Experience.—Interpreted in the sense of being simply a tax assessed on capital assets, capital levy has a very long history. In England some of the earliest-known taxes were assessed on capital assets. The Danegeld during the 10th and 11th centuries and the land tax raised in the kingdom of Wessex in the 7th century were assessed according to the area of land, regardless of its yield. For a long time, until the 17th century, a tax on movable goods was assessed on the taxpayers' possessions. On many occasions parliament voted several "tenths" or "fifteenths" of movable goods, payable in a single year, for financing wars. The burden of this tax in such years may well have exceeded the taxpayers' current incomes, so that it constituted a capital levy in the strict sense.

In its narrowest sense capital levy aims at achieving the surrender of a relatively substantial proportion of the taxpayers' wealth, to enable the government to cope with some nonrecurrent major emergency, or to bring about with one stroke a major redistribution of wealth, or a major reduction of the note circulation or of the national debt. It is in this latter sense that the idea gained popularity in Great Britain during and after World War I.

The first suggestion for a capital levy of this type in Great Britain was made by W. Watson Rutherford in the house of commons on Nov. 19, 1914. He advocated this tax as an alternative to an increase of the income tax. The idea received much support from all parties and also from academic economists. In his evidence before the Colwyn Committee on National Debt and Taxation, John Maynard Keynes (*q.v.*) declared that he would prefer even a capital levy to an income tax in excess of 6*s.* in the pound, even though he was fully aware of its grave disadvantages. A. C. Pigou also favoured the levy during the early postwar period. Labour politicians—Philip Snowden among others—advocated it originally as a convenient way of reducing the national debt. It was only gradually that the anticapitalist character of the proposal gained prominence, as the postwar slump materially weakened the economic argument in favour of such a tax, because a large proportion of the wealth created during the war and the postwar boom was wiped out, and inflation was a matter of the past. The device provided, however, a popular political slogan during the general elections of the 1920s, and eventually it became almost entirely identified with the Labour party.

Because the first Labour government did not have a majority in the house of commons it did not emphasize the political and social aspects of capital levy. It appointed the Colwyn committee with the object of considering the question of such a levy in relation to national debt and taxation in general. The report of the committee, issued in 1927, emphatically rejected the idea, largely because it anticipated strong resistance on the part of the taxpayers. The report concluded that "unless a levy were accepted with more goodwill than it would be possible to anticipate on the present conditions it would be highly injurious to the social and industrial life of the community." Even if the levy were well received "the relief from debt which it offers would be insufficient to justify an experiment so large, difficult and full of hazard."

There was a minority report in favour of the levy, subject to reservations. Capital levy disappeared from the official program of the Labour party after the publication of this report and there was no attempt to introduce it under the second Labour government of 1929–31. Individual Socialist politicians continued to press for it, however.

The idea was revived after World War II, and was put into practice on a modest scale by Sir Stafford Cripps in 1948, presumably in order to make his policy of wage restraint and austerity more acceptable to government supporters. As there was no time for the highly involved operation of a valuation of capital assets, it was levied in the form of an additional income tax assessed on incomes of more than £2,000 a year, the rates charged being 2*s*. for the first £250, 4*s*. for the next £500, 6*s*. for the next £1,000, 8*s*. for the next £3,000 and 10*s*. on incomes in excess of £6,750. For most of those taxpayers already paying surtax this meant a tax of more than 20*s*. in the pound so that part of the levy at any rate had to be paid out of capital. Throughout the budget debate government spokesmen emphasized that this tax would not be repeated. The yield of this levy was £79,400,000 during the first fiscal year. Up to March 1959 it produced £110,400,000.

Other Countries.—Capital levies were introduced in a number of European countries both after World War I and after World War II. During 1919–20 the device was adopted in Germany, Czechoslovakia, Austria, Hungary, Italy, Poland and Greece. In all these countries economic conditions were so chaotic that the majority of the taxpayers concerned were prepared to accept a capital levy as a lesser evil, for the sake of achieving financial stability.

In Germany there was already in 1913 a tax on capital called a defense levy. In 1920 a more substantial levy called the National Distress contribution was adopted. Its effect was completely wiped out, however, by the rapid progress of inflation. Italy, after toying with the idea of a forced loan assessed on capital, adopted an extraordinary tax on capital in 1920. Its rate varied from 4½% to 50% payable in 20 years. This meant that even at its highest rate the majority of taxpayers were able to pay it out of income, even though it was assessed on their capital. In 1936 Italy introduced a rearmament levy representing 5% of capital values. The schedule relating to real property yielded some 7,000,000,000 lire by March 1936, against an estimate of 8,700,000,000 lire. Hungary adopted a levy in 1938 partly to finance rearmament and partly to effect social improvement. It was called an investment contribution and was payable within five to six years.

During and after World War II several continental countries introduced taxes on capital the extent of which came, however, well within the annual income of most taxpayers. The Swiss federation introduced a defense tax in 1941 which continued till 1959. The Swiss cantons have capital taxes, the basic rate of which is under 1%. After World War II the German Federal Republic adopted an equalization of burden levy at a rate of 50%, payable over 30 years. Austria, too, adopted a similar levy the rate of which varied from 12% to 33% payable within 8 to 22 years. Smaller taxes of a similar nature were adopted by Finland, which first introduced a levy on the conclusion of the war with Russia in 1940, Belgium, and the Scandinavian and other countries. In Italy there is a capital element in the corporation tax.

Outside Europe, Ceylon introduced in 1959 a tax assessed on capital at rates varying from ½% to 2% per annum and India in the same year adopted a similar tax of 1% to 2% per annum. In both these countries this tax is additional to very high taxes on current incomes, so that many taxpayers have to pay it out of capital.

Arguments Pro and Con.—It is a matter for argument whether capital taxes at a sufficiently low rate to constitute a more or less permanent source of revenue are preferable to income taxes. In most instances the device was chosen in preference to income tax as a gesture to satisfy the clamour for social justice rather than for fiscal or economic considerations. The economic argument usually put forward in their support is that a tax levied on capital penalizes idle wealth and is therefore an incentive for the productive employment of wealth. The most popular argument is that capital taxes are directed mainly against classes which seek to avoid the effect of high current taxation on their standard of living by living on capital.

There are strong arguments against capital taxes, even if their rate is low, on the ground of the difficulty of making a fair valuation of capital assets. It would be necessary to make frequent revisions of the assessment in order to avoid grave injustices resulting from substantial changes in capital values. Yet in a number of the above instances the levy was assessed on the basis of capital values as of a given date and continued to be collected over a period of years regardless of the fluctuations of those values. The main argument against any tax on accumulated wealth is that it tends to discourage saving.

When it comes to the case for and against a substantial capital levy which has to be paid out of capital, the balance of argument is now considered to be overwhelmingly against it. Unless the payment is spread over a number of years it necessitates large-scale realizations of assets, leading to a disastrous slump of their prices and spelling ruin not necessarily confined to those directly affected. It is bound to cause grave dislocation in the national economy. From a purely fiscal point of view such a levy amounts to killing the goose that lays the golden eggs. The receipt of an abnormally large sum is bound to be followed by a substantial decline in the current yield of taxation during the following years. The argument that was so popular during and immediately after World War I, that it would be worthwhile to make sacrifices for the sake of a drastic reduction of the national debt, has long lost its popularity because in the meantime the inevitability of a gradual increase of the debt has come to be accepted. Nor does the argument presenting capital levy as an alternative to higher taxation of current incomes carry any conviction since it was found possible during and after World War II to maintain very high direct taxation of current incomes. The redistribution of wealth effected by such prolonged high taxation, combined with high death duties, has gone a long way toward weakening also the argument in favour of capital levy as a means of social justice.

The social argument formerly used in favour of a capital levy is now used in support of a capital gains tax. Such a tax is in operation in the United States, in the Scandinavian countries and in some other continental countries, but in every instance it is levied on realized profits only and not on increases of capital values, and so cannot be regarded as a capital tax proper. In Great Britain, too, the government decided in 1961 to introduce a capital gains tax confined to profits on stock exchange speculation and on certain transactions in real property.

The fact that capital levy in the sense of a heavy tax on capital assets that is expected to yield a substantial amount is no longer advocated by any responsible political party should not be regarded as proof that the idea is now dead and buried. It is likely to be revived in case of major emergencies or in countries where left-wing governments gain power. Once the taxation of current incomes and even of realized capital gains has reached its limits it would be tempting for such governments to impose a capital levy, or even a series of capital levies, as a form of expropriation in stages. The temptation is likely to be particularly strong where a considerable proportion of capital assets is owned by foreign investors.

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CAPITAL PUNISHMENT is the execution of a criminal pursuant to a sentence of death imposed by a competent court. In Roman law the term had a wider significance and meant, besides the *summum supplicium* (death), those punishments that affected the *caput* (status) of the citizen, namely, banishment (*aqua et igni interdictio*) under the republic or *deportatio* under the empire, and condemnation *in opus perpetuum* (a life sentence to hard labour).

Capital punishment was once a common penalty throughout the world. It was inflicted for a large number of crimes, especially during the Middle Ages and the early modern period, and was often aggravated by torture. Burning at the stake, breaking on the wheel, and slow strangulation were methods commonly used. The attitude of the legislative authorities toward human life is reflected in application of the death penalty to even petty property offenses. In England during the 18th century death was decreed for several hundred specific offenses, mostly against property.

The turning point came in that century, when the rise of a democratic political philosophy led to political struggles against the old regimes. The writings of Montesquieu and Voltaire and, especially, C. B. Beccaria's (*q.v.*) *Essay on Crimes and Punishments* (1764) proved to be a powerful stimulus to reform. The growing strength of the industrial working class and the humanitarian movement also played important roles. The number of offenses punishable by death was reduced in all leading countries. In the United States, where during colonial times a dozen or more crimes had been punishable by death, Pennsylvania limited such punishment to murder in the first degree in 1794, and other northern states adopted the same principle. In England, under the influences of Jeremy Bentham and Samuel Romilly (*qq.v.*), the number of capital crimes was reduced to 15 by 1834, and in 1861 to 4. Penalties involving torture disappeared and the principle that the punishment should aim solely at the swift deprivation of life, whether by the guillotine (in France, from 1792), the garrotte (in Spain), the headsman's axe (in Germany), or by fracturing the neck by hanging (in England), was firmly established. Where formerly the penalty was generally mandatory upon conviction, a trend began to develop toward making an alternative punishment, usually life imprisonment, available to the court. By the middle of the 20th century, mandatory death sentences were rare. Since 1835, when New York abolished public executions (England did so in 1868), these spectacles have disappeared in more advanced countries in favour of executions within a prison that are attended only by certain officials and perhaps by witnesses required by law.

Extent.—In the middle 1960s capital punishment could be inflicted on a criminal for certain crimes in a majority of jurisdictions throughout the world. Even where it had been abolished as a penalty for crimes committed during peacetime it was retained for treasonable crimes occurring in times of war or emergency, or for crimes in military law. Since discussions about the death penalty usually centre about its use in peacetime, this article will focus on that aspect of the problem.

In the late 1960s death was a possible punishment in Canada and in the United States under the federal code as well as all the states of the union except the following: Michigan (abolished in 1846 except for treason, abolished in 1963); Rhode Island (1852, except for murder by a prisoner serving a life sentence); Wisconsin (1853); Maine (1876; 1887); Minnesota (1911); North Dakota (1915, except for treason or murder by a prisoner sentenced for life); Alaska (1957); Hawaii (1957); Delaware (1958; restored, 1961); Oregon (1964); Iowa (1965); West Virginia (1965); Vermont (1965, except for a second unrelated murder or murder of policeman or prison employee on duty); New York (1965, except murder of policeman on duty or murder of prison officer by lifer serving sentence for murder). Puerto Rico abolished it in 1929, and the Virgin Islands in 1957. In Latin America, it existed in Bolivia, Chile, Cuba, Guatemala, Haiti, Honduras, Nicaragua, Paraguay, Peru, and El Salvador, but had been abolished in Costa Rica (1880), Colombia (1910), Panama (1903), Uruguay (1907), Venezuela (1863), Ecuador (1897), Argentina (1922), Brazil (1891), Dominican Republic (1924), the federal code of Mexico (1928), and in all but four states of the Mexican federation.

In Europe the death penalty was found in all Communist states, the Balkans, Ireland, France, and Spain. It had been eliminated in Sweden (1921; last execution, 1910); Finland (1949; last execution, 1822, except during the civil war of 1918 and World War II); Norway (1905; last execution, 1876, except for "quislings"); Denmark (1933; last execution, 1892; same exception); Netherlands (1870; last execution, 1860; same exception); West Germany (1949); Iceland (1944); Austria (1950); Italy (1944); Portugal (1867); Switzerland (1942; last execution, 1940, and Britain (suspended, 1965; made permanent, 1969, for murder). Belgium and Luxembourg had kept the penalty and occasionally imposed it, but Belgium's only execution after 1863 occurred in 1918 until numerous executions of enemy collaborators took place shortly after World War II; Luxembourg's last execution was in 1822.

All African and Asian countries retained capital punishment except Israel (abolished in 1954 except for treason and Nazi collaborators) and Nepal (1931). In Australia, Queensland had abandoned it entirely (1922; last execution, 1911). New Zealand abolished it in 1961, having previously done so during 1941–50; New South Wales abolished it for murder in 1955.

Crimes Punishable by Death.—Certain homicides are capital offenses in all countries that have retained the death penalty, but there are numerous variations in the definition of capital homicide. In the United States it ordinarily means murder in the first degree, *i.e.*, the premeditated and willful killing of a person, and (except in federal law) homicide in connection with certain serious crimes, usually arson, robbery, rape, or burglary. In France it covered assassination; parricide; poisoning; perjury resulting in a death sentence; ill treatment or kidnapping of a child under 15 years resulting in its death; premeditated infanticide by someone not the mother; homicide connected with another serious crime; and intentional arson leading to another's death. In Yugoslavia it included murder; the killing of an official or public employee in order to undermine the republic or socialist progress; and the killing of several people by intentional use of fire, inundation, explosives, poison, poisonous gases, motor power, electric or other energy, by an act dangerous to the public, by a dangerous instrument, or by destruction or injury to industrial safety devices. In Japan it included murder and parricide, and in the U.S.S.R., from 1954, ordinary murder.

As regards other capital crimes there were considerable variations among the many jurisdictions. In the United States, federal law made treason, espionage, and rape capital offenses and provided the death penalty in 28 other sections of the U.S. code. Kidnapping, usually associated with a demand for ransom, or harm, or death to the victim, had been made capital in 40 states, mostly from the early 1930s. Treason was capital in 19 states; rape, variously defined, in 16; robbery in 7; arson in 10; burglary in 3; train wrecking in 16; perjury in a capital case in 12; bombing and the use of machine guns in crime in 4; and assault by a prisoner serving a life sentence in 3. A few other crimes were also occasionally threatened with death in some states. In England and Wales, high treason, piracy, and the destruction of public arsenals and dockyards were punishable by death. In France, those committing treason or espionage; recidivists, twice previously sentenced to life imprisonment; those who illegally restrained and physically tortured a person; and those who committed armed robbery or carried a weapon in the vehicle used in perpetrating the crime could be sentenced to death. The situation in Communist countries could be inferred from the law of Yugoslavia, which provided a nonmandatory death penalty for robbery when the victim was killed or seriously injured; plunder of public property by an organized group or when it could have serious consequences for the economy; counterrevolutionary activity undermining defense; armed insurrection; espionage; service in an enemy army; organizing armed bands, terrorists, weapons, or propaganda in the republic; destruction of important economic installations or injury to means of production in order to undermine the government; sabotage, including failure to work or delaying work; violence against a member of a representative body, military official, or public employee to hinder him in the exercise of official or political duties; burning or destroying a building or the property of such a person for the same purpose; organizing gangs, conspiracies, or groups to commit any of the above offenses, or committing acts preparatory to doing so; failure by a responsible person to observe regulations governing construction work; endangering public circulation on bridges and streets by reckless driving, use of unfit vehicles, placing obstructions, etc.; endangering railroad, ship, or air travel; and failure by a responsible person to keep public transport facilities in order. The laws of all countries governing the conduct of military personnel provided the death penalty, at least for serious offenses in wartime such as treason, espionage, desertion, looting, etc.

Lack of mental responsibility, however defined, was generally a bar to a sentence of death. Many jurisdictions also forbade a death sentence to be passed on a child, usually under 14, 16, or 18 years of age, and some countries excluded women.

Executions.—The fact that the death penalty is provided by law does not mean that it is generally imposed or executed. It is a rare punishment, either because the crimes involved are relatively uncommon or because alternative penalties are chosen by the courts. The best way to disclose the characteristics and trends of capital punishment is by examining the data on executions.

In the United States such data have been systematically compiled since 1930. During 1930–65, 3,856 persons were executed—3,332 for murder, 455 for rape, 24 for armed robbery, 20 for kidnapping, 11 for burglary, 8 for espionage, and 6 for aggravated assault. Only 32 were women; all but two (kidnapping, espionage) of these were sentenced for murder. Fifty percent of those executed for murder, 90% of the rapists, and 45% of the rest were nonwhite. Only 33 were executed under federal law: 16 for murder, 2 for rape, 1 for armed robbery, 6 for kidnapping, and 8 for espionage. Sixty percent of the executions took place in the 17 Southern states, including all but ten of those for rape, and all of those for burglary. The unequal application of the penalty, greatly out of proportion to the relative criminality of racial groups in the South, is seen from the fact that 9 out of 10 rapists, all burglars, and 3 out of 4 robbers were Negroes. No death-penalty state was free from executions, but the total number ranged from 1 in New Hampshire and South Dakota to 366 in Georgia. In addition, the Army and Air Force carried out 160 executions, 148 of them during 1942–50. Of the total, 106 were for murder, 53 for rape, and 1 for desertion. The Navy had executed no one since 1849.

There has been a decline in the annual number of executions in the U.S. Comparing the period 1930–34 with that of 1961–65, the annual average dropped in the Northeastern states from 31 to 2, in the North Central states from 21 to 4, in the Southern states from 84 to 14, and in the Western states from 19 to 6, in spite of a tremendous population increase, especially in the West. There was a record low of execution in 1966 for murder. A part of the reason may be the decline in murder rates, but their decline has been much less than the fall in executions.

Shifts in the method of execution also occurred, prompted by a desire to find the most expeditious and "painless" method. Traditional hanging, used before the invention of the electric chair in 1888 (New York), was still used in 1930 by 19 states and the federal government, but 19 states and the District of Columbia had adopted electrocution and Nevada (1924) the gas chamber. Utah permitted the victim to elect shooting or hanging. By the late 1960s only 6 states used the gallows, 11 gas, Utah its old system of choice, and the federal government whatever method was employed in the state where the prisoner was executed; the rest used electrocution.

During 1900–49, 632 persons were executed in England and Wales for murder; of these, 11 were women. During the same period, 1,210 persons were sentenced to death, including 130 women. The percentage of death sentences executed each decade varied for men from 64% in 1920–29 to 47% in 1930–39, and for women from zero in 1910–19 to 18.5% the previous decade. From 1900 to 1913, in France, 5,388 convictions occurred for capital homicide, but death sentences were imposed in only 6.3% of the cases, and of these 338 only 78, or 23%, were executed. Between the two world wars, 1919–38, 555 (8%) of the 6,969 convictions resulted in death sentences, of which 176 (32%) were executed. During 1945–56, 431 sentences were pronounced and 155 executed, or 36%.

The postwar settlement with enemy collaborators resulted in a great number of executions in the occupied countries. From Aug. 1944 to Oct. 1946, 4,783 persons were executed in France; in Norway there were 37 executions, the last in 1948. In Denmark, Belgium, and the Netherlands there were also large numbers of cases.

Arguments Pro and Con.—Arguments for or against the death penalty are of two kinds. Some are categorical assertions based on traditional sentiments and beliefs. The claims that man's innate sense of justice requires that a murderer should lose his own life, or that man has no right to take life, which the Creator alone may dispose of, fall into this class; yet it is obvious that the "innate sense of justice" is a variable thing, since the world is sharply divided between countries that have abolished the death penalty and those that have retained it. Furthermore, many countries that once thought it "just" to burn witches, to bury adulterous women alive, and to break robbers on the wheel now find it "just" to execute only traitors and murderers.

There is another class of arguments, which are utilitarian or empirical in nature. Those who use them claim that capital punishment produces certain demonstrable effects or serves some demonstrable purpose. They mainly focus on the belief that it has a unique power to deter people from committing crimes. Life imprisonment, it is said, would not be equally effective; furthermore, it would expose prison staffs and fellow prisoners to dangerous murderers; and the risk later extends to the community, since such persons may escape or be pardoned or paroled; further, as long as life termers are in prison they must be supported, and therefore are an economic burden on the state. The death penalty, it is said, even has eugenic value; and without it, lynchings and vendettas might occur.

Opponents challenge the validity of these arguments. They say that there is no proof that capital punishment is more deterrent or protects the community better than does life imprisonment. Errors of justice could lead to the execution of innocent people, which would be intolerable. Sterilization would effectively prevent procreation. In well organized prisons, prisoners would be economic assets. The discriminatory or unequal use of the death penalty causes it to be applied mostly to the poor and defenseless, who cannot afford expensive lawyers or numerous appeals. Its existence complicates the administration of justice, lengthens trials, may lead to unjustified verdicts and greatly increases the burden on appellate courts and pardon authorities.

Regarding deterrence, it is well established by statistical studies that (1) when comparisons are made between contiguous states with similar populations and similar social, economic, and political conditions—some of these states lacking and others retaining capital punishment—homicide rates are the same and follow the same trend over a long period of time, regardless of the use or nonuse of capital punishment; (2) the abolition, introduction, or reintroduction of this penalty is not accompanied by the effect on homicide rates that is postulated by the advocates of capital punishment; (3) even in communities where the deterrent effect should be greatest because the offender and his victim lived there and trial and execution were well publicized, homicide rates are not affected by the execution; (4) the rate of policemen killed by criminals is no higher in abolition states than in comparable death-penalty states. Capital punishment, then, does not appear to have a specific influence on the number or trend of the kind of crime it is supposed to deter people from committing.

It is evident from statistical studies and the reports of prison officials that imprisoned murderers are among the best behaved prisoners and that they rarely commit new crimes—almost never a new homicide—if released. Though very rare, homicides in prison by murderers, whose death sentences were commuted, have been known, but the vast majority of such crimes are committed by prisoners serving sentences for crimes other than homicide, and when prisoners serving sentences for robbery, burglary, or theft are paroled they are later convicted of new crimes 10 to 15 times more often than are paroled murderers.

Executions of innocent persons have undoubtedly occurred, even though rarely, and with the decline in the number of executions and the increasing substitution of imprisonment, the likelihood of such errors is small. That the existence of the penalty may induce a person to seek execution as a devious method of suicide is apparently an accepted fact, rare as such cases may be. The fear that abolition of the death penalty may cause people to take the law into their own hands is unfounded; lynchings have been most frequent in states that have most often employed execution, and the vendetta, still practised in various parts of the world, is mostly confined to countries that have capital punishment.

The Abolition Movement.—Rare and short-lived experiments with abolition occurred in ancient and medieval times, but an effective movement can be said to date from the time of Beccaria. Thirteen of the countries that had abolished capital punishment by 1960 had ceased to apply it for peacetime offenses in the 19th century, and 20 more since 1900. Sporadic returns to the penalty had occurred in some of these states after an earlier experiment with abolition, just as sporadic experiments with abolition had occurred in several jurisdictions that had the penalty in 1960. Restoration was usually due to alarm over some brutal crime or an increase in criminality; its beneficial effects have never been demonstrated. All in all, the trend toward abolition has continued to grow in the peacetime codes of many nations.

See also CRIME: *Varying Attitudes and Practices;* CRIMINOLOGY: *Correction; see* also references under "Capital Punishment" in the Index.

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(T. SN.)

CAPITAL STRUCTURE, a term used to indicate the total amount and type of permanent capital invested in a business concern. Capital structure is not the same as a firm's financial plan, which shows the source of all assets used in a going concern and thus includes short-term as well as long-term borrowings.

A business firm's capital structure includes all outstanding capital stock and surplus, together known as net worth, as well as long-term creditor capital. All classes of capital stock are included in net worth, plus all classes of surplus accounts and certain reserve accounts, minus all operating or capital deficits. Other items included in the capital structure are pension fund liabilities, deferred income tax arising out of the use of accelerated depreciation, and intermediate-term loans. Some analysts also include a money figure representing an estimate of the capitalized value of long-term leases. Valuation reserves, such as a reserve for depreciation, would not be included. (O. R. G.)

Differences in Terminology.—There are, of course, variations in the detail of approach, not only as between different investment analysts but as between Great Britain and the United States. In the latter country some analysts would regard financial facilities as permanent if committed for more than one year. In Britain, any period from 1 to 5 years would be considered short term; 5 to 15 years would be medium term; and over 15 years, long term. The distinction is of importance particularly concerning the issue of loans of whatever type. Some analysts would be prepared to include short-term borrowing in the capital structure, while others would take a contrary view. Again, in the United States, some analysts would include in the capital structure a figure, admittedly estimated, representing the capitalized value of long-term leases when property has been the subject of sale-cum-lease back arrangements. In that country, too, some would exclude depreciation, while in Britain such a reserve would be admitted.

There are differences in terminology between the two countries which merit noting at this stage. Bonds in the United States are the debentures of Great Britain. Although the word bond is often used in Britain, it frequently refers to foreign government issues or is used indiscriminately to mean a debenture. On the other hand, debenture, when used in the United States, corresponds to what is known in Britain as an unsecured loan note. It is the practice in the United States to refer to bonds and preference stocks obviously ranking before the equity as senior securities or charges. Senior, in this context, is not used in Britain, but a recognized and accepted term is prior charges and capital.

By reason of the very nature of business growth, capital structure must fluctuate continually, although the nominal capital of a company may be relatively constant. Additional resources are generated from profitable trading operations and profits are "combed back" or "plowed back" into the business, appearing in the balance sheet as reserves or cash, or some form of investment such as (in Great Britain) tax reserve certificates or treasury bills. Sometimes, however, the dynamic expansion of a firm is insufficient to provide all its capital requirements from its own profit-making capacity. In such cases, further capital can be raised by means of a rights issue. The essentials of capital structure are, therefore, loans and prior charges, equity and reserves. (GA. S.)

Variations in Practice.—The capital structures of different firms and industries vary widely. Financial managers consider industry capital structure patterns in evaluating and designing a plan for a specific company, taking into consideration the financial and operating characteristics of the firm. Executives differ in their attitude toward risk, and exercise considerable discretion when adding to business risks through using leveraged capital structures. The ideal capital structure is one that provides sufficient capital to provide for efficient and profitable operations, a maximum rate of return with a minimum of financial risk, and a minimum dilution of control.

In the period following World War II, financial managers showed a greater willingness to use debt as a means of offsetting the effects of inflation. Another influence working in the same direction was the widespread belief in a growing economy. At the same time, tax rates and regulations had the effect of easing the burden of meeting income and capital maturities.

The use of borrowed funds or preferred stock is known in the U.S. as "trading on the equity." The term is not commonly used in Great Britain, but the practice is common. The extent of trading on the equity can be measured by the proportion of fixed income capital to total capital structure or can be measured by the leverage (or gearing as it is known in Britain); *i.e.,* the ratio of debt plus preferred stock to equity capital. The customary reason for trading on the equity, when the company is not obliged to do so, is in the hope of employing the senior funds at a rate of return higher than their cost in order to increase the return on the investment of the residual owners. The investment of the common stockholders serves as a protection to both the income and principal of the bondholders. Stockholders thus "trade" on the strength of their "equity." If earnings are high, they profit by the transaction; if earnings are poor, they lose by having to pay more in interest than the added investment earns. In a capital structure of $100,000, $50,000 of which represents bondholders' investment at an interest rate of 5%, and $50,000 representing equity, total earnings of $10,000, before interest but after taxes, would represent a 10% rate of return on the capital structure. The bondholders would receive 5% and the equity would earn 15%, reflecting the different nature of their earnings claims and the effect of leverage. Stockholders also risk partial or complete loss of their own investment if conditions grow so bad that the corporation is unable to fulfill its contractual obligations to bondholders.

The use of financial leverage involves a compromise between the liquidity function and the profit function of the financial manager. Cash flows must be arranged to meet fixed payments on debt; the more sales and profits fluctuate, the more difficult is the task of the financial manager in meeting the cash outflow for interest and debt repayments. One therefore finds a much greater willingness on the part of companies with stable sales and profits, such as U.S. electric utilities, to use higher degrees of leverage, resulting in capital structures carrying 50%–70% in senior capital. Before nationalization, the position of British electric companies was similar.

On the other hand, manufacturing and retailing have volatile earnings and sales and use a much lower degree of financial leverage, when possible. Net profit contributions through a capital structure design which emphasizes financial leverage would be minor, ordinarily, when compared to the net profit contribution of such factors as operating and financial efficiency, and would add substantial nonoperating risks to the business operation. One cannot create, only potentially improve, profit by financial design since the company must be profitable before it can gain an advantage by trading on the equity. Management should consider availability, suitability, maneuverability, risk, control and income among the major factors affecting the character of the capital structure. Therefore, the demands of essential capital contributors for a creditor relationship, the nature of the assets employed, the desire of the managers to increase the return to the equity holders by trading on the equity, and the ability of the company to generate and plow back earnings are important. The reluctance to share control, the relative costs of new financing, the utilization of available short-term credit and governmental actions in the areas of stability, inflation, regulation and taxes are also significant.

Managerial decisions on the extent of the use of credit in business operations and the availability of creditor capital for private and public enterprise directly affect the vitality of the economic system. An increased use of credit allows a greater utilization of available entrepreneurial, or risk, capital and results in an increase in productivity and in rate of economic growth. The economic risk created by the increased use of credit is one of greater instability and uncertainty in the course of the business cycle due to possible changes in the attitudes and demands of creditors. *See* also ACCOUNTING. (O. R. G.)

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CAPITO (KÖPFEL), **WOLFGANG FABRICIUS** (1478–1541), a leading reformer at Strasbourg, the son of a distinguished senator and master smith (hence "Fabricius"), was born at Hagenau in Alsace. His father was opposed to church vocations, so Wolfgang studied at Ingolstadt and Freiburg, becoming doctor in medicine and in law. After his father's death, he took a doctorate in theology at Freiburg and in 1512 became diocesan preacher in Bruchsal. There he came to know the future reformers John Oecolampadius and Conrad Pellicanus. When called to Basel in 1515 as cathedral preacher he lectured also at the university, became a friend of Erasmus and Zwingli, a correspondent of Luther, and a diligent biblical scholar, editing the psalter in Hebrew (1516). Somewhat to his dismay, the elector archbishop Albrecht of Mainz summoned him (1519) to Mainz as cathedral preacher, and later as chancellor. Badly torn in conscience, he twice visited Wittenberg, met Luther, and, despite an imperial patent ennobling him, finally (1523) left the service of Albrecht to settle upon a post at Strasbourg that had been given him by the pope (without cure) in 1521. Shortly, he was second only to Martin Bucer (*q.v.*) in the reform activities of Strasbourg and southern Germany. Though usually guided theologically by Bucer, he remained friendly to the Anabaptists and other dissenters until 1534. With Bucer he drafted the *Confessio Tetrapolitana* (1530). His most important work, on church discipline, was the *Berner Synodus* (1530). He was a participant in several important church councils. He died at Strasbourg in Nov. 1541.

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CAPITULARY (Lat. *capitulare*), the name given to certain acts of legislation, regulation or administration promulgated by the Carolingian sovereigns of western Europe. They are so called because they are divided into articles (*capitula*). The word *capitulare* is in fact first found in 779, in the reign of Charlemagne, but similar acts (*edicta* and *decreta*) were promulgated by the Merovingian kings.

As no capitularies are extant in their original form, their texts can be studied only through copies. In the manuscripts in which they have been transcribed, the capitularies are usually arranged in groups or classifications. In most cases this does not destroy their individuality, but in two collections compiled in the 9th century their individuality is considerably obscured. The first of these two, dating from 827, is the work of Ansegisus, abbot of the monastery of Saint Wandrille (Fontenelle). In it the contents of 26 capitularies are distributed in four books, the *capitula* being numbered consecutively in each book. The second such collection, made 20 or 25 years later by Benedictus Levita (Benedict the Deacon), purports to be a continuation of Ansegisus' collection by three further books. In reality, however, though it contains some articles lifted from genuine capitularies, it also contains material that has been recast, or expanded by interpolation, or even taken from documents which had nothing to do with Carolingian legislation. Hence this collection is usually designated as the *False Capitularies.*

In 1677 the French scholar Étienne Baluze published the text of most of the capitularies in two folio volumes, *Capitularia regum Francorum*, but the first critical edition was that by G. H. Pertz (1835), the first volume of the folio section of the *Leges* in the collection *Monumenta Germaniae historica.* The later edition by A. Boretius and V. Krause, two volumes (1883–97), the quarto series of the same collection, is that usually quoted by scholars.

As early as the Carolingian period those capitularies which dealt with ecclesiastical matters, *capitula ecclesiastica, ad ordinem ecclesiasticum pertinentia*, came to be set apart from those dealing with secular affairs, *capitula ad mundanam pertinentia legem.* Further distinctions were made between (1) *capitula legibus addenda*, (2) *capitula per se scribenda* and (3) *capitula missorum.* The *capitula legibus addenda* were those intended to supplement or to modify the national laws of the peoples of the Carolingian empire. They were therefore concerned, as were the laws themselves, with the penal law, with rules of procedure or with private law; *e.g.*, the *capitulary* added to the Ripuarian law (803), the *capitula* added to the Bavarian law (also probably 803), and the *capitula* added to the Salic law (819–820). The *capitula missorum* were instructions for the king's *Missi* or envoys (*see* MISSI DOMINICI), who were sent in pairs to a group of countries to supervise the local administrations, to stop abuses and to ensure obedience to the royal commands. The *capitula per se scribenda* are more difficult to characterize. Whereas the *capitula missorum* were issued to individuals, the *capitula per se scribenda* applied to a territory and contained provisions of a more general and permanent character. Finally, a distinction was made between Frankish and Italian capitularies, the latter valid only for the kingdom of Italy (corresponding to the former Lombard kingdom).

For the most part these distinctions are only approximate. Many capitularies deal both with ecclesiastical and with secular matters, and, as F. L. Ganshof has pointed out, several capitularies drawn up for *missi dominici* contain articles of general application, while *capitula per se scribenda* sometimes contain articles modifying national law or laws or even include instructions to *missi*. The Carolingians did not legislate according to a fixed system, and although certain capitularies are confined to one subject (such as the noted capitulary *De villis*, by which Charlemagne regulated the administration and the exploitation of the royal domains), most of them contain measures unrelated to each other. Even from the point of view of diplomatic they are not uniform.

Most of the capitularies were submitted to the *placitum* (assembly) of the notables for their *consensus*, but many historians believe that, at least up to the last years of the reign of Louis I the Pious, their force of law was derived from the royal authority alone and that the *consensus* was not a genuine vote of approval that the assembly could, if it wished, withhold.

After Louis I's death the Carolingians of Germany ceased to promulgate capitularies. Charles II the Bald, however, issued many. The last capitularies to be issued by a Carolingian are two of the French king Carloman and belong to the years 883 and 884.

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CAPITULATIONS, treaties by which one state conferred upon another state the privilege of exercising extraterritorial jurisdiction within its boundaries over nationals of the latter state (*see* EXTERRITORIALITY). The term arose because treaties of this type with Turkey were divided into chapters (*capitula*), and is to be distinguished from the military term "capitulation," an agreement for surrender. There was no element of surrender in the early capitulations made by European rulers with the powerful Turkish sultans who were motivated by a desire to avoid the burden of administering justice to foreign merchants. Later, ideas of exclusive territorial sovereignty penetrated to the eastern states, and capitulations, which in the case of China and other Asian states had resulted from military pressure by European states, came to be regarded as humiliating derogations from the sovereignty and equality of these states.

The legal explanation of the practice is to be found in conflicting conceptions of sovereignty and of law. In contrast to the modern conception, which relates sovereignty to territory, early conceptions related it to persons. The sovereignty of the state was held to apply only to its nationals. The privilege of citizenship was too precious to be extended to the alien, who was long practically an outlaw and his state sought to protect him and exercise jurisdiction over him even when he was living abroad. Therefore, when the numbers, wealth and power of foreigners residing within a state became such that it was felt politic to subject them to some law, it was naturally held that this law should be their own. This was particularly the case when people from Christian countries were living in countries where the principles of justice were based on non-Christian traditions. Thus, Christians living in Turkey would have been bound under Muslim law by the maxim that the oath of a Christian could not be accepted against a Muslim, and foreigners in China would have had to accept such alien ideas of justice as that of collective criminal responsibility, and indifference to any distinction between accidental and willful homicide.

Early examples of extraterritorial rights are to be found in the privileges enjoyed by the Phoenicians in Memphis in the 13th century B.C., the guarantees and commercial facilities accorded by Harun al-Rashid to the Franks in the 9th century A.D., and the concessions made to certain Italian city-states by the prince of Antioch and the king of Jerusalem in 1098 and 1123. The Byzantine emperors followed this example, and by the end of the 12th century Genoa, Pisa and Venice had all obtained capitulations. The system was continued under the Ottoman sultans, and capitulation treaties were signed with Genoa in 1453 and with Venice in 1454. In 1536 a capitulation treaty was signed between Francis I of France and Suleiman I of Turkey which became the model for later treaties with other powers. It allowed the establishment of French merchants in Turkey, granted them individual and religious liberty and provided that consuls appointed by the French king should judge the civil and criminal affairs of French subjects in Turkey according to French law, with the right of appeal to officers of the sultan for help in carrying out their sentences. Until 1583, when England obtained its first capitulation, France was the official protector of all Europeans in Turkey. Later, England claimed to protect the subjects of other nations, but in 1607 it was laid down that the subjects of all nations not represented at Constantinople by an ambassador should be under French protection. At first capitulations were for the sultan's lifetime only, but in 1740, after France's friendship had secured for Turkey a successful negotiation of the peace of Belgrade, a capitulation in perpetuity, which could not be modified without French consent, was granted. During the 18th century nearly every European power obtained capitulations in Turkey, and in the 19th century such newly established countries as the United States, Belgium and Greece followed suit.

The capitulation system spread widely in the 17th, 18th and early 19th centuries, when traders from the west were spreading western influence by a process of infiltration rather than by annexation. An interesting case was that of China. The first commercial treaties concluded with foreign powers, *e.g.*, that with Russia in 1689, granted special rights and privileges to nationals of both countries when living on one another's soil. Later, the system of "unequal treaties" was developed, and such treaties as the Chino-British supplementary treaty, 1843, and its later modifying enactments, set up a system of provincial courts and a British supreme court in China to try all civil and criminal cases involving British subjects, but granted no corresponding rights to Chinese residents in Britain. Capitulations in China were obtained by 17 other European powers, by the United States, and by Japan; Japan also obtained such rights in other countries.

Another country in which the system was of special interest was Egypt, which continued to grant capitulations to foreigners even after it ceased to be part of the Ottoman empire. In 1875, however, mixed courts were set up to decide civil and commercial cases between Egyptians and foreigners and between foreigners of different nationalities. Three district courts were established, at Cairo, Alexandria and El Mansura, each with one Egyptian and two foreign judges, with a court of appeals composed of six Egyptian and ten foreign judges, at Alexandria. Modifications introduced in 1889 and 1911 gave the court of appeals the right to approve legislation to be applied to foreigners.

Other countries where capitulations were in force during the 19th and early 20th centuries were Japan, Persia, Siam, Iraq, Abyssinia (despite the fact that it was a Christian country), Morocco, Albania, Crete, Tripolitania, Muscat and Bahrain.

The evils to which the system gave rise were exemplified particularly in Turkey and China. The fact that a foreign consul had jurisdiction in all matters concerning foreign nationals early led to encroachments on Turkish rights of sovereignty, and it was possible for foreign governments to levy duties on goods sold in Turkish ports; *e.g.*, the 2% duty established on Venetian goods by the treaty of Adrianople in 1454. Foreign powers were also able to set up banks, post offices and commercial houses on Turkish soil which were exempt from Turkish taxes and were able to compete with local firms. In both Turkey and China the existence of capitulations led to the development of a class immune from local jurisdiction—protégés of a foreign power, who, because they were employed by foreigners, claimed partial immunity from their own laws and were particularly useful as pawns in diplomatic intrigue. In China, especially, it was possible for fugitives from Chinese justice to seek sanctuary with foreigners. Then, inevitably, foreigners misused their privileges; their own law was sometimes badly administered, their courts tended to favour their own nationals at the expense of the natives of the countries in which they were living (particularly in China, where there were no mixed courts) and the way was opened for bribery and corruption. In the Chinese treaty ports, a multiplicity of territorial settlements and concessions, practically exempt from local jurisdiction, led inevitably to administrative confusion; each foreign legation had its own, sometimes conflicting, rights. A special political development arose when Manchuria, which was Chinese territory, was penetrated by Koreans who claimed exemption from Chinese law under the capitulations granted by China to Japan.

One positive effect of the system, however, was to be found in the example offered by the western ideas of justice. These, particularly in Turkey, became the basis for the development of a sound administrative and judicial system.

Inevitably, as the eastern countries became more conscious of their own sovereignty rights and more resentful of western domination, agitation began for the ending of capitulatory rights. At the same time improvements in the administration of justice made the western powers more willing to relinquish these rights. Turkey first raised the question of their abrogation in 1856, and in 1914 served notice on the Allies and on the central European powers that all capitulatory rights should cease. The United States denied the validity of unilateral abrogation, but the Central Powers formally relinquished their rights in 1919, Soviet Russia spontaneously renounced all such rights in 1921, and at the peace treaty between the Allies and Turkey signed at Lausanne in 1923 the capitulations were brought to an end. The first country to conclude treaties ending capitulations had been Japan (1899); they were ended in Tripolitania in 1911, in the Ottoman territories acquired by Greece and in Crete in 1914, in Morocco in 1920, in Siam in 1927, in Persia in 1928, in Iraq in 1931, in Abyssinia in 1936 and in Egypt (subject to a 12 years' modified transitional period) in 1937.

In China, agitation against capitulations led representatives of the powers concerned to provide, at the Washington conference of 1922, for a commission to make recommendations on the subject. The commission met in Peking in 1926, and recommended gradual abrogation. Treaties were concluded by China in 1928 with Belgium, Italy, Portugal, Spain and Denmark which conditionally abolished capitulations. In 1929 the Chinese government declared that all remaining rights should be at an end, but it was not until 1943 that Great Britain and the United States formally relinquished their rights in China. With that, except for certain arrangements in Muscat and Bahrain, capitulations ceased to exist and the equality of states, long recognized in the theory of international law, was recognized also in practice. *See* CONSUL; EXTERRITORIALITY.

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(Q. W.)

CAPIZ, a province of northern Panay Island, Republic of the Philippines. Land area 1,017 sq.mi.; pop. (1970 est.) 441,000. Rice and sugar cane are the chief crops grown in the eastern section, where pond raising of fish and coastal fishing also are important. Rice, coconuts, and abacá (Manila hemp) are the chief crops of the Aklan valley. The eastern area ships its surplus rice to nearby islands, whereas Aklan valley rice surpluses go to towns on the west coast of Panay.

The capital, Roxas City (formerly Capiz), received its new name and charter in 1951 (pop. [1970 est.] 69,400 [city]). The city is located on the Capiz River, 4 mi. from the sea, with port facilities at the river mouth, at which interisland ships call regularly. Roxas City is the northern terminus of the transisland railway running to Iloilo. In 1957 about half of Capiz province was created into Aklan (*q.v.*) province. (J. E. SR.)

CAPMANY Y MONTPALAU, ANTONIO DE (1742–1813), Spanish scholar and politician, was born at Barcelona, Nov. 24, 1742, and died at Cádiz, Nov. 14, 1813. He became secretary of the Real Academia de la Historia and, during the Napoleonic invasion, represented Catalonia in the nationalist *Cortes* of Cádiz. Among his best works are *Memorias históricas sobre la marina, comercio y artes de la antigua ciudad de Barcelona* (1779–92) and *Teatro histórico-crítico de la elocuencia española* (1786–94), an anthology meant to prove to foreign critics, who judged Spain's past by its present decadence, that its language and literature are among the finest in Europe. Later he entered into controversy with the poet Quintana. (I. L. Mc C.)

CAPO D'ISTRIA, GIOVANNI ANTONIO: *see* KAPODISTRIAS, IOANNES ANTONIOS, COUNT.

CAPPADOCIA, the ancient name of a district in eastern Asia Minor, stretching from the Taurus mountains in the south to the Black sea in the north, and bounded on the west by the great central salt desert and Lake Tatta (mod. Tuz Gölü), and on the east by Armenia and the Euphrates river. Originally a whole, it was divided for administrative purposes by the Persian kings into two satrapies, Pontic Cappadocia, the northern region (*see* PONTUS), and Cappadocia proper or Greater Cappadocia, which comprised the central and southern districts, the subject of the present article. Its area has been estimated at 33,000 sq.mi.

The country forms a rugged tableland, with extremes of temperature and a poor soil. Mountain barriers cut it off from both the Mediterranean and the Black sea. For a long time there were no cities and little intercourse with neighbouring lands. The rearing of horses was one of the few things for which the wild terrain was suitable. The yearly tribute to the Persian kings consisted of 1,500 horses, 2,000 mules and 50,000 sheep. The ancient temple state of Comana (*q.v.*) in southern Cappadocia where the great nature mother-goddess Ma was worshiped, and the similar temple of Zeus at Venasa in western Cappadocia, with their high priests and thousands of temple slaves, survived into the 1st century A.D.

When Cappadocia became part of the Persian empire in the 6th century B.C., it attracted settlers from Iran, some of whom were priests or magi of the fire worship of Zoroaster, who introduced their cult (*see* ZOROASTRIANISM), while others became local dynasts, living in strongholds from which they dominated the countryside, ruling the native population who became their serfs. This feudal system, which had no doubt prevailed before the Persian conquest, continued until the country became a Roman province in the 1st century A.D.

During his campaigns in Asia (334–323) Alexander the Great did not find time to conquer Cappadocia, but in 322 Perdiccas (*q.v.*) subdued it and installed Eumenes (*q.v.*) as satrap. Macedonian control under Antigonus I and later under the Seleucid kings (*see* SELEUCID DYNASTY) was slack. A native dynasty exercized power in the country after the death of Antigonus at the battle of Ipsus in Phrygia (301), as it had done earlier under the Persians and Alexander. These rulers were nominally vassals of the Seleucid king. About 255, however, Ariarathes III proclaimed his independence by taking the royal title. This king and his successor Ariarathes IV married daughters of ruling Seleucids, and Ariarathes IV supported Antiochus III till his defeat by the Romans at Magnesia in 190, whereupon Cappadocia became a client kingdom of Rome. Ariarathes V, reigning from about 165 to 130, followed a policy of unfaltering loyalty to Rome. Educated at Athens, he was Greek in outlook and sympathies. Under him Hellenization, hitherto very slow, was speeded up. His sister became the wife of Eumenes II of Pergamum. But in 130 he was killed while fighting alongside the Romans against the Pergamene pretender Aristonicus, and Cappadocia entered a long period of chaos. The two following kings Ariarathes VI (d. 111) and VII (d. *c.* 100) were assassinated, and by 96 Mithradates VI, king of Pontus, was in control. This foreign occupation was resisted by the Cappadocian nobles. They invited Roman intervention, and one of their own number, Ariobarzanes I. Philoromaios, was appointed king and recognized at Rome (*c.* 95).

After the overthrow of Mithradates (63) and Pompeius' reorganization of the east, Cappadocia was bound even more closely to Rome as a client kingdom. Ariobarzanes III (*q.v.*) was succeeded in 42 by his brother Ariarathes who was deposed by Antony in favour of Archelaus (*q.v.*) in 36 B.C., who ruled until the emperor Tiberius called him to Rome about A.D. 14. After his death (A.D. 17) the kingdom was annexed by Tiberius as a Roman province governed by a procurator. It came to be an important military district because of its strategic position on the Roman frontier with Armenia, and later it had the large garrison of two legions. Two cities only were important, Mazaca, the royal capital (later Caesarea, mod. Kayseri [*q.v.*]), and Tyana (10 mi. S.W. of mod. Nigde). The population was distributed under the kings into ten *strategiae* (generalships), and these administrative divisions were retained by the Romans. Before the Roman annexation Cappadocia had developed very gradually into an area of Greek civilization and language, the native and Iranian elements being overcome. The Roman occupation ensured that Hellenism retained its dominance, and through improving communications and facilitating the exploitation of natural resources it brought a greater prosperity to the region.

See D. Magie, *Roman Rule in Asia Minor* (1950). (R. H. Sr.)

CAPPARIDACEAE, the caper family, mainly tropical plants with strong drought resistant tendencies. It includes herbs, shrubs or trees, with simple or palmately compound alternate leaves, and mostly bisexual, somewhat irregular flowers, with usually four separate sepals and petals, six to many stamens, a superior one-celled ovary and fruit that may be sessile but is more characteristically stalked. The family is closely related to the more temperate (mostly northern) mustard family (Cruciferae).

The Capparidaceae has been divided into two major subfamilies. The woody Capparidoideae have indehiscent, rather fleshy berries or pods and usually many stamens. The pantropical, simple-leaved genus *Capparis* (200 species) includes *Capparis spinosa,* the caperbush, grown for its flower buds, which, when pickled, are sold as capers (*q.v.*). Some species of *Capparis* are characteristic desert shrubs of South America, Africa and Asia; others are trees of tropical rain forests of the Amazon region, and jungle climbers of southeastern Asia. Two species occur in the Florida keys. Other genera include the tropical garlic pear, *Crataeva religiosa,* and the African desert genera *Maerua* (about 40 species) and *Boscia* (30 species).

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THE PINK SPIDERFLOWER (CLEOME SPINOSA)

The mainly herbaceous subfamily *Cleomoideae* have dry capsules dehiscent by two valves, which fall from a hoop-shaped placenta releasing the seeds; usually six stamens; and palmately compound, rarely simple, leaves. The large, mainly annual genus *Cleome* (200 species) is nearly world-wide in tropical to temperate-arid regions. *Cleome hassleriana* (*C. spinosa*), native from southeastern Brazil to northeastern Argentina, is the commonly cultivated pink spiderflower; *C. speciosa* is frequently cultivated in the tropics. *Cleome serrulata,* Rocky Mountain bee plant, is widespread in the western mountains. *C. isomeris,* burro-fat, is characteristic of California deserts. *C. viscosa* and *C. gynandra* are pantropical weeds. *Polanisia* (6 species) is clammyweed, common in North America. (H. H. I.)

CAPPEL, LOUIS (Ludovicus Capellus) (1585–1658), French Huguenot theologian and Hebrew scholar, was born Oct. 15, 1585, at St. Elier, near Sedan. He studied theology at Sedan and Saumur, and Arabic at Oxford, where he spent two years. In 1613 he accepted the chair of Hebrew at Saumur, and in 1633 became professor of theology. It was Cappel who first concluded that vowel points and accents were not an original part of Hebrew but were inserted by the Masoretic Jews of Tiberias, not earlier than the 5th century A.D., and that the primitive Hebrew characters are those now known as Samaritan, while the square characters are Aramaic and were substituted for the more ancient at the time of the captivity. Cappel's important *Critica Sacra* (1634) met with such theological opposition that he was not able to print it until 1650, at Paris, and then only by the aid of a son who had turned Roman Catholic. The various readings in the Old Testament text and the differences between the ancient versions and the Masoretic text convinced him that the integrity of the Hebrew text, as held by Protestants, was untenable. This amounted to an attack on the verbal inspiration of Scripture. Bitter as was the opposition, however, it was not long before his results were accepted by scholars.

CAPPONI, GINO, Marchese (1792–1876), Italian historian and statesman whose writings contributed to the inspiration of the Risorgimento, was born in Florence on Sept. 13, 1792, of an ancient Florentine family. After the restoration of the Habsburgs to the grand duchy of Tuscany in 1814, Capponi began a long period of travel that brought him into touch with the most notable intellects of his day in England (where he formed a lasting friendship with Lord John Russell), in Scotland, the Netherlands, Germany and Switzerland. Returning to Florence in 1820, he devoted himself to historical studies and to promoting the economic and educational welfare of Tuscany. The periodical *Antologia* that he founded in 1821 was modeled on the *Edinburgh Review* (as a result of his meeting with Francis Jeffrey in Scotland), and he was also one of the founders of the periodical *Archivio storico.* By 1844, however, he had become completely blind. Nevertheless, in 1848, when the grand duke Leopold II decided to grant his people a constitution, Capponi, whose writings had gained him a reputation as a liberal, was appointed prime minister (Aug. 17–Oct. 27). Having voted for the union of Tuscany with the kingdom of Sardinia in 1859, he was made a senator in 1860.

Capponi's *Pensieri sull'educazione* appeared in 1845, and in 1848, despite his blindness, he began his great work, the *Storia della repubblica di Firenze* (1875). He died in Florence on Feb. 3, 1876. A large number of his miscellaneous writings were published under the title of *Scritti inediti* (1877); there are also selections, *Le più belle pagine,* ed. by G. Gentile (1926).

CAPPS, EDWARD (1866–1950), U.S. classical scholar, noted as an authority on the Greek theatre, was born in Jacksonville, Ill., on Dec. 21, 1866. He graduated from Illinois college, Jacksonville, in 1887 and received the degree of Ph.D. from Yale university in 1891. In 1890 he was appointed tutor at Yale. He was professor of Greek language and literature at The University of Chicago from 1892 to 1907. In 1903 he was special lecturer at Harvard and during the next two years studied in Europe at Athens and Halle. During 1906–07 he was managing editor of *Classical Philology* and in 1907 was called to Princeton university as professor of classics. In 1914 he was president of the American Philological association and in 1917 was Turnbull lecturer on poetry at Johns Hopkins university, Baltimore, Md. In 1918 he was appointed head of the American Red Cross commission to Greece and became also chairman of the managing committee of the American School of Classical Studies at Athens. In 1920 he was appointed minister to Greece, resigning in March 1921 and returning to Princeton. He was editor in chief of The University of Chicago decennial publications, 29 volumes, and became the U.S. editor of the Loeb Classical Library. His works include *The Greek Stage According to the Extant Dramas* (1891); *From Homer to Theocritus* (1901); *The Introduction of Comedy Into the City Dionysia* (1903); and *Four Plays of Menander* (1910).

CAPRAIA (Lat. Capraria, from *capra,* "wild goat"), an Italian island between the mainland of Italy and the north point of Corsica, lies 50 mi. S.S.W. of Leghorn. Pop. (1961) 619. Area 7.4 sq.mi. Belonging to Leghorn province, the island is volcanic and rises to about 1,467 ft. It produces wine and is a centre of the anchovy fishery. It became Genoese in 1527 and was strongly fortified. About 24 mi. N. is Gorgona island (2 sq.mi.)

also famous for its anchovies. Both islands have penal colonies. (G. Kh.)

CAPRARA, GIOVANNI BATTISTA (1733–1810), Italian ecclesiastic and diplomat, who negotiated between the Vatican and Napoleon, was born at Bologna on May 29, 1733. After service at Ravenna he became nuncio at Cologne in 1767, at Lucerne in 1775 and at Vienna from 1785 to 1792, in which year he was created cardinal. Despite his long diplomatic career Caprara was too timid and pliant to be an effective defender of papal interests in a period of exceptional difficulty. It was doubtless knowing this that Napoleon requested that Caprara be appointed legate in France to implement the terms of the concordat and that in Feb. 1802 he procured for him the archbishopric of Milan. At his formal reception in Paris on April 9, 1802, Caprara appeared to commit himself to respect the Gallican liberties, and in the issues of the institution of former "constitutional" bishops and the retracting of their errors by "constitutional" clergy, as in other matters, he accepted compromises unpalatable to the Vatican. He assisted in the negotiations leading to Napoleon's coronation by Pius VII in 1804 and himself crowned him king of Italy in 1805. Caprara died in Paris on June 21, 1810.

See V. Bindel, *Histoire religieuse de Napoléon* (1940). (J. P. T. B.)

CAPRERA (Isola Caprera), an island 4 mi. in length off northeast Sardinia, in Sassari province, Italy, is connected by causeway with the adjacent island of Maddalena. Pop. (1951) 114. The Italian patriot Giuseppe Garibaldi (*q.v.*) established himself there in 1856 and died there on June 2, 1882. His house and tomb are national monuments.

CAPRI (Isola di Capri), an island in the Bay of Naples in Napoli province, Campania, Italy, 6.25 km. (3.9 mi.) long with a maximum width of 3 km. (1.8 mi.) and an area of 10.36 sq.km. (4 sq.mi.). Its highest point is Monte Solaro, 589 m. (1,932 ft.), in the west, above a group of cliffs rising 274 m. (899 ft.) sheer from the sea. The island is a single block of limestone, consisting of a western high portion, where the town of Anacapri, 275 m. (902 ft.), is located, and an eastern lower portion upon which stands the capital, Capri, 138 m. (453 ft.). Two small indentations on the coast serve as landing places: Marina Grande, on the north shore, is protected by a breakwater, while Marina Piccola on the south shore, which is open, is used when the north wind is particularly strong. Until a carriage road was built in the late 19th century between Capri and Anacapri, the latter could only be reached from the sea by a flight of 800 steps (now there are less) called the "Phoenician stairs." Although there is a general lack of water, vineyards, olive groves and gardens are highly productive, as the climate is exceptionally mild. The flora is among the most varied in Italy and large numbers of migratory birds often rest there for days. The name of the island may have two possible origins: either *capra* (goat) or *kapros* (wild boar). Stone age artifacts have been found in one of the caves with which the rocky shores of Capri abound; the most notable of which, the Blue Grotto (Grotta Azzurra), on the north coast, can only be reached by boat. Its entrance, shaped roughly like a keyhole with much the greater part below the water line, is barely 4 ft. high and sunlight entering through the water gives to it an extraordinary blue light. Although known in Roman times, this cave was rediscovered in 1826.

Capri, at one time joined to the mainland, was inhabited in prehistoric times and later became a Greek colony and then a resort (Capreae) of emperors in the early years of the Roman empire. Augustus resided there and Tiberius built several villas, one of which, the Villa Iovis on the northeastern tip of the island, was excavated. Its view of Naples and the Sorrento peninsula is exceptionally fine. To the northeast of Anacapri rise the ruins of the Castello di Barbarossa, destroyed in 1535, and in the same neighbourhood is the Villa San Michele, built by the Swedish writer, Axel Munthe, on the site of a Tiberian villa. The oldest church (10th–11th centuries) is that of S. Costanzo, the island's patron saint.

During the 10th century the population, fearing pirate raids, moved from seaside settlements to the present towns high above the shore. In the middle ages Capri belonged to the abbey of Monte Cassino, and later to the republic of Amalfi. In the course of the Napoleonic wars it changed hands several times, and in 1806 was captured by the British fleet under Sir William Sidney Smith. Although strongly fortified by the governor, Sir Hudson Lowe, it fell again to the French, led by Maximilien Lamarque, in 1808, and was returned to the kingdom of the Two Sicilies in 1813. Since the second half of the 19th century, Capri has gradually become one of the most popular resorts of southern Italy. There are numerous hotels in Capri and Anacapri, and villas scattered throughout the island. A frequent steamer service connects Capri with Naples and Sorrento. Capri had a population of 9,292 in 1951.

See Norman Douglas, *Siren Land* (1911); Axel Munthe, *The Story of San Michele* (1929). (G. Kh.)

CAPRICCIO, an Italian name, in English and French caprice, given to various types of musical compositions, usually implying a vivacity of rhythm and a freedom of construction. In the 16th century the term was synonymous with the vocal *canzone* and the instrumental fantasia and *ricercare*. In the 17th century Girolamo Frescobaldi wrote fugal capriccios on themes of arias or to illustrate devices of counterpoint, and Domenico Scarlatti gave the title *Capriccio* to one of his one-movement sonatas. The term was widely applied in German 18th-century keyboard music, notably by J. S. Bach. Nineteenth-century examples include the 24 capriccios, in the form of studies, for violin solo by Paganini, and the brilliantly scored *Capriccio italien* by Tchaikovsky and the *Capriccio espagnol* by Rimski-Korsakov. The term *capriccioso* was used by Weber and Mendelssohn to convey a fleeting sense of fantasy.

In the 20th century the title *Capriccio* was used by Igor Stravinsky for his three-movement piano concerto (1929) and by Richard Strauss for his one-act opera (1942).

CAPRICORNUS (the Goat), in astronomy, a constellation and sign of the zodiac. The word is derived from Lat. *caper*, "goat," and *cornu*, "horn." The constellation was sometimes pictured as a goat with the tail of a fish. Its stars, which are generally faint, outline the figure of an inverted cocked hat. The sign Capricornus, which has shifted to the west of the constellation, gives its name to the tropic of Capricorn. When the sun, about Dec. 22, arrives at the winter solstice and enters the sign, it is directly above this important circle of the earth. (R. H. Br.)

CAPRIFOLIACEAE, the honeysuckle family, dicotyledonous plants of the order Rubiales, most closely related to the Rubiaceae (madder family). They are shrubs, rarely vines (*Lonicera*) or herbs (*Triosteum, Sambucus ebulus*); the leaves are opposite, simple (pinnate in *Sambucus*) and without stipules (except *Sambucus*); the flowers are bisexual and clustered (in two's in *Linnaea, Lonicera*); the calyx tube is united with the ovary (ovary inferior); the petals are united into a tubular or open, five-lobed, regular or two-lipped corolla; the stamens are five (rarely only four) and borne on the corolla tube alternate with the lobes; the ovary is one–eight-celled; the fruits are fleshy or dry.

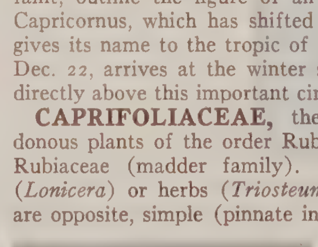
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FIG. 1.—FRUIT OF VIBURNUM

The family contains about 13 genera and 400 species, many of which are important in horticulture. They are propagated by seeds, layering or by cuttings. Since they are mostly native in northern parts of Eurasia and America they are usually rather hardy. The largest genus is honeysuckle (*Lonicera*), with 175 species, about 50 of which are in cultivation, among them the woodbine (*L. periclymenum*), a twining European plant, and the Japanese honeysuckle (*L. japonica*). The latter escaped from cultivation to become one of the worst weeds of the eastern United States, scrambling over the native vegetation and smothering it;

control has been difficult. The tubular, often highly coloured flowers of honeysuckles are pollinated by moths or hummingbirds. The arrowwood (*Viburnum*) includes about 40 ornamental species in cultivation, especially the wayfaring tree (*V. lantana*) and the cranberry bush or guelder-rose (*V. opulus*), in which many of the flowers become enlarged and sterile, forming large, white inflorescences, whence the name snowball bush. Plants of this genus are mostly deciduous, and the foliage assumes a handsome fall colouring. The snowberry (*Symphoricarpos*), a North American plant of hedges and thickets with clusters of white berries, is common in cultivation. *Weigela* includes a number of prized garden shrubs with clusters of large pink or white flowers in the spring, and *Abelia*, *Kolkwitzia* (beauty bush) and *Leycesteria* (Himalayan honeysuckle) are other important ornamentals. The fruits of the wild elder (*Sambucus*) were formerly much used to make elderberry wine. The remaining genera of the family are all rare except the twinflower (*Linnaea*, named for the celebrated Carolus Linnaeus, the "father" of systematic botany), a small trailing plant of northern woods in Europe and North America; the whitish or pinkish flowers are borne in pairs on erect stalks. (C. V. M.)

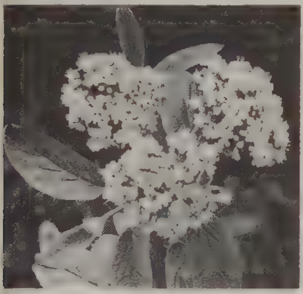

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FIG. 2.—FLOWER CLUSTERS OF VIBURNUM

CAPRIMULGIDAE, a family of nocturnal birds with large mouths and a jarring song. *See* Nightjar; Nighthawk; Whip-poorwill.

CAPRIVI, LEO, Graf von (1831–1899), German statesman, a soldier who came to be chancellor from 1890 to 1894, was born in Berlin-Charlottenburg on Feb. 24, 1831, the son of a member of the Prussian upper house. His family, originally from Gorizia, had been ennobled during the Austro-Turkish wars and had come to Prussia via Silesia about 1700. Joining the army in 1849, Caprivi became a member of the general staff in 1860 and distinguished himself in the Franco-German War as chief of staff of the X (Hanover) corps. In 1883, against his will, he was appointed head of the German admiralty as successor to A. von Stosch. Doubting the wisdom of Germany's colonial policy, Caprivi was also skeptical about the building of a high sea fleet and advocated the development of the torpedo boat arm in which the young Alfred von Tirpitz began his career. Unlike Tirpitz, he emphasized the need for coastal defenses in view of possible war on two fronts against France and Russia. When, in 1888, the young emperor William II prepared to separate the command and the administration of the fleet, Caprivi raised strong objections and resigned, since he could not force his will on the chancellor Bismarck and William II.

Caprivi now became commander of the X corps and was in Bismarck's opinion the "best horse in the army stable." In March 1890, moreover, Bismarck proposed Caprivi to the emperor as his successor in the post of prime minister of Prussia—not knowing that already, in February, William II had prepared Caprivi to succeed him not only in that but in all his offices. On Bismarck's resignation, therefore, Caprivi became chancellor.

Caprivi took office regretfully, realizing that his military career was finished and not confident in his political abilities. An example of his sense of inadequacy might be seen in his deference to his advisers in the foreign office, who persuaded him to allow the "Reinsurance" treaty with Russia to lapse in 1890. On the other hand this much criticized decision was in keeping with Caprivi's own conviction that a war on two fronts against France and Russia was inevitable and that for this reason alliance with Austria-Hungary was indispensable for Germany. Caprivi did not necessarily wish to jettison Bismarck's foreign policy, but in fact he became the representative of the "new course" in German foreign policy. He concluded the treaty of 1890 granting Zanzibar to Great Britain in exchange for Heligoland for which he was immoderately attacked by the "Pan-Germans"; he maintained a discouraging reserve toward Russia; and, in 1891 he was responsible for the ostentatious renewal of the Triple alliance of Germany, Austria-Hungary and Italy. The new policy did not deliberately break the link with St. Petersburg, but in the event surrendered it and thus smoothed the way to the Franco-Russian alliance of 1893, finally ratified by Russia in March 1894.

Nevertheless Caprivi tried, with the Russian trade treaty of Feb. 9, 1894, to restore better relations with the great eastern power and thus produced that uncertain situation the consequences of which seriously affected German policy right up to 1907. His attempt to continue the policy of the "free hand" between Russia and Great Britain prepared the way for the mistakes that Friedrich von Holstein and Bernhard von Bülow (*q.v.*) were to make at the turn of the century. Nevertheless the Triple alliance acquired a considerable weight in the European balance of power between Great Britain on the one hand and Russia and France on the other.

Caprivi's conscientiousness expressed itself in a domestic policy which, if not free from weaknesses and mistakes, was nevertheless worked out from personal convictions. His main achievement was a series of trade treaties. These, beginning with the lowering of the corn duties in 1891, aroused the bitter opposition of the great landowners east of the Elbe river and provoked the founding, in 1893, of the Agrarian league. Caprivi succeeded in his aim of finding more markets for the industrial produce of the *Reich*, especially in Europe, but his firm adherence to the tradition of a supra-party administration in the constitutional monarchy meant that he could not rely even on the Liberals for constant support. It was the Liberals, in fact, who in 1892, with the emperor's backing, secured the rejection of his elementary schools bill for Prussia, with its favourable provisions for church schools. Caprivi thereupon resigned the prime ministership of Prussia to the Conservatives in the person of Botho von Eulenburg, confining himself to the imperial chancellorship. The result was that during his last years in office the dangerous dualism between the *Reich* and Prussia once again made itself felt.

Added to his other difficulties, Bismarck's passionate criticism weighed heavily on Caprivi, and its consequences were intensified by the fear of his colleagues Holstein, Adolf von Marschall and Eulenburg that the Bismarcks might return to power. Out of loyalty to the monarchy Caprivi took the responsibility for the notorious order of June 1892 forbidding the German embassy in Vienna to attend Herbert Bismarck's wedding so as to divert the anger that it aroused from William II's person to himself. He was thus all the more compromised by the apparent reconciliation between the emperor and Bismarck which occurred soon afterward.

Caprivi's brittle, rather rigid and often pedagogic nature became yearly more irksome to the emperor. His elevation to the rank of count in 1891 marked the zenith of his favour, and his standing at court diminished from then on. His strong monarchism did not prevent him from seeing that the government of the modern German *Reich* could not be indefinitely conducted against the wishes of the majority in the *Reichstag*. In the empire he could not dispense with the help of the Centre and liberal elements, to the indignation of the court and the Conservatives, while in Prussia he had to meet increasing pressure from the Conservatives, who were supreme thanks to the Prussian three-class suffrage laws. He foundered on this dilemma. His greatest success as a legislator, the great bill of 1893 which raised the strength of the army by 84,000 men, could be achieved only at the price of reducing the period of conscription to two years instead of the three years traditional since William I's time. William II, who gave his assent to the measure most unwillingly and against military opinion, held Caprivi responsible for this capitulation.

The end came in 1894. The emperor, disappointed at the slight success of his "new course" in social policy, angrily demanded a return to repressive measures against the growing Social Democratic party and let Eulenburg persuade him into considering a *coup d'état* against the system of universal suffrage for the *Reichstag*. Caprivi showed a true sense of responsibility and political maturity in resolutely opposing these plans. After a crisis rich in intrigue, Caprivi and Eulenburg were simultaneously dismissed on Oct. 28, 1894.

Caprivi spent his last years in strict retirement. His reticence sharply distinguishes him from Bismarck, and historians are still sadly lacking in material for his personal history. He died at Skyren, near Crossen-an-der-Oder, on Feb. 6, 1899.

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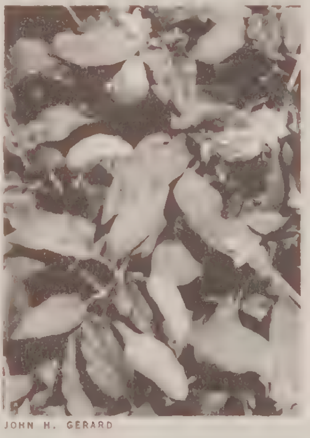
CAPSICUM (red pepper, cayenne pepper), a genus of perennial woody plants of the nightshade family (Solanaceae; *q.v.*), best known in northern vegetable gardens as herbaceous annuals. The genus appears to be native in Central and South America, with one anomalous species in Japan; American species are one to several, depending on the authority. Most authors, however, include all the cultivated forms of the genus under a single species, *Capsicum frutescens* (including those formerly classified as *C. annuum* and *C. baccatum*), with several varieties, such as var. *abbreviatum,* the ornamental bush pepper; var. *cerasiforme,* cherry pepper; var. *conoides,* Tabasco and coral gem peppers; var. *fasciculatum,* cluster pepper; var. *grossum,* bell or sweet pepper; var. *longum,* long, cayenne, chilli, yellow peppers; and var. *typicum,* the bird pepper.


JOHN H. GERARD

CHILI PEPPER (CAPSICUM FRUTESCENS LONGUM)

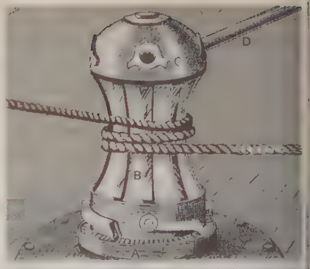
An oleoresin, used as a counterirritant, is obtained from red pepper. The active principle, considered to be capsaicin, when applied to the skin causes a feeling of warmth followed by an almost intolerable burning. Taken internally in small doses it stimulates gastric secretions but if used in excess causes inflammation. *See* Cayenne Pepper. (F. L. A.; J. M. Bl.)

CAPSTAN, an appliance used chiefly on board ships or in shipyards for mechanical power to move or lift heavy weights, consisting primarily of a barrel-sized, spool-shaped, cast-iron drum which is mounted vertically. Power is supplied either manually or by steam or electricity; when operating, the whole capstan revolves and winds in a line that has been wrapped around it.

The term "capstan" is also used to denote a shaft that rotates with constant angular velocity so as to maintain constant speed in the tape drive system of a magnetic tape recorder (*see* Tape Recording, Magnetic).

Prior to the advent of anchor chain both the capstan and the windlass could be used to haul in the anchor cable, but since the capstan was mounted vertically while the windlass was mounted horizontally it was much easier to "walk the capstan around" than to "pry" or "crank over" the windlass. With the introduction of anchor chain and auxiliary power on the forecastle (the donkey engine), shipbuilders developed a recessed drum which would fit around the links of the anchor chain and prevent slippage around the drum. This "wildcat" drum operated originally with better control when used on a horizontal axis, and consequently the term windlass became so popular that modern usage tends to call all anchor-handling machinery by that name. However, some modern equipment uses a low vertically mounted wildcat above the deck, but locates the power machinery below. If this vertical drum has sockets for capstan bars and can be operated manually, then technically it should be termed a capstan.

The basic parts of the capstan are the base plate, the spindle, the barrel with pawls, the drumhead and the capstan bars. The base plate bolts to the deck and supports the barrel and drumhead by the spindle and a roller path. The pawls attached to the bottom rim of the barrel ride over a notched track in the base plate and operate in much the same way as a ratchet to prevent backward motion. The spool shape of the barrel keeps the turns of line sliding toward its middle rather than working off the top. "Whelps" or ridges fitted vertically around the barrel prevent wet lines from slipping. The "pigeonholes" in the drumhead hold and support the capstan bars, which radiate out from the rim when inserted for use. These bars vary from 5 to 6½ ft. in length, and are notched at their outer end to receive a rope "swifter" to confine them to their pigeonholes when the ship is rolling. In operation, men push against these bars as they walk around the capstan, and as it revolves the rope wrapped around the barrel is put under tension and tends to move any object to which it is attached.



CAPSTAN SHOWING: (A) BASE PLATE: (B) BARREL WITH PAWLS; (C) DRUMHEAD; (D) CAPSTAN BAR

The crank capstan and the geared capstan are modifications which multiply manual power through use of gears in the drumhead. (M. H. I.)

CAPTAIN, in its general application refers to the leader, master, chief or person of similar status in any walk of life. Captains are chosen for teams in sports, and the expression "captain of industry" has become hackneyed. It is in the military and maritime services, however, that the word applies to a definite rank, distinguished for its antiquity. In most armies and some air forces, a captain is the commander of the largest group of soldiers that an officer can be expected to know personally—a company in the infantry, a battery in the artillery, a flight in the air force and a troop in the cavalry when that arm flourished. In the U.S. coast guard the captain of the port supervises anchorage regulations, the loading and unloading of explosives and the movement of shipping.

On the sea a captain is usually the commander of a large warship—a cruiser, battleship or aircraft carrier in the navy, and any sizable ship in the mercantile marine service. Because of his isolation, he has traditionally exercised powers and privileges far beyond those granted to an officer of equivalent station on land. He can perform marriages and conduct burial services; he has life and death powers of decision in matters affecting the safety of his ship or the welfare of its crew or passengers.

In the British and U.S. navies the rank corresponds to the army rank of colonel, as does the term group captain in the Royal Air Force. It is customary to give an officer of lower rank the courtesy title of captain when he is in command of a ship, but this does not allow him the right to claim the rank or to be so addressed in writing. The term is also generally applied to the officer in charge of an aircraft or group of aircraft, whether in military or civilian service. *See* Insignia, Military. (Ln. Ms.)

CAPTIVE: *see* Laws of War; Prisoners of War.

CAPTURE AT SEA: *see* Blockade; Contraband; Neutrality; Prize; Visit and Search.

CAPUA (mod. Santa Maria Capua Vetere), the chief ancient city of Campania in Italy, was situated 16 mi. N. of Neapolis (Naples). The site is that of modern Santa Maria Capua Vetere, not modern Capua (which was ancient Casilinum). Occupying the northeastern edge of a plain, it lacked natural defenses and depended on the produce of the plain. It was founded about 600 B.C., probably by the Etruscans, and its name was applied to the whole surrounding plain, *ager campanus* (*Capuanus*) or Campania. It controlled neighbouring communities (Casilinum, Calatia, Atella) but not all Campanian cities such as Teanum (Teano), Nola, Neapolis and Cumae, which were independent. With the weakening of Etruscan power in the south after 474 B.C., the Etruscan period at Capua ended when it was captured by Samnites (*q.v.*), Sabellian tribes from the mountains, about 440; the city adopted the Oscan language and customs (*see* Oscan). Whether or not the Campani of Capua had made an alliance with Rome in 343 against new Samnite invaders, they at first supported the revolt of the Latins and other allies against Rome in 340. In 338 Rome confiscated their *ager Falernus* on the right bank of the Volturnus (Volturno) river and distributed it to Roman citizens who were enrolled in a new tribe, the *Falerna*, but the Campani were given *civitas sine suffragio* (a limited form of Roman franchise); the aristocracy probably did not receive full Roman citizenship. Thus Capua became a municipium (*q.v.*), but it kept its local Oscan language and its magistrates (*meddices*); from 318 it had to receive Roman prefects (but probably not regularly). Its connection with Rome was reinforced by the construction of the Appian way in 312 which linked the two cities. Its prosperity increased and it became the second city in Italy, famous for its bronzes and perfumes. After the battle of Cannae (216 B.C.) during the Second Punic War its loyalty to Rome was shaken and it revolted to Hannibal, whose troops wintered there. During the revolt Capua issued a series of independent coins. It was recaptured by Rome after a short siege (212–11) and severely punished: its citizens were deprived of political rights, and their local magistrates were replaced by regular Roman prefects. The territory was confiscated: part was used for Roman colonies (Volturnum [Castel Volturno] and Liternum [Villa Literno] in 194 B.C.), but most was rented to small farmers until Julius Caesar redistributed it to 20,000 colonists in 59 B.C. Further colonists were sent, in 44 B.C. by M. Antonius, in 36 B.C. by Octavian (Augustus) and later by Nero. In 90 B.C. it had recovered municipal status, and although it suffered during the civil wars at the end of the republican period, it prospered as a *colonia* during the empire. In the 4th century it was the seat of the *consularis Campaniae* (*see* CAMPANIA). It was sacked by the Vandal Gaiseric in 456 and was finally destroyed by the Saracens in 840; only the church of Santa Maria survived. It has given its name to the late medieval village and the modern town.

Early tombs and traces of two 6th-century temples survive. Roman monuments include a grand amphitheatre, baths, a theatre and a fine Mithraeum. The amphitheatre recalls Capua's addiction to gladiatorial shows: here Spartacus and his fellow gladiators escaped in 73 B.C. This darker side of Capuan society is offset by the ribaldry of the Atellan farces (*see* ATELLANA FABULA) and the gaiety of the Oscan paintings that survive.

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(H. H. SD.)

CAPUA (anc. CASILINUM), a town and episcopal see of Campania, Italy, in Caserta province, lies 11.26 km. (7 mi.) W. of Caserta, on the Volturno river and the ancient Appian way. Pop. (1961) 18,326 (commune). The modern town is 4.8 km. (3 mi.) N.W. of the ancient Capua (now Santa Maria Capua Vetere), and was founded in A.D. 856 by the citizens of ancient Capua on the site of the old city of Casilinum. Capua has the appearance of a medieval town. The cathedral (856) was largely destroyed in 1943 and rebuilt, though the original tower (861) survived. Among other buildings are the churches of S. Salvatore ad Curtim (960) and Sta. Caterina (1383); the Norman castle (1050); the towers of Frederick II's castle (1239) and several palaces. The Campanian museum contains important pre-Roman and Roman collections. Capua has good rail and road connections. Industry includes munitions, chemical and sugar factories.

Ancient Capua (*q.v.*) was an Etruscan and then a Samnite stronghold and became a Roman colony in 59 B.C. It was destroyed about A.D. 840 by the Saracens. Ancient Casilinum, where Capua now stands, was a strategic road junction and was contended for by Hannibal and the Romans from 217 to 214 B.C., during the Second Punic War; it lost its importance to ancient Capua. Modern Capua changed hands frequently in the middle ages and was part of the kingdom of Naples until 1860.

(J. B. W.-P.; S. G. V.; X.)

CAPUANA, LUIGI (1839–1915), Italian novelist whose works showed pathological and occult tendencies, was born at Mineo, Sicily, May 28, 1839. His psychological novel *Giacinta* (1879) is one of the earliest Italian examples of this genre. Influenced by Hegel and looking forward to Verga and Pirandello, he was also one of the early realists in Italian literature. Other novels have serious psychological themes, among them *Il Profumo* (1890) and the Sicilian story *Il marchese di Roccaverdina* (1901), though some of his works have been accused of being merely pseudoscientific. Detached in outlook but highly imaginative, he wrote successful fairy tales as well as some literary criticism. He died at Catania, Nov. 29, 1915.

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CAPUCHIN MONKEY, a tropical American monkey, *Cebus capucinus;* the name is often extended to embrace all species of the same genus, whose range extends from Nicaragua to Paraguay. These monkeys, among the most intelligent in the new world, are the typical representatives of the family Cebidae, and belong to a subfamily (Cebinae) in which the tail is generally prehensile. From the other genera of that group with prehensile tails, capuchins are distinguished by the comparative shortness of that appendage and the absence of a naked area on the undersurface of its extremity. The hair is not woolly, the general build is that of a house cat and the limbs are of moderate length and slenderness. The name capuchin is derived from the cowllike form assumed by the thick hair on the crown. These monkeys go about in troops, frequenting the summits of tall forest trees. In addition to fruits, they consume tender shoots and buds, insects, eggs and young birds. Many of the species are difficult to distinguish, and little is known of their habits in a wild state. Capuchins are easily trained; they are gentle and good-natured, traits which make them valued as pets and performers. *See* PRIMATES.

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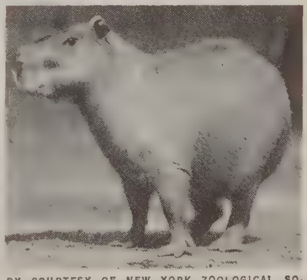
CAPUCHIN MONKEY (CEBUS CAPUCINUS)

CAPUCHINS (ORDO FRATRUM MINORUM CAPUCCINORUM; O.F.M. CAP.), an order of friars, chief among the permanent offshoots of the Franciscans. It arose about the year 1525, when Matteo da Bascio (1495–1552), an Observant Franciscan, became possessed of the idea that the habit worn by the Franciscans was not the one that St. Francis had worn; accordingly he made himself a pointed or pyramidal hood and also allowed his beard to grow and went about barefooted. Matteo was soon joined by others and a recognized order grew out of the movement. Their life was to be one of extreme austerity, simplicity and poverty—in all things as near an approach to St. Francis' idea as was practicable—and though this has been to some extent mitigated they remain very strict. In 1619 they were constituted into an independent order, with a general of their own. Their chief work is missionary. Like the Franciscans the Capuchins wear a brown habit. The general motherhouse is at Rome. *See* also FRANCISCANS; ORDERS AND CONGREGATIONS, RELIGIOUS.

CAPYBARA (CARPINCHO), *Hydrochoerus* species, the largest living rodent, belonging to the family Hydrochoeridae. It is characterized by its partially webbed toes, of which there are four in front and three behind, hooflike nails, sparse hair, short ears, cleft upper lip and the absence of a tail. When full grown the length of the animal is about four feet, the girth three feet



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SOUTH AMERICAN CAPYBARA (HYDROCHOERUS HYDROCHOERUS) and the weight up to 100 lb. Capybaras are aquatic, frequenting the banks of lakes and rivers in South America from Panama to Uruguay. They associate in herds, spending most of the day under cover along the banks and most of the evening and morning feeding on water plants and bark; in cultivated areas they do much harm to crops. Capybaras are shy, gentle animals, which voice a low, abrupt grunt when pleased, and which at the slightest sign of danger resort to the water. They swim and dive with expertness, often remaining below the surface for several minutes. One litter, comprising usually five to eight young, is borne yearly. Although only a few species survive in modern times, many extinct species occur in the Tertiary deposits (from 70,000,000 to 1,000,000 years ago) of Argentina, some considerably larger than the living forms. *See* RODENT.

CARABINIERS, originally 16th-century light cavalry armed with "large pistols called carabins having barrels 3 ft. long." English carabiniers are mentioned as early as 1597 at the battle of Turnhout under Sir Francis Vere. The early practice in England and France was to attach a proportion of men armed with carabins to each regiment, and it was not until the 17th century that regiments of carabiniers were formed. The original duties of carabiniers were analogous to those of grenadiers of the infantry, in fact they were mounted infantry. In 1660 the life guards were equipped with carabins (or carbines) while the other cavalry regiments had swords and pistols until 1678. As a reward for its services in Ireland in 1692, William III designated the ninth horse "the Carabiniers" (later the 6th dragoon guards or the Carabiniers), and although the term "carabiniers" was more common in France than in England it was not until 1693 that Louis XIV constituted his companies of carabiniers into a corps with the distinct title of royal carabiniers. He had, however, regimented them for tactical purposes at Neerwinden in that year. In Italy the *gendarmerie* are called *carabinieri*.

CARABOBO, a state located in north central Venezuela with a Caribbean coast line of 46 mi. It has an area of 1,795 sq.mi. and a population (1961) of 381,636. Principal cities are Valencia, the capital (pop. [1961] 164,322), and Puerto Cabello (pop. [1961] 52,493), one of the busiest ports in the nation. Other cities of importance are Guacara (pop. [1961] 11,343) and Güigüe (pop. [1961] 9,422). Lake Valencia, area 92 sq.mi., is situated almost entirely within the state. Carabobo has relatively good communications. In the 1950s it had 256 mi. of highways, including the Transandine, which provides excellent connections with Caracas. The Caracas-Valencia railroad extends for 62 mi. within the state and there is a 34-mi. line from Valencia (which has an airport) to Puerto Cabello.

Carabobo is important both agriculturally and industrially. Rice, cotton, corn, tobacco, coffee, cocoa and sugar are produced. The state has an expanding dairying industry which supplies, in part, the requirements of Caracas. Cattle from the llanos are fattened on the pastures surrounding Lake Valencia. One of the nation's main experiments in planned agricultural communities is carried on at Chirgua, where Venezuelans and immigrants work together. Cement, powdered milk, textiles and shoes are manufactures produced within the state, primarily in Valencia. There is a major petroleum-chemical plant between Valencia and Puerto Cabello. The state was named in commemoration of the battle which proved decisive in the Venezuelan independence movement. At the time the Spaniards conquered Venezuela, there were Indians known as the Carabobos. (J. J. J.)

CARACAL (*Lynx caracal*), sometimes called Persian lynx, an animal widely distributed throughout southwestern Asia and a large portion of Africa. It is somewhat larger than a fox, uniformly reddish brown above and whitish beneath, with two white spots above each of the eyes and a tuft of long black hair at the tip of the ears. It dwells among grass and bushes. Its prey consists of gazelles, small deer, hares and peafowl and other birds. The caracal is easily tamed and in some parts of India is trained to capture small antelopes, deer and large birds.

CARACALLA (MARCUS AURELIUS ANTONINUS) (A.D. 186–217), sole Roman emperor 211 to 217 and joint emperor with his father Septimius Severus 198–211, was born, with the name Septimius Bassianus, at Lugdunum (Lyons) on April 4, 186. When his father made him Caesar in 197, he was given the name M. Aurelius Antoninus to emphasize that the new dynasty was a continuation or revival of the golden days of the Antonines. His nickname Caracalla refers to a kind of duffel coat, native to the Rhineland and Gaul, which he habitually wore.

The bitter rivalry between Caracalla and his brother Geta attracted to each the support of rival groupings in the empire, until in 212 Caracalla murdered Geta and executed his principal adherents, including the great jurist Papinian. Caracalla spent his remaining five years campaigning on the Rhine, Danube and Euphrates, leaving civilian administration to his mother, Julia Domna. He was murdered by an army officer with a personal grudge, at Carrhae in Mesopotamia, on April 8, 217.

Caracalla's reign is described by two contemporaries, Dio Cassius and Herodian, to whom he was a monster, massacring without provocation. Numerous portrait busts show a compelling face, vigorous, alert and aggressive. Contemporary papyri, however, and occasional tales in the historians, show him as a patient and good-humoured judge in the face of obstreperous pleaders.

Caracalla's principal monuments are his colossal baths in Rome and his edict of 212, giving Roman citizenship to all free inhabitants of the empire. This was, at least in part, inspired by the financial motive of making all citizens liable to taxes payable by Romans alone; but its effect over two or three generations was to level out the historical privileges of Italy, and to open to all provincials the prizes of empire, including the throne itself.

See also references under "Caracalla (Marcus Aurelius Antoninus)" in the Index. (JN. R. M.)

CARACARA, the common name given to four American bird genera of the family Falconidae. Also called carrion hawks, the caracaras are recognized by their long legs and the bright-reddish naked skin of the cheeks and throat. They are gregarious and feed largely on carrion, birds, reptiles and amphibians. Audubon's caracara (*Polyborus cheriway auduboni*) is resident in Florida, Texas, Arizona and Lower California to northwestern South America, and on islands off the west coast of Mexico. Nine other species are found throughout Central and South America, including the common caracara (*P. plancus*), from the Amazon to Tierra del Fuego; the chimango or beetle eater (*Milvago chimango*), of southern South America; and the black caracara (*Daptrius ater*), of tropical South America.

CARACAS, the principal city and capital of Venezuela and of the federal district (pop. [1961] 786,863, city; 1,336,464, metropolitan area), lies 3,000 ft. above sea level in a valley towered over by ranges of the central highlands. Surrounded by mountains and difficult of access, the site was selected more by chance than by design. Nevertheless the city grew and prospered. Its pleasant and healthful climate has made Caracas known as the "city of eternal spring." During the rainy season (May–November) the humidity is high, but during the dry season (December–April) the weather is delightful.

Temperatures range from 91° to 45° F (32.8° to 7.2° C), the annual mean being about 68° F (20° C). When it became the capital of the Venezuelan republic in 1829, the city's preeminence was assured and subsequently maintained over its more advantageously located rival, Valencia.

In a narrow rift valley, enclosed by mountains to the north and south and a chasm to the west, Caracas has expanded to the east, into Miranda state. Its greatest growth was achieved after 1963. In the original city, the main square was meant to be the heart of the community but for more than a century it functioned as a public market. In 1865 it was christened the Plaza Bolívar. Around the plaza are grouped the palace of justice, city hall, ministry of foreign affairs, and cathedral.

The older part of the city followed the pattern of narrow streets and square blocks. Around and beyond the Casco (the old city as originally plotted) lie haciendas, then vast fields of sugarcane interrupted by villages. The growth of Caracas was retarded for three decades by the dictator Juan Vicente Gómez, who favoured Maracay, and it was not until after his death in 1935 that rapid development took place. In the 1950s Caracas, with a growing

BY COURTESY OF VENEZUELAN MINISTRY OF DEVELOPMENT, TOURISM DEPARTMENT

AERIAL VIEW OF THE SIMÓN BOLÍVAR CENTRE, CARACAS

population, embarked on an ultramodern urbanization program.

Two great earthquakes in 1755 and 1812 destroyed most of the 16th- and 17th-century buildings. Little remains of the old Spanish colonial houses and narrow cobbled streets once characteristic of the city. As population soared and construction proliferated, labourers migrated from rural areas and from abroad to work on construction jobs, adding to the housing difficulties. Hence extending high up the mountain slopes were shacks and shanties built of scrap materials. The government made great efforts to eliminate these slums, and large sums of money were expended on low-rent housing projects consisting of blocks and superblocks of apartments for workers' families. Caracas became in the 1960s one of the world's most exciting examples of city planning.

Caracas alone accounts for 70% of Venezuela's industrial production. Although there was widespread feeling that manufacturing should be more widely dispersed throughout the nation, in the late 1960s manufacturing was spreading to only a few regions outside greater Caracas. Among Caracas' leading industries are those engaged in the production of sugar, processed foods, beer, paper, tobacco, glassware, textiles, rubber goods, and pharmaceuticals. Improved connections with the city's port, La Guaira, via one of the world's finest highways, the Autopista, have contributed much to the continued importance of Caracas. At a cost of some $60,000,000, this ten-mile-long superhighway conducts traffic from port and airport (Maiquetía) to the capital in 15 or 20 minutes via bridges and tunnels leading through the mountains, rather than over them as before.

The first settlement was made in 1560 by a mestizo, Francisco Fajardo, who was seeking gold. He was driven out by the Indians, however, and Diego de Losada is credited with the actual founding of the city in 1567. He named it Santiago de Leon de Caracas for the Indians of the area who were called the Caracas. It was sacked by English buccaneers in 1595. Simón Bolívar was born there in 1783, and under his leadership it became the centre of the first colonial revolt against Spain in 1810. Caracas served successively as provincial capital, the residence of the captain general of Venezuela, and capital of the republic after independence was achieved.

Caracas in the 1960s dominated Venezuelan cultural, political, and economic life; the manufacturing and trading centre of the country, it lay in the nation's most important agricultural region. However, rapid growth led to congestion which affected adversely the efficient operation of city services. Definitely a "motorcar city," Caracas suffered from transport clogging and delay. Suburbs sprang up along highways throughout much of the basin, decentralizing Caracas' industrial activity. (L. We.)

CARACCIOLO, FRANCESCO, Duca di Brienza (1752–1799), Neopolitan admiral who was executed on the orders of Admiral Nelson for supporting the republican revolution at Naples in 1799, was born in Naples on Jan. 18, 1752, of an ancient noble family. He learned his seamanship under Adm. George Rodney and fought for a time in the British service in the American Revolution. Returning to Naples in 1781, he commanded the Neapolitan fleet against the French Revolutionary army at Toulon in 1793.

Caracciolo was the best officer of the Neapolitan navy, and jealousy arose between him and the British admiral Nelson (*q.v.*) when the latter won the confidence of the Bourbon court. He followed King Ferdinand IV, however, on the royal family's flight to Palermo (in Nelson's ship) when the French were advancing on Naples (Dec. 1798). Then, with Ferdinand's permission, he returned to Naples to attend to his private affairs (March 1799). There he was persuaded to assume command of what remained of the Neapolitan navy in the service of the new republic. The Bourbons, however, raised a large army under Cardinal Fabrizio Ruffo, which recovered Naples and made republican resistance useless. Caracciolo attempted to escape but was arrested, brought in chains on board Nelson's flagship and summarily tried there. Sentenced to death for treason, he was hanged from the yardarm of his own flagship, the frigate "Minerva" on June 29, 1799.

CARACTACUS (correctly Caratacus, the Latin form of the Celtic Caradoc) (1st century A.D.), a son of Cunobelinus, king of the British tribe of Trinovantes. His kingdom, embracing the Atrebates of Hampshire and probably the Dobunni of Gloucestershire, lay in the west. At the time of the Claudian invasion of Britain, he led the native resistance against Aulus Plautius (A.D. 43–47), and after being defeated withdrew into south Wales (*see* Britain). He was finally defeated by Ostorius Scapula in A.D. 50, somewhere on the Welsh marches, in the territory of the Ordovices. He himself fled to the Brigantes, whose queen, Cartimandua, delivered him to the Romans. He and his family featured in a victory parade of Claudius, who granted them pardon and life.

See Tacitus, *Annals*, xii, 31, 37; *Histories* iii, 45; Dio Cassius, lx, 19–22. (I. A. Rd.)

CARAGIALE, ION LUCA (1852–1912), Rumanian playwright and prose writer of great satirical power, was born at Haimanale, near Ploesti, probably on Jan. 30, 1852. His comedies expose the effects on Rumanian urban society of over-hasty introduction of a modern way of life, and the comical results of social and political change. *Conul Leonida* ("Mr. Leonida"; 1879), *O noaple furtunoasă* ("A Stormy Night"; 1880) and *O scrisoare pierdută* ("A Lost Letter"; 1884) are among the most popular. With *Năpasta* ("The False Accusation"; 1890) he created the peasant drama. His short stories, *O făclie de Paşte* ("An Easter Torch"; 1889), *Păcat* ("The Sin"; 1892) and *Kir Ianulea* (1909) are among the best prose works in Rumanian literature; *Momente* and *Schițe* are vivid sketches of the change from rural to urban society. Caragiale died in Berlin on June 10, 1912. (G. Ns.)

CARAJÁ, a tribe of South American Indians living along the Araguaia river, near the inland island of Bananal, in central Brazil. Their language may be distantly related to Ge, which is spoken by most of the surrounding tribes. The three subtribes of the Carajá—the Carajá proper, the Shambioá and the Javahé—have almost identical cultures and are all oriented toward the river rather than toward the forest. The principal source of food is fish, with agricultural produce of almost equal importance. Clearings are made in the jungle flanking the river and planted with manioc, maize and a variety of other crops. Like most tropical forest peoples, the Carajá wear little clothing but use a variety of ornaments. Men wear labrets in the lower lip, as well as earplugs, while both sexes use a great deal of body paint and tattoo a small circle on each cheek as a tribal mark.

In the wet season large, permanent thatched houses are occupied by the members of several related families, but during the dry season flimsy shelters are built on the sandy beaches along the river. Within the village the social unit is the matrilocal extended family, and the heads of these families are the effective leaders of the society. The village chief, although granted considerable deference, has little authority. For most purposes the villages are independent of one another, but some adjoining villages cooperate in holding religious ceremonies.

An artistic people, the Carajá are noted for the singing and dancing which are prominent features of all ceremonies. The religion is dominated by the men, who hold masked dances during which they impersonate spirits and the ghosts of slain enemies.

See William Lipkind, "The Carajá," in *Handbook of South American Indians,* ed. by Julian H. Steward, Bureau of American Ethnology *Bulletin 143,* vol. 3, pp. 179–191 (1948). (Se. L.)

CARAN D'ACHE (Fr. play on Russ. *karandash,* "pencil"), pseudonym of Emmanuel Poiré (1858–1909), French caricaturist and illustrator, who was born and educated in Moscow but settled in Paris where he gained great popularity as a contributor to several periodicals. He was an early exponent of the episodic strip cartoon technique. He was also a well-known book illustrator. The grandson of a Napoleonic officer, he spent five years in the French army, and often favoured military subjects in his illustrations. Essentially self-taught, he was particularly influenced by the contemporary German caricaturists Wilhelm Busch and Adolf Oberländer. He died in Paris on Feb. 26, 1909.

CARAT, a unit of weight for diamonds, other gems and pearls; it also indicates the purity or fineness of precious metals. Originally grains or leguminous seeds were used for the weighing of precious stones and as these were not of uniform size or weight the carat in different gem centres varied considerably. Thus, the London market for many years used a carat equal to 0.2053 g. (3.163 troy grains); in Florence it was 0.1972 g.; in Amsterdam 0.2057 g., and so on. After various attempts to simplify and standardize the carat, the metric carat of 0.200 g., or 200 mg., was adopted in the United States in 1913, and has now become the standard in the principal countries of the world. The metric carat permits the weight of gems to be expressed conveniently in decimals, whereas formerly it was customary to use a clumsy series of fractions, such as $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$ and $\frac{1}{64}$ of a carat. When the term carat is used to indicate the purity or fineness of metals it means $\frac{1}{24}$ part. Thus, 18-carat gold consists of 18 parts of gold and 6 parts of alloy. *See* Diamond; Gold.

CARAUSIUS, MARCUS AURELIUS (d. A.D. 293), Roman general and usurper in Britain of the title of emperor (286–293), was of humble origin in the Belgic tribe of the Menapii. He served with distinction as an officer under the emperor Maximian against the Bagaudae and Franks in Gaul about 285–286, and was put in command of a fleet, based at Gessoriacum (Bononia, mod. Boulogne), with the task of protecting the Belgic and Armorican coast from Frankish and Saxon pirates. Accused of complicity with the raiders he anticipated his execution by revolting and occupying Britain (286–287). Maximian attacked him in 289 but was defeated, and Carausius was left undisturbed for four years. During these years he issued coins in the names of himself and "his brothers," meaning the joint emperors Diocletian and Maximian, but they did not return the compliment and probably did not recognize him officially. In 293 Constantius Chlorus received the title of Caesar, and captured Gessoriacum. Shortly afterward Carausius was murdered by Allectus, one of his ministers, who succeeded him as ruler in Britain.

See P. H. Webb, *The Reign and Coinage of Carausius* (1908). (A. H. M. J.)

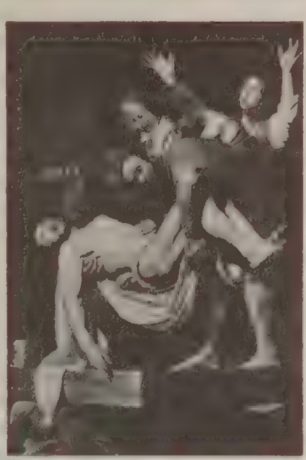
CARAVAGGIO, MICHELANGELO DA (Michelangelo Merisi or Amerighi) (1573–1610), Italian painter who virtually revolutionized Italian painting with his conception of light, colour and iconography, and infused the objects in his paintings with a degree of reality which was almost tangible. He was born at Caravaggio near Brescia in Lombardy on Sept. 28, 1573, the son of Fermo Merisi, a mason and master builder for the marchese di Caravaggio. Caravaggio was a leader in the formation of the early baroque style.

Caravaggio's first master was Simone Peterzano (active 1573–92), a Mannerist painter from whom he gained a solid technical education during his apprenticeship in Milan (1584–88). None of his paintings from this period survive. Between 1588 and 1591 he went to Rome. Important influences from his Lombard years which led to the development of his early Roman style include the works of Antonio Campi, Girolamo Savoldo, Girolamo Romanino, Moretto and Lorenzo Lotto. From these artists Caravaggio acquired some of the characteristics of his early works; *e.g.,* the (originally Giorgionesque) half-length figure, the simplified modeling, the use of clearly defined local colours and emphatic whites and the precise rendering of surfaces and textures. The subjects of this period are mostly adolescent boys. "Boy With a Fruit Basket" (Borghese gallery, Rome), "A Music Party" (Metropolitan museum, New York) and "Fortune Teller" (Louvre, Paris) are of this period. These early pictures reveal a fresh, direct and empirical approach; they are taken from life and are almost without trace of the academic Mannerism prevailing in Rome. They were bought by discerning private patrons, the chief of whom was Cardinal del Monte. Del Monte almost certainly secured Caravaggio his first public commission—the altarpiece ("St. Matthew and the Angel") and the two canvases on the side walls (the "Calling of St. Matthew" and the "Martyrdom of St. Matthew") in the Contarelli chapel of S. Luigi dei Francesi. The latter paintings, his first indubitable masterpieces, were very probably begun in 1598 and substantially finished by 1600. They not only caused a sensation in Rome but also marked a radical change in Caravaggio's artistic preoccupation. His activity now was devoted almost entirely to the painting of traditional religious themes to which he gave a whole new iconography and interpretation. He often chose subjects susceptible to dramatic, macabre or violent emphasis, divesting them of their idealized associations and taking his models from the streets. He used a lantern hung to one side in the shuttered studio; a harsh, raking light struck across the composition, illuminating parts of it and plunging the rest into deep shadow. This heightened the emotional tension, focused the detail and isolated the figures, usually placed in the front plane of the picture. His strong contrasts of light and darkness imposed a coherent surface pattern on the deliberately casual grouping of the figures. This insistence on clarity and concentration, together with a firmly plastic figure style, links his mature Roman work with the classical tradition of Italian painting. Classical qualities are evident in "Supper at Emaus" (National gallery, London). He subsequently restricted his pallette, using only one strong colour—a warm red—and abandoned his earlier taste for gallants in picturesque costume. "The Entombment" (Vatican) and the "Death of the Virgin" (Louvre) are among the monumental altarpieces dating from before 1606.

At the peak of Caravaggio's artistic maturity and fame, his personal life became infused with turbulence and violence, and he is often mentioned as an offender in police records from 1600 until 1610. In May 1606, after a game of *palla a corda*—a kind of tennis—Caravaggio killed his opponent in a duel over payment of a bet, and was forced to flee to the Sabine mountains. There he painted two pictures and at the end of 1606 or the beginning of 1607 went to Naples where he executed many large and lucrative commissions. By Sept. 1607 he had probably left Naples for Malta where he gained several commissions and was received into the Order of St. John. However, shortly thereafter he was imprisoned because of a quarrel with a Cavaliere di Giustitia but he managed to escape to Sicily. There he moved from town to town, whether in an attempt to find sufficient commissions to finance his return to Rome or because he was being pursued by representatives of the Maltese Knights is not known. His works, *e.g.,* the "Raising of Lazarus" (Messina), were preponderantly black and sombre. From Palermo Caravaggio went to Naples where he was so severely injured by enemies who attacked him that he was forced to remain eight or nine months. He later executed several commissions.

He left Naples, probably for Rome, in June 1610, but died of fever at Port'Ercole in July 1610.

Together with the Carracci of Bologna and Cigoli in Florence, he provided the most effective reform of the Mannerist style. Caravaggio was a thoroughgoing self-conscious revolutionary in painting. He affected to despise the old masters, though he was not untouched by the contemporary revival of interest in the High Renaissance. He worked directly on the canvas; yet he composed slowly and painfully and his brushwork is without "personality." His ability to fuse the humble with the sublime made his paintings the greatest, most effective interpreters of the popular religious movements of his time. However, his influence in Rome, though striking, was short-lived and lasted longer and affected greater artists outside Italy, where the so-called Caravaggisti were concerned more with his genre subject matter, colour, composition and chiaroscuro effects than with perpetuating his way of spiritual communication. He had several close followers in the Netherlands, a major one in France—Georges de la Tour—and the early development of Velázquez is unthinkable without taking him into account. Rembrandt, moreover, made use of Caravaggesque devices in a highly original manner.


ALINARI

"THE ENTOMBMENT" BY MICHELANGELO DA CARAVAGGIO. IN THE VATICAN GALLERY, ROME, ITALY

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CARAVAGGIO, POLIDORO DA (POLIDORO CALDARA) (*c.* 1500–1543), Italian painter, influenced by Raphael and the classical antique, was born at Caravaggio in Lombardy. Hired first as a hod carrier during the decoration of the Vatican *loggie* (galleries), he was later employed as a fresco painter and worked with another young artist, Maturino da Firenze. Together they decorated house façades in chiaroscuro. Their style, known from drawings and from engravings, derives from study of Hellenistic art and of Raphael, and is influenced by Baldassare Peruzzi. Their frescoes in S. Silvestro al Quirinale, Rome, mark the renewal of idealized classical landscape for its own sake. Rubens, Pietro da Cortona and others regarded Polidoro as an authority on antiquity.

After the sack of Rome he fled to Naples, then to Messina where in 1543 he was murdered. His altarpiece "Christ Bearing the Cross," painted in Messina, reflects Raphael's "Spasimo di Sicilia" and the influence of Dürer.

See G. Vasari, *Lives of the Most Eminent Painters,* English trans. by G. du C. de Vere (1912–15); A. Venturi, *Storia dell' arte italiana,* vol. 2 (1926).

CARAVAN, a word of Persian origin (*karawan*), signifying a group of merchants, pilgrims or travelers journeying together, usually for mutual protection; it is also used in Britain for a gypsy covered wagon and for a mobile home or trailer. In India oxen were employed for transport; in mountainous areas mules, donkeys and horses. In the deserts of Asia and north Africa the animal most commonly used was the camel, because of its catholic appetite, its hardiness and its loading capacity (*see* CAMEL). In some areas the camel was harnessed to a cart, *e.g.,* in the tea trade between Kalgan and Kyakhta, but usually the load was divided into two parts and secured on either side of the camel's back. In hot weather, on a long journey, a camel ordinarily carried about 350 lb., but on shorter journeys, in cooler weather, or to evade customs duties the load might be increased to 1,000 lb. Passengers were carried in panniers slung one on each side of the camel.

The camels were supplied by the merchant or traveler, or hired from neighbouring nomads, Arabs, Tuaregs, Kazakhs, or Mongols, who were often also the drivers, being not only skilled camel herdsmen, familiar with the routes, but also by their presence conferring some protection from other nomads. The leader of the caravan, elected by the members, was frequently a nomad chief. He decided the order of march and stopping places.

The size of the caravan was dependent upon the amount of traffic, the insecurity of the route, and the availability of camels. In Syria a chronic shortage of camels forced the Levant company to use caravans which were too small to confer adequate security. The largest recorded caravans were those for special purposes, *e.g.,* the pilgrim caravans from Cairo and Damascus to Mecca, which might include over 10,000 camels or the Saharan salt caravans from Taoudenni to Tombouctou or Bilma to Air. Even in its decline in 1908 this latter caravan numbered 20,000 camels.

Ropes, passed through the nose ring and tied to the saddle of the camel in front, were used to fasten the camels together in strings of up to 40. Three or four strings might travel abreast, as was usual with nomad drivers, or the whole caravan might travel in one long line, as in some Chinese caravans.

The timing of caravans was governed by the availability of water and pasture, or, in the case of the pilgrim caravans, by the need to be in Mecca on the 8th day of the month of Dhu 'l-Hijja. Consequently the Orenburg caravan left Bukhara after the melting of the winter snow, and the Basra caravan left Aleppo after the rains of late autumn. On long-distance routes it was customary to start slowly in order to allow the camels to build up endurance gradually. Once under way the caravan averaged 2 or 3 m.p.h. for 8 to 14 hours a day, or in hot weather, a night. If possible it was arranged to stop at a caravansary, which usually consisted of a courtyard, surrounded on all sides by a number of small rooms, on an elevation, with stables underneath. The endowment of caravansaries, particularly for pilgrims, was regarded as a pious duty. The great Arab traveler Ibn Batutah records the presence of caravansaries founded by the wife of Harun al-Rashid all along the Baghdad-Mecca route.

Although the opening of the sea routes to the east was partly responsible for the decline of certain routes, *e.g.,* the Great Silk road from China to the Mediterranean, yet several important caravan routes flourished until the 19th century, when road and rail transport and the abolition of the slave trade led to their ruin. Some local caravans survive in the absence of alternative transport, and certain others because of some particular appeal or advantage. The Powindah caravan from the Derajat in West Pakistan into Afghanistan coincides with the annual migration of the tribe; some of the pilgrim caravans continue because it is regarded as more meritorious to travel the hard traditional route, and the Saharan salt caravans because of superior qualities attributed to Saharan salt by the western Sudanese. (M. E. Y.)

CARAVANSARY (CARAVANSERAI), in the middle east, a public building for the shelter of a caravan (*q.v.*) and of wayfarers generally. It is commonly constructed in the neighbourhood, but not within the walls, of a town or village. It is quadrangular in form, with a dead wall outside; this wall has small windows high up, but in the lower parts merely a few narrow air holes. Inside a cloisterlike arcade, surrounded by cellular storerooms, forms the ground floor, and a somewhat lighter arcade, giving access to little dwelling rooms, runs round it above. Broad open flights of stone steps connect the stories. The central court is open to the sky, and generally has in its centre a well with a fountain basin beside it. A spacious gateway, high and wide enough to admit the passage of a loaded camel, forms the sole entrance, which is furnished with heavy doors and is further guarded within by massive iron chains, drawn across at night. The entry is paved with flagstones, and there are stone seats on each side. The court itself is generally paved, and large enough to contain 300 or 400 crouching camels or tethered mules; the bales of merchandise are piled away under the lower arcade, or stored in the cellars behind it. The upstairs apartments are for human lodging; cooking is usually carried on in one or more corners of the quadrangle below. Should the caravansary be a small one, the merchants and their goods alone find place within, the beasts of burden being left outside. A porter, appointed by the municipal authority, is always present, lodged just within the gate. He sometimes has one or more assistants. These form a guard of the building and of the goods and persons in it, and have the right to maintain order and, within certain limits, decorum; but they have no further control over the temporary occupants of the place. It is always kept open for all arrivals from prayer time at early dawn till late in the evening. Neither food nor provender is supplied.

Many caravansaries have considerable architectural merit; their style of construction is in general that known as Saracenic; their massive walls are of hewn stone; their proportions apt and grand. The portals especially are often decorated with intricate carving; so also is the prayer niche within. (*See* Islamic Architecture.)

By extension, the word has sometimes been applied to well-designed motels in semitropical desert regions, even though their plans only roughly resemble the originals.

Khans—*i.e.,* places analogous to inns and hotels, where not only lodging but often food and other necessaries or comforts may be had for payment—are sometimes confounded with caravansaries. They are generally to be found within the town or village precincts, and are much smaller than caravansaries. The khan of Asad Pasha at Damascus is a model of constructive skill and architectural beauty. (A. B.-B.)

CARAVEL, a light ship of the 15th, 16th and 17th centuries, much used by the Spanish and Portuguese for long voyages. Apparently developed by the Portuguese for exploring the coast of Africa, the caravel's chief excellence lay in its capacity for sailing to windward. It was also capable of remarkable speed. Two of the three ships in which Columbus made his historic voyage in 1492 were caravels, the "Niña" and "Pinta."

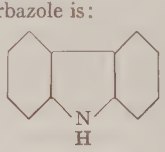
The design of caravels underwent changes over the years but a typical caravel of the late 15th century may be described as a broad-beamed vessel of 50 or 60 tons burden; some were as large as 160 tons. About 75 ft. long, the typical caravel had two or three pole masts, lateen rigged, *i.e.,* with triangular sails. Later versions added a fourth mast with square sail for running before the wind. Caravels were usually built with a double tower at the stern (the sterncastle) and a single tower in the bow (the forecastle). As a type, caravels were smaller and lighter than the Spanish galleons of the 16th century. In later years the term was applied to small fishing boats along the coast of France, and to a Turkish man-of-war.

CARAWAY, the fruit, or so-called seed, of *Carum carvi,* a plant of the carrot family (Umbelliferae; *q.v.*) growing throughout the northern and central parts of Europe and Asia, and naturalized in waste places in England and in North America from Newfoundland to Colorado. The plant has finely cut leaves and compound umbels of small white flowers. The fruits, commonly called caraway seeds, are flattened and oval. Caraway has a pleasant aromatic odour when bruised, and an agreeable spicy taste. It yields a volatile oil, the chief constituent of which is carvone. The plant is cultivated in north and central Europe and Morocco, as well as in the south of England, the produce of more northerly latitudes being richer in essential oil than that grown in southern regions. The oil is obtained by distillation for use in medicine as an aromatic stimulant and carminative, and as a flavouring material in cookery and in liqueurs for drinking. Caraway seeds are more extensively consumed entire, however, in certain kinds of cheese, cakes and bread.

CARAZO, a small department (area 367 sq.mi.) established in 1891 on the Pacific coast of Nicaragua. The population ([1963] 65,888) is mostly concentrated in valleys and on the lower slopes of volcanic mountains in the eastern half of the department. This area, with deep fertile soils and 60 in. of rainfall annually, produces coffee, tobacco, corn, beans, other vegetables and fruits. It has many large haciendas. The departmental capital, Jinotepe (pop. [1963] 16,112 [mun.]), at 2,511 ft. above sea level enjoys a subtropical climate and is connected by the Inter-American highway with Managua. It has a beautiful colonial church. (C. F. J.)

CARBAZOLE, or dibenzopyrrole, a constituent of coal tar, is a white crystalline solid in its pure form. Commercially it is of some importance as the raw material for a valuable dyestuff, hydron blue R, which is made in all the leading industrial nations of the world. In Europe carbazole is obtained from coal; in the United States it is made synthetically. Carbazole may be prepared synthetically by a number of processes, for the most part employing nitro and amino substituted diphenyl. For conversion to the dyestuff, it is first condensed with nitrosophenol in sulfuric acid at temperatures of from −40° to −50° C. The resulting indophenol is then reduced to its leuco compound, and this in turn is heated in alcoholic sodium polysulfide solutions until colour formation is completed. The product is a deep-blue vat dyestuff with somewhat better fastness properties than indigo. However, it is somewhat inferior in this respect to the blue vat dyestuffs derived from anthraquinone. Inasmuch as carbazole can be easily ethylated to *N*-ethyl carbazole, this substance is used for the production of a dyestuff, hydron blue G, which gives textile fibres a much greener shade of blue than hydron blue R.

Carbazole occurs in high boiling fractions of coal tar along with anthracene and phenanthrene. It is best separated from these materials by fusion with caustic potash, whereby the carbazole is converted into a salt, potassium carbazolate. The anthracene or phenanthrene can then be distilled off, or extracted with solvents such as coal-tar naphtha or pyridine. The crude carbazole is recovered by hydrolysis with water, and can then be purified either by crystallization from suitable solvents or by sublimation. Pure carbazole melts at 238° C.; the chemical formula is $C_{12}H_9N$. It dissolves in concentrated sulfuric acid with a yellow colour which on the addition of oxidizing agents turns to green. It forms a red picrate, $C_{12}H_9N.C_6H_3O_7N_3$, melting at 182°–186° C. The structural formula of carbazole is:



(J. H. Ss.)

CARBIDES, a class of chemical substances in which carbon is combined with a metallic or semimetallic element. The most important carbides are: (1) calcium carbide (CaC_2), used for the generation of acetylene (*q.v.*); (2) iron carbide (Fe_3C), cementite, the most important hardening constituent in steel; (3) silicon carbide (*q.v.*) (SiC), carborundum, used for grinding wheels, high-temperature refractories and electrical heating elements; and (4) tungsten carbide (WC), which is the main constituent in superhard tools for the high-speed machining of metals.

Properties.—In general, the carbides are very hard, brittle, crystalline materials which are readily reducible to powder form. Chromium carbide (Cr_4C) will scratch topaz; silicon carbide and boron carbide (B_4C) have almost the hardness of diamond. The carbides have extremely high melting points; tantalum carbide (TaC) has the highest melting point of any known substance (4,150° C.). Calcium carbide ranges in colour from clear colourless crystals for the pure form to dark gray masses for the commercial product. Most powders are dull gray, while some have colours quite different from the metal, such as bright yellow for aluminum carbide (Al_4C_3), brown for tantalum carbide and lavender for niobium carbide (NbC). When crystallized from a molten solvent metal such as nickel or aluminum, the carbides of the refractory metals form large crystals which are exceedingly pure and sparkle with a gemlike brilliance. The carbides are odourless except for those, like calcium carbide or thorium carbide (ThC_2), which react with moisture to yield acetylene and other hydrocarbon products.

Chemically, the carbides range from explosively active materials to those which are practically inert at high temperatures. Silver carbide (Ag_2C_2) is explosively violent in its decomposition; calcium carbide reacts vigorously with water to give acetylene; iron carbide reacts with dilute acids to give a mixture of hydrocarbon gases; tantalum carbide is resistant to all acids except a mixture of hydrofluoric and nitric acids and it must be heated somewhat before it oxidizes; and silicon carbide is so inert that it withstands oxidation at white heat.

Preparation.—The two most important methods for the preparation of the carbides are: (1) the direct union of carbon with the metal; and (2) the reaction of carbon with an oxide of the metal. Some form of an electric furnace is required to obtain the high temperatures needed to complete the reactions. Henri Moissan pioneered in the fundamental investigations of many of the carbides, following his development of the electric arc furnace in 1892. The first method may be illustrated by tungsten carbide, which is made by intimately mixing tungsten powder and lampblack, packing the mixture in a graphite crucible and heating to 1,400° C. in an electric furnace of the high-frequency or muffle type. The reaction is $W + C = WC$. The second method is the more common and may be illustrated by the reaction of tantalum oxide and carbon which are placed in a similar furnace but heated to 2,000° C. to complete the operation: $Ta_2O_5 + 7C = 2TaC + 5CO$. Silicon carbide, first prepared by Edward Goodrich Acheson in 1891, is made from a mixture containing silica (SiO_2), coke, salt and sawdust which when heated in still another type of electric furnace produces lustrous iridescent pale-green to sapphire-blue crystals. Silicon carbide is the most widely used of all the carbides. A similar method is used for the preparation of calcium carbide: the oxide or carbonate of calcium in the form of lime or limestone respectively is mixed with carbon in the form of coke or powdered coal and heated in an electric furnace from which the molten product is tapped off at 2,000° C. Most carbides are formed at temperatures below their melting points; calcium carbide is one of the exceptions.

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(C. C. B.)

CARBINE, in modern military language, a light short-barreled shoulder weapon. The term came into use toward the end of the 16th century to denote a form of small smoothbore firearm, shorter than a standard musket and intended chiefly for use by mounted men. The word retained this meaning through many subsequent modifications of firearms design, including the introduction of rifling and automatic operation. (*See* Small Arms, Military.)

During the early years of the 20th century carbines were replaced in the U.S. army by the ordinary rifle, even for cavalry, because rifles had become shorter and lighter. But the carbine came back into prominence in World War II. As a personal weapon for U.S. service troops in rear areas it replaced the pistol, a short-range weapon of limited accuracy. Only three feet long and weighing less than six pounds, the new calibre .30 carbine was lighter and easier to carry than the standard rifle. It had an effective range of about 300 yd., sufficient for close-in defense. It was gas operated, semiautomatic (fully automatic in later models) and fired a light cartridge that differed from the standard rifle cartridge in several respects. During the early part of the 20th century the British army used the term machine carbine to denote the type of weapon known in the United States as the submachine gun, but the term was dropped to eliminate confusion during World War II. The Soviet army classed as carbines certain 7.62 mm. weapons that would be termed rifles by U.S. army standards. With adoption by the U.S. army in 1957 of a new light rifle that combined many of the best features of rifle and carbine, the World War II carbine was marked for obsolescence. (H. C. T.)

CARBO, the cognomen or third name of a Roman plebeian family of the *gens Papiria.* The following are the most important:

Gaius Papirius Carbo (d. 119 B.C.), tribune of the people 131 B.C. He was impeached by Lucius Licinius Crassus (*see* Crassus), probably on a charge of treason, and committed suicide.

Gaius Papirius Carbo (d. 82 B.C.), son of the above, was a supporter of the Optimates (*see* Roman History) and tribune with M. Plautius Silvanus in 89. He was put to death by the party of Gaius Marius (*q.v.*) in 82.

Gnaeus Papirius Carbo (*c.* 130–82 B.C.), nephew of the first-mentioned Gaius, was a strong supporter of the party of Marius. In 85 he was chosen by Lucius Cornelius Cinna (*see* Cinna) as his colleague in the consulship. He too was put to death in 82, but by Gnaeus Pompeius Magnus (*see* Pompeius).

CARBOHYDRATES. The carbohydrates constitute a large group of closely related organic compounds that are composed of carbon, hydrogen and oxygen. These substances, with proteins and fats, form the major organic components of living matter, maintaining the functional activity of the cells and serving as structural and reserve materials. Honey, cane or beet sugar, starch, cotton and vegetable gums may be cited as typical carbohydrate substances of natural occurrence.

If a single biochemical process may be regarded as more fundamental than any other, it is the photochemical assimilation of carbon dioxide from the air by the green plants and the subsequent production of carbohydrates through a complicated cycle of enzymic reactions. This process results in the recovery of carbon dioxide from the air and the conversion and storage of the atomic energy of the sun in a form utilizable by living matter.

Carbohydrate chemistry has wide industrial applications in the manufacture of paper, cloth and synthetic materials, as well as foodstuffs. Already the combined value of the industries employing carbohydrate source material far exceeds that of those using other sources, a situation offering promise for the absorption of farm crop surpluses. Furthermore, carbohydrates arise from renewal crops independent of mineral findings.

The development of the chemistry of the carbohydrates began with the investigations of Emil Fischer and his collaborators, who established the basic structures and configurations of the component units. How these units link to form the larger molecules was elucidated largely by the methods devised by Sir Norman Haworth and his school. Claude S. Hudson and his associates determined significant fine points concerned with tautomeric or shifting structures.

The relatively simple carbohydrates, generally termed sugars, are nearly all sweet, crystalline and water-soluble solids. The early knowledge of sugars related to the art of making sweetmeats and sweetening agents and dates back to antiquity. After the conquest of Persia, the Arabs became familiar with the sugar industry and spread it through the Islamic domain, including Spain.

More complex carbohydrates are formed from the simple sugars by the combination of basic units, providing almost infinite possibilities of variation. In the basic units, termed monosaccharides, the carbon atoms are joined together in a chain and are further combined with the elements of water. This provides the general formula $C_n(H_2O)_n$ and explains the origin of the name carbohydrate (Fr. *hydrates de carbone;* Ger. *Kohlenhydrate*).

A colossal number of carbohydrate compounds have been characterized and great progress has been made in the investigation of their properties and structures. These strides have culminated in the solution of problems of exceptional interest and difficulty and have materially contributed to the understanding of the cognate subjects of the biosynthesis and biological function of carbohydrates.

The following are the main sections and divisions of this article:

I. Monosaccharides
  1. Stereoisomerism
  2. Occurrence
  3. Properties
  4. D-Glucose
  5. D-Fructose
  6. Interconversion and Synthesis
II. Oligosaccharides
  1. Maltose
  2. Cellobiose
  3. Gentiobiose
  4. Lactose
  5. Melibiose
  6. Sucrose
  7. Trehalose
III. Polysaccharides
  1. Cellulose
  2. Starch
  3. Glycogens
  4. Dextrans
  5. D-Fructose Polymers

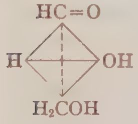
6. Hemicelluloses
7. Pectic Materials
8. Plant Carbohydrate Gums
9. Chitin
10. Mucopolysaccharides

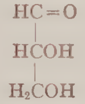
IV. Biosynthesis of Oligosaccharides and Polysaccharides

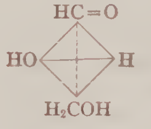
I. MONOSACCHARIDES

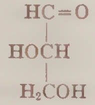
The monosaccharides are divided into two groups: the aldoses of the formula $CH_2OH—(CHOH)_n—CHO$, related to the aldehydes; and the ketoses, of the formula $CH_2OH—(CHOH)_n—CO—CH_2OH$, related to the ketones. These are further classified according to the length of their carbon chain. Thus, there are aldopentoses, aldohexoses, ketopentoses (pentuloses) and the like. More extensive variations in the structure of the monosaccharides result from the differences in the spatial arrangements of the elements of water (hydrogen, —H, and hydroxyl, —OH) attached to the carbon atoms within the chain.

1. Stereoisomerism.—The above differences in the spatial arrangements derive from the fact that the four valence bonds of the carbon atom are tetrahedrally disposed in space and if each of these bonds is attached to a different group, the result will be an asymmetric carbon which cannot be superimposed upon its mirror image. The smallest aldoses containing an asymmetric carbon are D-glyceraldehyde (I and IA) and L-glyceraldehyde (II and IIA). At this stage it should be noted that the presentation of the three-dimensional structure of the monosaccharides in the plane of the paper is a matter of some difficulty and is only attained through a number of conventions. A simple method is the formalized projection of the imaginary tetrahedra in the plane of depiction, as in IA and IIA:


I


IA


II

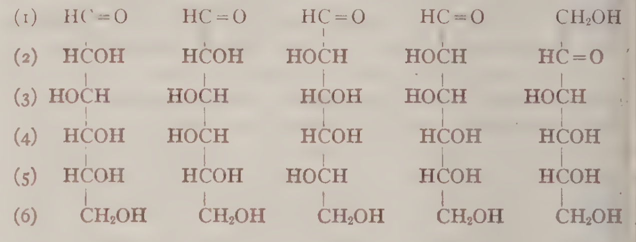

IIA

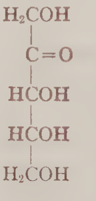
As the number of carbon atoms in the chain increases, the addition of each new asymmetric carbon doubles the number of possible forms. Consequently, there are 16 aldohexoses and 8 hexuloses of the general formula $CH_2OH—(CHOH)_4—CHO$ and $CH_2OH—(CHOH)_3—CO—CH_2OH$, respectively. These forms are termed stereoisomers.

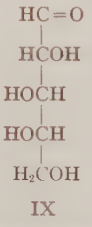
As will be described, the ketoses can be related to the aldoses and the aldoses can be synthesized from D- and L-glyceraldehyde by the stepwise addition of the repeating CHOH entity. By agreement, the monosaccharides related to D-glyceraldehyde are assigned the configurational symbol D and those related to L-glyceraldehyde carry the configurational symbol L. This divides the monosaccharides into two series. The mirror image of each compound belonging to the D series forms the corresponding member of the L series. Such pairs of stereoisomers are termed enantiomorphs.

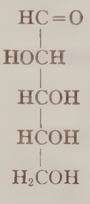
The presence of an asymmetric carbon atom in the molecule results in the phenomenon of optical activity, that is, the rotation of the plane of polarized light by solutions of the compound (*see* STEREOCHEMISTRY). The direction and degree of optical rotation, determined under defined conditions, are expressed as specific rotation, $[\alpha]$, and are characteristic of each sugar. The enantiomorphous compounds rotate the plane of polarized light to the same extent but in opposite directions. Those that rotate to the right or positive direction are said to be dextrorotatory and the others are termed levorotatory. For instance, the naturally occurring D-glucose, $[\alpha] + 52.2°$, is dextrorotatory and the synthetic L-glucose, $[\alpha] - 52.2°$ (measured in dilute aqueous solution at 20° C. with light of 589.25 $m\mu$ wave length), is levorotatory. The formula I, originally assigned to the dextrorotatory form of glyceraldehyde purely by convention, has been proved to conform to reality. Since the configurations of the other sugars are related to this standard reference substance through the study of their physical and chemical properties, an absolute basis for the assignment of correct projection formulas to the various monosaccharides is so provided. It should be noted that all the D-sugars are not necessarily dextrorotatory and that the configuration of the highest numbered (*see* III) asymmetric carbon atom determines whether a compound belongs to the D or L series, irrespective of the direction or sign of the optical rotation.

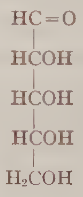
2. Occurrence.—A wide variety of monosaccharides is found in naturally occurring materials as free sugars or as components of more complex substances. D-Glucose (III) is by far the most widely distributed sugar. In the free state it is found in fruits, honey, plant juices, blood and diabetic urine. Cellulose, starch, glycogen and dextran are formed from the combination of D-glucose units. Other naturally occurring aldohexoses are D-galactose (IV), L-galactose (V) and D-mannose (VI). In the ketose series, D-fructose (VII) is of major natural occurrence. This sugar is frequently found in association with D-glucose, either in the free state or in combination as the disaccharide sucrose (cane sugar). Inulin (from dahlia tubers) and the fructans from grasses are polysaccharides composed of D-fructose units. The heptulose D-*altro*-heptulose (sedoheptose) and D-*erythro*-pentulose, a ketopentose (VIII), are considered to be important transition products in the process of photosynthesis. The aldopentoses found in nature are L-arabinose (IX), D-arabinose (X), D-ribose (XI) and D-xylose (XII). L-Arabinose and D-xylose are found in plant exudates (gums), in plant structural materials (as corncobs) and in bacterial polysaccharides. D-Ribose is one of the carbohydrate constituents of cell nuclear material (nucleic acids); the other carbohydrate constituent is a modification of this sugar termed "2-deoxy-D-ribose" (XIII). D-Arabinose has been isolated from the tubercle bacillus (*Mycobacterium tuberculosis*). The trioses D-glyceraldehyde and dihydroxyacetone occur in their phosphate derivatives as intermediate metabolic products.

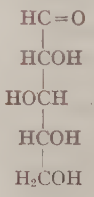

III IV V VI VII

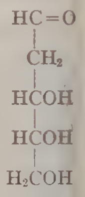

VIII


IX

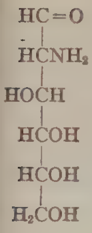

X


XI


XII

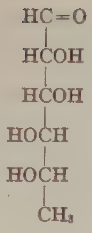

XIII

As with the "2-deoxyribose" already mentioned, not all of the naturally occurring monosaccharides conform to the general pattern described above. The amino sugar 2-amino-2-deoxy-D-glucose (D-glucosamine) (XIV), found in animals, bacteria and fungi, contains the elements of ammonia ($—NH_2$ and —H). In the deoxy sugars, one or two of the —OH groups are replaced by hydrogen atoms, as in "2-deoxyribose," 6-deoxy-L-mannose (L-rhamnose, XV) and 2,6-dideoxy-D-*ribo*-hexose (digitoxose, XVI). The *Strophanthus* and Convolvulaceae glycosides contain a variety of deoxy sugars. D-Glucuronic acid (XVII) and other uronic acids have a carboxylic acid function. Some sugars, as streptose (XVIII), a component of the antibiotic streptomycin, contain a branched carbon chain. A number of other sugars of unusual structure have been found in the antibiotics. The alditols are polyhydric alcohols that are reduction products of the carbonyl functions present in aldoses and ketoses. Sorbitol (D-glucitol, XIX), found especially in the fruits of Rosaceae, belongs to this category. The inositols, $(CHOH)_6$, with a cyclic carbon chain, provide another variety of naturally occurring polyhydric alcohols.



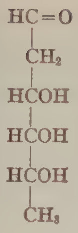
$$\begin{array}{c} HC{=}O \\ HCNH_2 \\ HOCH \\ HCOH \\ HCOH \\ H_2COH \end{array}$$

XIV



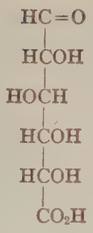
$$\begin{array}{c} HC{=}O \\ HCOH \\ HCOH \\ HOCH \\ HOCH \\ CH_3 \end{array}$$

XV



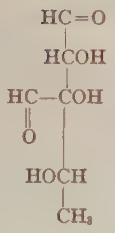
$$\begin{array}{c} HC{=}O \\ CH_2 \\ HCOH \\ HCOH \\ HCOH \\ CH_3 \end{array}$$

XVI

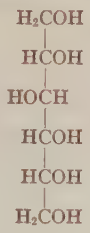


$$\begin{array}{c} HC{=}O \\ HCOH \\ HOCH \\ HCOH \\ HCOH \\ CO_2H \end{array}$$

XVII



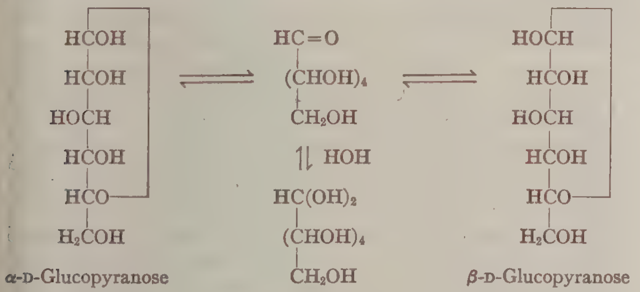
XVIII



$$\begin{array}{c} H_2COH \\ HCOH \\ HOCH \\ HCOH \\ HCOH \\ H_2COH \end{array}$$

XIX

3. Properties.—The normal aldoses and ketoses differ in the position of their carbonyl group ($>C=O$). The aldoses, with the carbonyl group at position one, react as polyhydroxy aldehydes and the ketoses, having the carbonyl group at position two, react as polyhydroxy ketones. As noted above, the four valence bonds of the carbon atom form a tetrahedron. Consequently, the carbon atoms are joined together through an angle of 109° 28′. This creates an inherent tendency in the sugar molecule to curl and brings the carbonyl function in a position to react with one of the hydroxyl groups. The reaction products are the cyclic forms of the monosaccharides (designated monocyclic hemiacetals) in which an oxygen bridge joins two of the carbon atoms. This process alters the carbonyl function and forms a new asymmetric carbon atom with a hydroxyl group that can be oriented in either of two directions to form stereoisomers designated anomers. Six-membered (pyranose) and five-membered (furanose) rings are preferred, with the former being the more stable. Thus, an aqueous solution of D-glucose will be a mixture consisting mainly of two crystallizable and interconvertible forms designated α-D-glucopyranose and β-D-glucopyranose. The former compound (XX) melts at 146° C. and exhibits a specific rotation of +112° while the latter (XXI) melts at 148°–150° C. and possesses the lower dextrorotation of +19°. When either form is dissolved in water, the rotation undergoes a spontaneous change termed mutarotation with the eventual establishment of the equilibrium value of +52.5°. This change is promoted (catalyzed) by both acids and bases but especially by bases with the catalytic action of water being due mainly to its slight dissociation into hydroxyl ions.

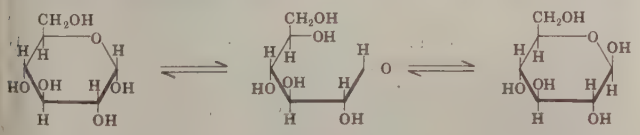


α-D-Glucopyranose β-D-Glucopyranose

XX XXI

Although the above equilibrium favours the structures XX (about one-third) and XXI (about two-thirds), an aqueous solution of D-glucose can react in both cyclic and acyclic (aldehydo) forms.

The true spatial relations of XX and XXI are better represented by XXA and XXIA and even better by the statistically favoured

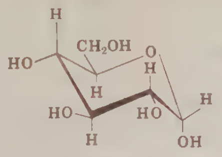


α-D-Glucopyranose *aldehydo*-D-Glucose β-D-Glucopyranose

XXA XXIA

staggered ring conformation shown for the α-D anomer in XXB.

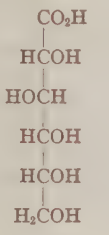
We will examine next the general properties of D-glucose and D-fructose as typical examples of members of the aldose and ketose groups of monosaccharides.



XXB

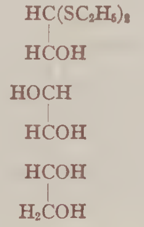
4. D-Glucose (dextrose or grape sugar) is fermentable by yeast. It exhibits aldehydic properties inasmuch as it reduces alkaline copper solutions, is oxidized by hypohalite ions to an aldonic acid (D-gluconic acid, XXII) without loss of carbon and gives characteristic derivatives with such reagents as phenylhydrazine, hydroxylamine and ethanethiol (*see* XXIII). It does not, however, give a normal Schiff colour reaction, which is specific for the simple aldehydes. The aldehydic function disappears when the sugar is hydrogenated, the product being the alditol D-glucitol (sorbitol, XIX) which when further reduced with hydrogen iodide gives a derivative of normal hexane (XXIV).

This proves that the six carbon atoms of glucose are arranged in an unbranched chain. The oxidation of D-glucose, or of D-gluconic acid, with nitric acid yields a dibasic acid, D-glucaric acid (saccharic acid, XXV). Another oxidation product is D-glucuronic acid (XVII).



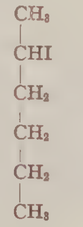
$$\begin{array}{c} CO_2H \\ HCOH \\ HOCH \\ HCOH \\ HCOH \\ H_2COH \end{array}$$

XXII



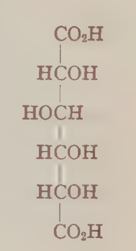
$$\begin{array}{c} HC(SC_2H_5)_2 \\ HCOH \\ HOCH \\ HCOH \\ HCOH \\ H_2COH \end{array}$$

XXIII



$$\begin{array}{c} CH_3 \\ CHI \\ CH_2 \\ CH_2 \\ CH_2 \\ CH_3 \end{array}$$

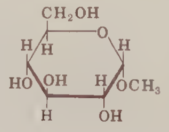
XXIV



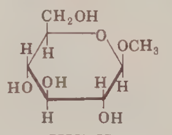
$$\begin{array}{c} CO_2H \\ HCOH \\ HOCH \\ HCOH \\ HCOH \\ CO_2H \end{array}$$

XXV

The action of hydrogen chloride on a solution of D-glucose in methanol at 100° C. provides a mixture of two crystalline substances which are interconvertible when dissolved in hot methanol containing acid. These substances are related to each other in the same manner as α- and β-D-glucopyranose and are termed methyl α-D-glucopyranoside (XXVI) and methyl β-D-glucopyranoside (XXVII). They can be considered as mixed acetals and are members of the group of substances known generically as glycosides. The nonreducing (toward mild oxidizing agents) acetal linkage in the glycosides undergoes hydrolysis (chemical fixation of the elements of water) by acids or by enzymes to regenerate the original sugar and the hydroxylic compound. When the hydroxylic component is another monosaccharide, the combination is termed a disaccharide (*see* below).



XXVI

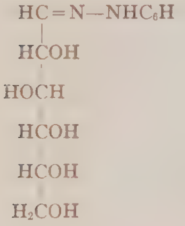


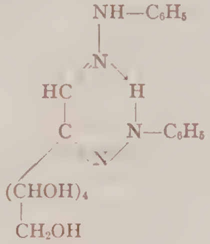
XXVII

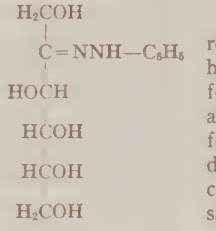
Other ring structures for D-glucose derivatives are known to the chemist. The primary and secondary alcohol groups in the sugar rings can form derivatives characteristic of such groups. Thus, they can form esters with carboxylic and inorganic acids and they can form ethers, of which the methyl and benzyl ethers have been especially useful to the structural and synthetic chemist.

5. D-Fructose (levulose) and other ketoses share most of the properties described for D-glucose and other aldoses. A principal difference between the two groups is that the ketoses are resistant to oxidation with hypohalite and cannot be converted to aldonic acids without loss of carbon. The ketoses all exhibit abnormal mutarotatory characteristics (as does D-ribose) and it is probable that furanose and acyclic (*keto*) forms constitute significant components of their equilibrium mixtures. When in combination with other monosaccharides in nature, D-fructose always occurs in its furanose form.

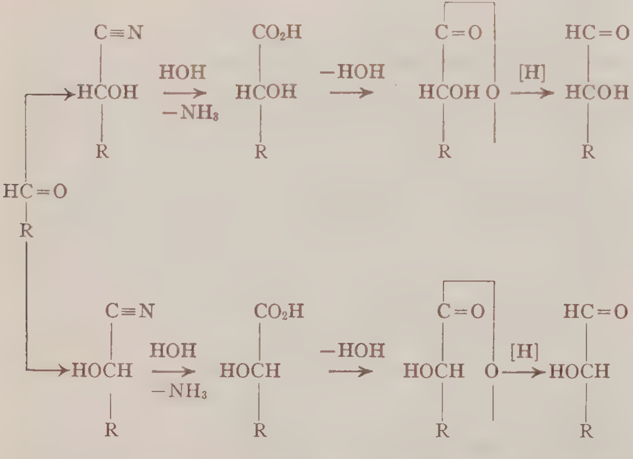
D-Fructose and D-glucose are closely related in structure and are in fact interconvertible by chemical and biological reactions. They both yield a highly crystalline and characteristic compound known as D-*arabino*-hexosulose ("D-glucose phenylosazone") (XXIX) on reaction with phenylhydrazine, the initial product being the phenylhydrazones XXVIII and XXX. Oxidation of these products with excess reagent and condensation with a second molecule of phenylhydrazine results in the formation of the phenylosazone. Since the oxidation takes place at position two of the D-glucose and position one of the D-fructose, the phenylosazone formed from each is the same.


XXVIII


XXIX


XXX

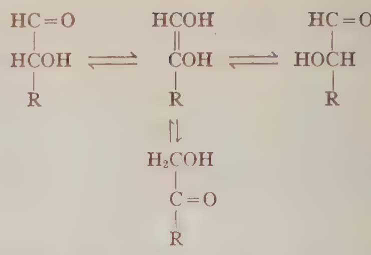
6. Interconversion and Synthesis.—By combining certain reactions, it is possible to pass from any monosaccharide to one containing an additional carbon atom. Thus, the addition of hydrogen cyanide to an aldose gives two products (nitriles) which on subsequent hydrolysis to the aldonic acid and appropriate reduction of the lactone (inner ester) of the acid yields the two higher aldoses, as shown below (R = the remainder of the sugar molecule).



Another synthesis of higher aldoses involves the sequence: $R{-}CHO \rightarrow R{-}CHOH{-}CH_2NO_2 \rightarrow R{-}CHOH{-}CH{=}NO_2Na \rightarrow R{-}CHOH{-}CHO$.

The opposite procedure, or degradation, can be accomplished by several methods. In one of these the calcium salt of, for example, D-gluconic acid is oxidized with hydrogen peroxide in the presence of ferric acetate, whereupon the following reaction takes place: $R{-}CHOH{-}CO_2H \rightarrow R{-}CHO$. In this case D-arabinose is formed.

The action of mild bases on the aldonic acids results in the inversion of configuration (2-epimerization) on the carbon (second) adjacent to the carboxyl function. A means is thus provided for the conversion (after subsequent reduction of carbon one to the aldehyde stage) of D-glucose into its 2-epimer D-mannose. Action of mild bases on the aldoses or ketoses leads to a mixture in which the ketose predominates. The ketoses may also be synthesized from the next lower aldoses by the following sequence of reactions performed on suitably substituted sugar derivatives: $R{-}CHO \rightarrow R{-}CO_2H \rightarrow R{-}CO{-}Cl \rightarrow R{-}CO{-}CHN_2 \rightarrow R{-}CO{-}CH_2OH$.



II. OLIGOSACCHARIDES

As noted above, the glycosidic function of a monosaccharide can react with one of the several free hydroxyl groups (including the hydroxyl group at position one) of another monosaccharide to form a disaccharide. Variations in the component monosaccharides and their ring structures, as well as the position and anomeric form of the glycosidic linkage, can provide an immense number of disaccharides. These compounds can further react to form trisaccharides, higher oligosaccharides and polysaccharides. The oligosaccharides contain an established number of monosaccharide units while the polysaccharides contain an estimated large number, generally 100 or more, monosaccharide units. In analogy with the glycosides, the acidic or enzymic hydrolyses of these materials will produce their original components. The glycosidic (acetal) linkage in some aldose disaccharides involves both hydroxyl groups at position one (potential carbonyl functions). Thus, they cannot display the reducing and other properties associated with the potential carbonyl function and are termed nonreducing disaccharides. In reducing disaccharides one of the glycosidic hydroxyl groups is still available. These compounds reduce Fehling's reagent and may be crystallized in anomeric forms which mutarotate in solution. They form osazones and if the reducing monosaccharide is not a ketose, they can be oxidized with hypohalite to aldonic acids or reduced to the combination of a monosaccharide and an alditol.

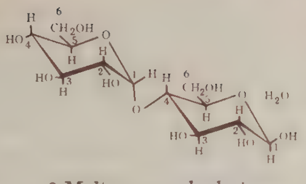
When the reducing monosaccharide is a ketose, the reduction provides a mixture of the two corresponding alditol derivatives. These reactions can also be applied to the higher oligosaccharides. An important property of the oligosaccharides and of the more complex carbohydrates is their partial hydrolysis by acids or enzymes to smaller fragments including disaccharides. Thus, the isolation of disaccharides from such hydrolytic products provides a method for investigating the structure of complex carbohydrates (fragmentational analysis). The various structural features of a disaccharide can be determined by a combination of physical and chemical properties some of which have been briefly mentioned.

In general, the reducing oligosaccharides, with the notable exception of lactose, originate from the partial hydrolysis of polysaccharides, higher oligosaccharides and plant glycosides. In contrast, the nonreducing oligosaccharides are mainly found in the plant products as the free compounds. The following is a brief description of certain reducing and nonreducing disaccharides and oligosaccharides.

1. Maltose (malt sugar) is formed by the action of the amylase enzymes (from germinating cereal grains) on starch. Maltose is a reducing sugar which crystallizes as the β-D anomer, and is hydrolyzed to its D-glucose components by the enzyme maltase, which specifically cleaves the α-D-glucosides. It has been shown that the glycosidic linkage in this compound (XXXI) involves position four of the reducing monosaccharide.

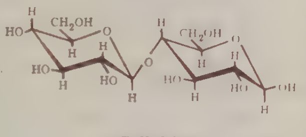
2. Cellobiose is obtained as its acetate derivative by the partial cleavage of cotton cellulose with a mixture of sulfuric acid and acetic anhydride. It is hydrolyzed by the enzyme emulsin. Except for the anomeric form of the glycosidic linkage, which is β-D-$(1 \rightarrow 4)$, cellobiose (XXXII) has all the structural features of maltose.

3. Gentiobiose is a component of the trisaccharide gentianose and certain plant glycosides. It contains two D-glucopyranose units joined through a β-D-$(1 \rightarrow 6)$ linkage. The sugar is an isomer of isomaltose, a minor hydrolytic product of starch. The glycosidic linkage of isomaltose is α-D-$(1 \rightarrow 6)$.



β-Maltose monohydrate
XXXI

4. Lactose (milk sugar) is a constituent of the milk of mammals. It is composed of a D-galactopyranose unit joined through a β-D-glycosidic linkage to position four of a D-glucopyranose unit and thus it resembles cellobiose.

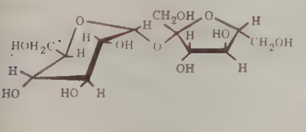


β-Cellobiose
XXXII

5. Melibiose, a constituent of the trisaccharide raffinose, is composed of D-galactopyranose and D-glucose joined through an α-D-$(1 \rightarrow 6)$ linkage.

6. Sucrose (cane sugar, beet sugar) is commercially the most important sugar. It is formed as a product of photosynthesis and constitutes the main sugar in the sap of plants. For a description of its physical properties and the processes for manufacturing it *see* SUGAR. Structurally, sucrose has been shown to be a nonreducing disaccharide in which the α form of D-glucopyranose is combined with the β form of D-fructofuranose (XXXIII). Sucrose is readily hydrolyzed to these monosaccharides by the action of dilute acid or by the enzyme invertase. Since, despite the positive optical rotation of sucrose, the mixture of equilibrated hydrolytic products is levorotatory, this process is termed inversion.

The chemical combination of sucrose with D-glucose and D-galactose provides a group of oligosaccharides, including melezitose, raffinose and gentianose, found in a variety of plant products.



Sucrose
XXXIII

7. Trehalose, found in fungi and mushrooms, is another biologically significant nonreducing disaccharide. It is formed by the combination of two α-D-glucopyranose units. It is the circulating sugar in the blood of insects.

III. POLYSACCHARIDES

The polysaccharides form a large group of natural products that are widely distributed in living matter. The established general physiological functions of these compounds are to serve as reserve foodstuffs or as structural and protective materials. In their protective capacity they are found in the exoskeletons of crustaceans and insects, the capsular material of certain bacteria and as gums and exudates which seal plant wounds. As structural materials, they help to maintain the rigidity of plants and they form the main constituents of plant mucilages, animal joint fluids and animal cartilages. The constituents responsible for the specificity of blood-group substances, the immunological properties of certain materials and the anticoagulant function of animal tissue components have been shown to be polysaccharide in nature.

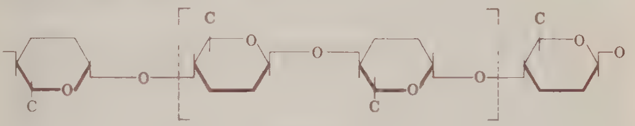
Chemically, the polysaccharides may contain one or several monosaccharide constituent units. The former varieties (homoglycans), represented by cellulose and starch, are more abundant while the latter substances (heteroglycans) are more numerous. These compounds may have linear structures, as cellulose, branched structures, as gum arabic, or a mixture of both, as the starches (*see* below). The linear polysaccharides often pack together with frequent secondary attachments (hydrogen bonding) to provide a rigid structure. The branched polysaccharides, on the other hand, are generally water soluble and make cohesive and thick pastes.

1. Cellulose.—The purest form of cellulose (*q.v.*) is cotton fibres, which are single cells ranging from 10 to 50 mm. in length. Other commercial sources are wood, flax, hemp and straw. The manifold industrial uses of cellulose (*see* PAPER MANUFACTURE; FIBRE) depend primarily on its fibrous nature, which results from the linear structure of the molecule, shown in skeleton form in XXXIV.

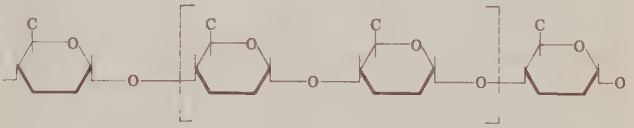
Cellulose constitutes the main component of the cell walls of land plants and as such it is the most abundant naturally occurring organic substance. The biological function of cellulose is reflected by its insolubility, its chemical inertness and its physical rigidity.

Chemically, cellulose is composed of D-glucose units joined together end to end through β-D-$(1 \rightarrow 4)$ links. This is partially demonstrated by fragmentational analysis which gives the disaccharide cellobiose (shown in brackets in XXXIV) and a group of larger fragments. The chain length, that is, the average number of D-glucose units, often described as the degree of polymerization (D.P.), may be determined by several physical and chemical methods, including viscosity measurements. The result varies according to the source of the cellulose, the treatment to which it has been submitted and even the method of determination. The D.P. of native cellulose is considered to be in excess of 3,000 and perhaps several times this value.

Nitrate esters of cellulose, of varying degrees of nitration, are used for the production of explosives (guncotton) and plastic materials.

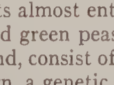


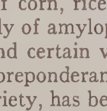
XXXIV



XXXV

2. Starch.—Large amounts of starch (*q.v.*) are laid down in the storage organs of plants. These include seeds, tubers, roots and stem pith. The starch appears in the form of distinct granules characteristic of their origin. These starches provide a reserve food supply for the plant, sustain the root or tuber through winter dormancy and nourish the growing embryo during the germination period. The main commercial sources of starch are corn (maize), potato and tapioca. Most of the common starches are a mixture of two different molecular species. These are amylose, which has a linear structure (XXXV, XXXVI), and amylopectin, which has a branched or bushy structure (XXXVII). The proportion of the two fractions is again characteristic of each species. Potato starch and cereal starches contain about 15% to 30% amylose. However, in the waxy cereal grains that constitute genetic varieties of corn, rice and grain sorghum, the starch consists almost entirely of amylopectin. The starches from wrinkled-seed green peas and certain varieties of sweet corn, on the other hand, consist of a preponderant amount of amylose. High amylose corn, a genetic variety, has been bred to contain 70% amylose.


Amylose
XXXVI


Amylopectin
XXXVII

Unlike cellulose, the starches can be dispersed in hot water. When a suspension of starch granules in water is heated to a certain critical temperature, the granules suddenly swell and an opalescent dispersion is formed (gelatinization) which sets to a paste when cold. Amylose is considered to contribute jelling characteristics and amylopectin the gummy or cohesive properties to the paste.

Starch is hydrolyzed by dilute acids and the group of enzymes known as the amylases. Complete hydrolysis, by acids or, better, by mixtures of enzymes, provides a quantitative yield of D-glucose.

Maltose (XXXI) bears the same relation to starch as cellobiose does to cellulose. A large number of higher fragments, known as dextrins, have been prepared by the controlled action of acids and heat on starches.

Amylose (XXXV, XXXVI) consists of a long chain of D-glucose units (about 200 to 500) joined together through α-D-(1 → 4) links. The linear structure thus produced has, unlike cellulose, all the $-CH_2OH$ residues at one side and has a tendency to coil in a helical form. In amylopectin (XXXVII) the units are joined together in a manner that provides a highly branched structure. At the branching points the D-glucose molecule is attached to other units through position six, α-D-(1 → 6), as well as positions one and four, α-D-(1 → 4). The branched and unbranched components of starch are distinguished by the colour of the respective iodine complexes (amylose, blue; amylopectin, reddish-purple), and can be separated by the addition of amyl alcohol, and many other simple organic compounds, which precipitate the amylose fraction as a microcrystalline complex.

3. Glycogens are quite similar to amylopectins and serve as reserve carbohydrates in animals. These substances are also produced by yeast, fungi and algae. Like amylopectins, glycogens have very high molecular weights and branched-chain structures composed of D-glucose units. The principal difference between them is that the glycogens have more frequent and shorter branches. This results in a more compact and bushlike molecule, with a higher solubility and lower viscosity.

4. Dextrans are the polysaccharides found in the slimes produced by the growing of certain bacteria, particularly *Leuconostoc mesenteroides,* on solutions of sucrose. They have a high molecular weight and are composed of D-glucose units predominantly joined through α-D-(1 → 6) linkages. Partially hydrolyzed dextrans, dissolved in physiological saline, provide a substitute for blood plasma in the treatment of shock.

5. D-Fructose polymers (fructans) supplement or replace starch as reserve carbohydrates in certain plants, particularly the Compositae and Gramineae. Inulin, widely distributed in many roots and tubers (as the Jerusalem artichoke and dahlia) falls in this category. It is composed of 30 to 40 D-fructofuranose and 1 or 2 D-glucopyranose units. The D-fructose radicals are joined together with β-D-(1 → 2) links in a chain that ends with a sucrose moiety. Other varieties of fructans are found in grasses or are produced by certain microorganisms including *Bacillus subtilis.*

6. Hemicelluloses.—There is a wide range of water-insoluble polysaccharides found in plant cell walls in association with cellulose. They contain a large amount of xylans, with α-D-(1 → 4) linked D-xylopyranose units, and other combinations of D-xylose, L-arabinose, D-glucose, D-galactose, D-mannose, D-glucuronic acid and D-galacturonic acid. The solubility of hemicelluloses in dilute alkaline solutions provides a method for their separation from cellulose.

7. Pectic materials are found in the cell walls and intercellular layers of plant tissues. They have great jelling power and are commercially produced from citrus rind, apple pomace and beet pulp. They are composed of a poly-D-galacturonic acid, partially esterified with methanol, in association with an arabinan and a galactan.

8. Plant carbohydrate gums constitute a group of polysaccharides with very complex structures. Their solutions are highly viscous. Gum tragacanth is an exudate from small thorny shrubs of the genus *Astragalus* (order Leguminosae) found in the Middle and Near Eastern countries. Gum arabic is produced by small trees of the *Acacia* genus when growing in warm, semiarid areas. The latter substance contains L-arabinofuranose, D-galactopyranose, L-rhamnose (6-deoxy-L-mannose) and D-glucuronic acid.

9. Chitin is the polysaccharide found in the exoskeletons of crustaceans and insects. Crab and lobster shells contain about 25% chitin and 75% calcium carbonate. The structure of chitin is similar to that of cellulose but differs in that chitin is composed of 2-amino-2-deoxy-D-glucose units in which the amino groups are acetylated. In other words, in chitin the hydroxyl group at position two of the D-glucose unit is replaced by an acetamido ($-NHCOCH_3$) group. The substance is quite inert and difficult to hydrolyze.

10. Mucopolysaccharides encompass a group of physiologically significant substances that, among others, include: chondroitin 4-sulfate from cartilage; heparin, the anticoagulant constituent found in the mast cells of animals; dermatan sulfate from skin and other animal tissues; and hyaluronic acid from animal joint synovial fluid, umbilical cord, the capsules of certain bacteria and animal tissues in general. The sugars that may be present are 2-acetamido-2-deoxy-D-glucose; 2-acetamido-2-deoxy-D-galactose; D-glucuronic acid; and L-iduronic acid. All of these polysaccharides, except hyaluronic acid, contain sulfuric acid esters, and heparin carries a sulfoamino rather than an acetamido group. These substances are acidic and in the native state most of them are considered to be combined with an associated protein. The combination is believed to be a serine component of the protein through connecting D-galactose or D-xylose units. The blood group substances are sometimes classified with the mucopolysaccharides. They bear amino acid residues chemically combined in a peptide chain with carbohydrate side chains containing the sugars D-galactose; 6-deoxy-L-galactose (L-fucose); 2-acetamido-D-glucose; and 2-acetamido-D-galactose.

IV. BIOSYNTHESIS OF OLIGOSACCHARIDES AND POLYSACCHARIDES

These substances are considered to be synthesized biologically by a series of enzymic reactions involving phosphate esters of sugars and substances known as glycosyl nucleotides. Thus, in the synthesis of trehalose, an α-D-glucopyranosyl unit is transferred from the glycosyl nucleotide donor to D-glucopyranose 6-phosphate, to yield a trehalose phosphate from which the phosphate group is then removed by an enzyme known as a phosphatase. Trehalose is a nonreducing disaccharide and the reaction stops with its synthesis. Repetitive reactions of the same general type are considered to lead to a synthesis of the higher oligosaccharides and polysaccharides. There may be more than one pathway present in the organism; and especially in the synthesis of starches in plants, it is believed that another type of biosynthesis may occur that involves the action of phosphorylase enzymes on α-D-glucopyranosyl phosphate with the production of the starch polymer and phosphate ions.

See also references under "Carbohydrates" in the Index.

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(M. L. WM.; F. SEH.)

CARBON, a nonmetallic element belonging to the solids, is found in both free and combined states. It is estimated that more than 1,000,000 carbon compounds are described in chemical literature, and chemists synthesize many new ones each year. Much of the diversity and complexity of organic forms is due to the capacity of carbon atoms for uniting with each other in various chain and ring structures and three-dimensional conformations, as well as for linking with other atoms.

Most of the energy of our bodies, as well as that which drives our machines, is supplied by the oxidation of carbon and its compounds, and every form of animal and plant life requires carbon for survival. Plants obtain it from the carbon dioxide in the air, converting carbon dioxide and water into carbohydrates in the process of photosynthesis. Animals consume the carbohydrates, returning carbon dioxide to the atmosphere by the processes of exhalation and excretion and the decomposition of their bodies under bacterial action after death. This endless chain linking animal and plant life is known as the carbon cycle.

Carbon (mainly in the combined state) is widely distributed in the earth's crust, though it comprises only about 0.2% of the outer ten miles. Carbon dioxide, which constitutes approximately 0.03% by volume of the atmosphere, is found also in all natural waters. Carbon is a constituent of coal, petroleum and natural gas, and of many minerals (*see* CARBONATES).

Only three of the many forms of carbon can be definitely characterized: diamond, graphite and black carbon, all stable at ordinary temperatures and insoluble in common solvents. Diamond and graphite are crystalline; black carbon is more or less amorphous, depending on the mode of preparation, and there are many varieties. (*See* PHASE EQUILIBRIA.)

Carbon is of prehistoric discovery and belongs to Group IV in the periodic classification of the elements, being related to silicon. Its principal valency is four, but a few compounds of mono-, di- and trivalent carbon have been prepared. The four valency electrons of the carbon atom may be shared with those of other atoms to form a stable system of eight electrons (an electron octet).

The symbol of carbon is C; atomic number, 6; atomic weight, 12.011; atomic radius, 0.77 Å (single bond); and orbital arrangement of electrons, $1s^2 2s^2 2p^2$, where the superscript indicates the number of electrons in the corresponding sublevel. Carbon sublimes at $> 3{,}500°$ C. and boils at about 4,200° C. Seven isotopes of carbon are known: C^{10}, C^{11}, C^{12}, C^{13}, C^{14}, C^{15}, and C^{16}. Isotopes 12 and 13 are stable; the others are radioactive, having half-lives as follows: C^{10}, 19.1 sec.; C^{11}, 20.4 min.; C^{14}, 5,720 yr.; C^{15}, 2.4 sec.; C^{16}, 0.74 sec. Carbon forms several oxides of which the most common are carbon monoxide (CO) and carbon dioxide (CO_2) (for other oxides *see* CARBON, OXIDES OF). At ordinary temperatures it combines with sulfur vapour to form carbon disulfide (CS_2), and with silicon and with certain metals to form carbides (*q.v.*). When carbon is heated with nitrogenous substances and alkaline carbonates, cyanides are formed. It combines directly with hydrogen to form acetylene (C_2H_2) when an electric arc is passed between carbon poles surrounded by hydrogen; small proportions of methane (CH_4) and ethane (C_2H_6) are also produced. At a lower temperature (1,200° C.) almost quantitative yields of methane are obtained. Carbon unites directly with fluorine (but not with other halogens) at room temperature to give the tetrafluoride (CF_4). At high temperatures carbon is a good reducing agent and large quantities of it, in the form of coke, are used in metallurgical processes for the reduction of metallic oxides such as those of iron and zinc.

Diamond.—The hardest substance found in nature, diamond (*q.v.*) has a value of 10 (the highest) on the Mohs scale. In 1957 a new substance, borazon (cubic boron nitride), was synthesized; it is as hard as diamond and scratches it with ease. Diamond is a poor conductor of heat and electricity. Its atomic heat is 1.25 at ordinary temperatures, as compared with 6.4, the Dulong and Petit average value for a solid element. At 985° C. its atomic heat is 5.5; at −186° C., 0.03; and at −227° C. it is almost nil. The specific gravity of diamond is 3.51, the refractive index is 2.4173 (for sodium light), and it belongs to the regular (isometric) system, though the actual crystal shape varies in different localities; *e.g.*, Brazilian diamonds are cubic; those from South Africa are usually octahedra or hexakisoctahedra.

Within the diamond lattice each carbon atom is surrounded by four others in the form of a regular tetrahedron; this arrangement confirms the tetravalency of carbon and the postulated directionality of its valence bonds. Pure diamonds are colourless and transparent, but they are frequently coloured red, blue, green or yellow because of small amounts of impurities; all except the yellow stones are highly valuable as gems. Carbonado and bort are black diamonds; they are valueless as gems, but on account of their extreme hardness they are extensively used in making tools for drilling, cutting and grinding. Artificial diamonds were prepared at General Electric Research laboratories in 1955. Previously, particles made by J. B. Hannay in 1880 were found to be diamonds, first by a British Museum expert, and again in 1943 by modern methods. Claims by H. Moissan in 1893 and others at different times to have produced synthetic diamonds have not been authenticated.

Graphite.—Widely distributed in nature, graphite (*q.v.*) is found as soft, gray-black, shiny leaflets. It is also manufactured on a large scale; the Acheson process yields one of the purest grades, having an ash content of only 0.5%. Graphite feels cold and greasy to the touch, has a specific gravity of about 2.25 (for the purest) and, unlike diamond, is a good conductor of heat and electricity. Its structure consists of connected planar hexagonal rings linked vertically to similar planar rings, thus producing the characteristic layer arrangement of graphite. It appears to be the most stable form of carbon as indicated by its heat of combustion, the best measure of the relative energy content, the value being slightly less for graphite (about 7,832 cal. per gram) than for diamond (7,873 cal. per gram). The hardness of graphite varies between 0.5 and 2.0, the low value being due to the fact that the ordinary test is made parallel to the cleavage planes; at right angles to these planes its hardness approaches that of diamond. Most varieties of graphite are attacked by strong oxidizing agents such as mixtures of sulfuric acid with nitric acid, chromic acid or chlorates to give graphitic acids and finally mellitic acid, $C_6(COOH)_6$, whereas diamond is unaffected by such treatment. In 1942–45 graphite was first used as a moderator in the production of neptunium and plutonium from uranium in connection with the development of the atomic bomb. Vitreous carbon is a graphite which approaches the diamond in properties. It is formed by the decomposition of hydrocarbon gases on smooth surfaces (such as glazed porcelain) at a temperature above 650° C.—a topochemical process.

Black Carbon or Amorphous Carbon.—This heading includes coke (*see* COKE, COKING AND HIGH-TEMPERATURE CARBONIZATION), lampblack, carbon black or gas black, gas carbon or retort carbon, soot and the charcoals (*q.v.*), of which there are many varieties, each depending upon the process employed in the manufacture and upon the starting material. Actually, X-ray examination of various "amorphous" carbons has shown them to be more or less crystalline, resembling graphite in structure; but there are many intermediate stages between amorphous carbon and graphite. All varieties are more or less readily attacked by the strong oxidizing agents that react with graphite. Carbon black is used extensively in the manufacture of automobile tires and printer's ink. The charcoals (sugar charcoal, wood charcoal, animal charcoal or bone black, etc.) are very porous, and consequently their specific gravity is apparently only about 0.25, but when the air is pumped out of the pores this becomes 1.4–1.9. Charcoal is hard and brittle and is a poor conductor of electricity. Like soot, it is dead black and without lustre.

An important variety of black carbon is activated carbon, made by heating inactive carbon in steam (or other gases). It has a great capacity for adsorbing dissolved substances and gases. This property makes activated carbon valuable as a decolourizing agent in sugar refining, and as an agent to remove gases from contaminated air. It is the principal component in gas masks.

Compounds of Carbon.—More than 1,000,000 compounds of carbon are known; the exact number never has been tallied. There are more compounds of carbon than of all other elements combined. The study of carbon and its compounds makes up the major subdivision of chemistry known as organic chemistry. For a discussion of organic chemistry and many of the major compounds of carbon, *see* the *Organic Chemistry* section of CHEMISTRY.

Articles on compounds of carbon include: ACETYLENE; ALCOHOL; ALDEHYDES AND KETONES; ALKALOIDS; AMINES; ANTHRACENE; ANTIBIOTICS; BENZENE; CARBON, OXIDES OF; CARBIDES; CARBONATES; CARBONYLS, METAL; CARBOXYLIC ACIDS; CARBOHYDRATES; CELLULOSE; COAL TAR; DIAZO COMPOUNDS; ESTERS; ETHER (IN CHEMISTRY); ETHYL ALCOHOL; FUELS; GRIGNARD REAGENTS; HYDROCARBON; METHANE; NAPHTHALENE; NITRO COMPOUNDS; NUCLEIC ACIDS; OILS, FATS AND WAXES; OLEFIN; ORGANOMETALLIC COMPOUNDS; PARAFFIN HYDROCARBONS; PETROLEUM; PHENANTHRENE; PHENOLS; PROTEINS; QUINONES; STEROIDS; SULFONAMIDES; SULFONIC ACIDS; TERPENES; UREA. *See* also references under "Carbon" in the Index. (J. H. Y.)

CARBON, OXIDES OF. Two well-defined oxides have been formed by the direct union of carbon and oxygen, viz., the monoxide (or carbonic oxide), CO, and the dioxide (or carbonic acid gas), CO_2. Additional oxides have been prepared from specific carbon compounds by suitable chemical reactions. Those so far described are carbon suboxide, C_3O_2; pentacarbon dioxide, C_5O_2; and mellitic anhydride, $C_{12}O_9$.

Whenever carbon burns in oxygen, carbon monoxide and dioxide are produced simultaneously (T. F. E. Rhead and R. V. Wheeler), the relative proportions depending upon the temperature, the amount of oxygen and other conditions. Both gases enter into many reactions of the greatest industrial importance. A number of the most widely used metallurgical processes depend for their success on the proper control of the equilibrium $CO_2+C \rightleftharpoons 2CO$. This equilibrium determines the composition of producer gas. At atmospheric pressure the carbon oxide content of producer gas is 94% carbon monoxide at 850° C. and 99% at 950° C. However, at constant temperature an increase in pressure tends to increase the carbon dioxide content. If steam reacts with carbon both oxides are produced in accordance with the "water gas" equilibriums $C+H_2O \rightleftharpoons H_2+CO$ and $CO+H_2O \rightleftharpoons CO_2+H_2$. Theoretically, pressure does not affect the second of these reactions but an increase in pressure hinders the first. At high temperatures, above 900° C., carbon monoxide and hydrogen predominate, while at lower temperatures the principal products are carbon dioxide and hydrogen. This is important because the chemical industry has demanded more and more of one or the other of these mixtures. At high temperature the reaction between steam and natural gas produces the same set of products so that the second of the "water gas" equilibriums is also involved. Thus it becomes necessary to understand these equilibriums (for the fundamental principles of which, reference should be made to the articles CHEMISTRY: *Physical Chemistry;* THERMODYNAMICS) when dealing with the production of the two oxides now to be described.

Carbon monoxide is a colourless and odourless gas. It does not ordinarily occur in the atmosphere but is known to be present in volcanic gases. The poisonous nature of the gas is the result of its uniting with the hemoglobin of the blood to give carboxyhemoglobin. As low a concentration as 0.14% in air is dangerous, while 0.4% is nearly always fatal in less than 30 minutes. Coal gas contains (6%–12%) carbon monoxide and it is readily detected in the exhaust gases of motorcars. On a still day it has been known to accumulate from this source to such an extent in the congested areas of large cities that pedestrians have developed headaches from its poisoning action. Large tunnels that have been constructed to carry heavy motor traffic have automatic devices which start the operation of ventilating fans before the carbon monoxide reaches dangerous proportions.

This gas was first prepared and isolated by J. M. F. de Lassone (1776) by heating zinc oxide with carbon, and was for a time considered to be identical with hydrogen. However, W. Cruikshank (1800) and F. Clément and J. B. Désormes (1801) proved it to contain only carbon and oxygen, and J. Dalton (1803) showed that it had only half as much of the latter per weight of carbon as carbon dioxide. It may be prepared by passing carbon dioxide over red-hot carbon or red-hot iron; by heating many metallic oxides with carbon; by heating formic or oxalic acid or their salts with sulfuric acid (in the case of oxalic acid an equal volume of the dioxide is produced); or by heating potassium ferrocyanide with a large volume of concentrated sulfuric acid: $K_4Fe(CN)_6+8H_2SO_4+6H_2O \rightarrow 4KHSO_4+FeSO_4+3(NH_4)_2SO_4+6CO$. Carbon monoxide is about as heavy as air (sp. gr. 0.968) and is only slightly soluble in water. It is not easily liquefied: its critical temperature is −139.5° C., its critical pressure 35.5 atm., its boiling point −192° C., and its melting point −207° C. In these and other physical properties it closely resembles nitrogen. Carbon monoxide burns with a well-known blue flame, giving off the dioxide, but its burning is greatly retarded in very dry air or oxygen. It combines directly with heated alkaline hydroxides (or soda lime) to give formates ($KOH+CO \rightarrow HCOOK$) and with chlorine to give carbonyl chloride. Under high pressures, suitable mixtures of carbon monoxide and hydrogen react over specific catalysts to give alcohols while other ratios of the same gases (synthesis gas) over different catalysts form liquid fuels (F. Fischer-H. Tropsch). Both are reactions of increasing industrial importance. It was reported in 1945 that carbon monoxide would combine with acetylene and water, or like substances, in the presence of nickel carbonyl, $Ni(CO)_4$, to form acrylic acid ($CO+C_2H_2+H_2O \rightarrow CH_2{:}CHCOOH$) or its derivatives (*see* PLASTICS). Carbon monoxide unites with many metals (*e.g.,* nickel, iron, cobalt, molybdenum, ruthenium, etc.) to give a series of carbonyls (*see* CARBONYLS, METAL), that of nickel being used in the manufacture of the pure metal. Potassium carbonyl, $K_6(CO)_6$, at times formed in heating potassium carbonate with coke, as well as by direct union, is explosive and is of a different type, being a benzene derivative. Carbon monoxide is often a powerful reducing agent, and its reduction of iodine pentoxide to iodine is used to detect and determine minute quantities of the gas in air. In 1918 a catalyst, hopcalite, was developed which would oxidize carbon monoxide in any air which passed through it. This catalyst has become an important material in gas masks where protection against this gas is desired. The gas is absorbed by ammoniacal or hydrochloric acid solutions of cuprous chloride (colourless crystals of the resulting compound, $CuCl.CO.2H_2O$, have been obtained) and this reaction is used in gas analysis and on a large scale in the purification of such gases as the hydrogen used in the synthesis of ammonia. Carbon monoxide is finding an ever wider use in synthetic chemistry.

Carbon dioxide was first discovered by J. B. van Helmont (1577–1644) who observed that it was formed in the products of combustion and fermentation. Later J. Black named it "fixed air" because of its being a constituent of carbonated alkalis. A. L. Lavoisier (1743–94) demonstrated its nature by burning carbon in oxygen. Carbon dioxide is a regular component of the atmosphere (normally 3 vol. per 10,000), and is found in mineral waters, volcanic gases, the gases issuing from some gas wells, certain grottoes near Naples and in Poison valley, Java. It is a constituent of the carbonates found in many minerals (*see* CARBONATES). It is formed in the process of respiration, in the combustion of all carbonaceous material and in fermentation, some of the liquid and solid carbon dioxide of commerce being derived from breweries. In the presence of sunlight, the green chlorophyll of plants is able to convert (photosynthesis) carbon dioxide and water into carbohydrates and oxygen ($6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$). This is one of the fundamental reactions of the life process. Industrially, carbon dioxide is used in the manufacture of soda by the Solvay or ammonia-soda process (*see* ALKALI MANUFACTURE), in the sugar industry, in the preparation of mineral waters and carbonated beverages, in the production of dry ice and in the fighting of fires. Automatic refrigeration in insulated pressure tanks has made it possible to transport and use large volumes of liquid carbon dioxide. Fire trucks carrying several tons of this liquid have proved their merit especially in rapid control of fires in planes that crash at airports.

Carbon dioxide is a colourless gas, possessing a faint pungent smell and a slightly acid taste. It may be prepared by burning carbon in an excess of air or oxygen, by heating many carbonates or bicarbonates or by the action of acids on these: $M_2CO_3+2HCl \rightarrow 2MCl+H_2O+CO_2$. It does not burn and does not ordinarily support combustion, but metals such as magnesium when ignited will continue to burn in it, giving oxides and liberating carbon. It is 1.53 times heavier than air, and requires only a pressure of 35 atm. to liquefy at 0° C. Critical temperature and pressure are 31.1° C. and 73 atm. respectively; the liquid freezes at −56.6° C. under 5 atm., and the solid sublimes at −78.5° C. under atmospheric pressure. The solid "snow," often called dry ice, has become widely used where low temperatures are desired, as in the preservation of frozen foods. At 0° C., 1 vol. of water dissolves 1.79 vol. of the gas (0.33%), and it is twice as soluble in alcohol. The solubility in water markedly increases with pressure, making possible the preparation of carbonated beverages. The aqueous solution is feebly acidic, as a result of the presence of a small proportion of carbonic acid, H_2CO_3; solutions of caustic alkalis absorb the gas readily to give carbonates and ultimately bicarbonates.

The physical properties of carbon dioxide are remarkably similar to those of nitrous oxide. The gas reacts with limewater or baryta water to give a white precipitate of the corresponding carbonate, making possible its detection and estimation. Carbon dioxide and ammonia gases unite to give ammonium carbamate, NH_2COONH_4 (*see* AMMONIA). If passed over molten sodium, carbon dioxide converts it to sodium oxalate, $Na_2C_2O_4$. At high temperatures the gas dissociates slightly: $2CO_2 \rightleftharpoons 2CO + O_2$; under atmospheric pressure the decomposition amounts to only 0.1% at 1,300° C. but rises to about 40% at 3,000° C.

Additional Oxides.—Carbon suboxide was first produced in 1906 by O. Diels and B. Wolf. They heated the ethyl ester of malonic acid with phosphorus pentoxide to 300° C. under diminished pressure, the reaction being essentially one of dehydration: $CH_2(COOC_2H_5)_2 \rightarrow 2C_2H_4 + 2H_2O + C_3O_2$. Since then it has been made in a number of ways, but the highest yield has been obtained by the pyrogenic decomposition of diacetyltartaric anhydride. When cooled the gas readily condenses to an almost colourless, refractive, extremely mobile liquid which boils at 6.3° C. The liquid may be frozen to a solid which melts at −107° C. The oxide is very reactive and has the properties of a ketene (*q.v.*). Spectroscopy proves the structure of the molecule to be linear, OC:C:CO, and its chemical behaviour shows it to be the anhydride of malonic acid. When burned with oxygen it gives an amount of carbon dioxide which confirms its composition ($C_3O_2 + 2O_2 \rightarrow 3CO_2$). It is a colourless suffocating gas which tends to polymerize to a red-brown solid on a number of surfaces. The liquid often turns to a polymerized dark-red mass on standing. This compound is the second in a series of carbon oxides having the general formula C_nO_2 where n is always an odd number, the first member of the series being CO_2. Theoretical considerations rule out the possibility of any linear C_nO_2 oxides of carbon having an even number of carbon atoms. In 1937 A. Klemenc and G. Wagner reported that they had prepared small quantities of the third member of this series, pentacarbon dioxide, C_5O_2. They claimed to have obtained this oxide along with C_3O_2 while dehydrating malonic acid but they never found it when decomposing diacetyltartaric anhydride. Grave doubt has arisen as to the actual production of a pure pentacarbon dioxide. Mellitic anhydride, $C_{12}O_9$, is a different type of oxide of carbon. It has been made by dehydrating mellitic acid, $C_6(COOH)_6 \rightarrow C_{12}O_9 + 3H_2O$. Mellitic acid is a benzene derivative, as is the anhydride. (L. H. R.)

CARBONADO is a dark massive form of impure diamond, known also as carbonate and in trade simply as carbon. It is sometimes called black diamond. Once of little or no value, it came into use on the introduction of diamond drills (*see* DRILLING MACHINERY), and is extremely valuable for mounting in the steel crowns used for diamond boring and for other industrial uses. Generally it is found in small masses of irregular polyhedral form, black, brown or dark gray in colour, with a dull resinoid lustre; it breaks with a granular fracture, paler in colour and in some cases resembling that of fine-grained steel. Being slightly cellular, its specific gravity is rather less than that of well crystallized diamond. It is as hard as the more familiar form of diamond but less brittle. Carbonado is found chiefly in the state of Bahia in Brazil, where it occurs in the cascalho or diamond-bearing gravel. Borneo also yields it in small quantities.

CARBONARI were members of certain secret revolutionary societies of the early 19th century. Too many of the secret societies of the period have been inaccurately called Carbonarist by their friends and enemies alike and the term is often used loosely to mean any Italian conspirator of that time. The real Carbonari (Ital. "charcoal burners") have left few unambiguous records.

There are hints that a trade fraternity of the charcoal burners of the Jura and the Black forest which existed in the 18th century began to have some political significance during the early years of the Directory in France, but the Carbonari proper first appear definitely under Napoleonic rule in Italy. Guesses as to the precise date of their origin have varied between 1802 and 1810, and some have claimed even to trace them back before 1799 to the secret anti-French organizations of those years. From the beginning, however, the appearance of the Carbonari is linked with the French army, which always contained some republican officers hostile to the Bonapartist evolution of France toward monarchy. In 1806 a French-Swiss regiment was stationed at Capua, and it is there that almost at once the first firm indications of Carbonarist lodges can be detected.

The nature and function of the lodges is easier to describe than their origins. Their ritual was strongly marked by masonic and Christian symbolism. Members addressed one another as *buoni cugini* ("good cousins") and the sect revered God as the "Grand Master of the Universe." They were recruited mainly from the nobility and official classes and always included many officers of the Italian army of Joachim Murat. Later, more small landowners came to join the lodges. Although the aims of the lodges varied from time to time, the general function of the organization was to provide foci for political opposition first in Napoleonic and then in Restoration Italy. They for some time hoped to achieve constitutional guarantees and the protection of Italian interests against the French with Murat's help. When this hope faded they turned against Murat. It has been alleged that some of the lodges were then used as subversive organizations by the British operating from Sicily, but their next major development came during Murat's campaign in 1814. The Carbonari then spread with the army's movement northward and by the end of that year were cooperating with other secret anti-French societies in Lombardy.

After 1815, the Carbonari in the kingdom of the Two Sicilies took up a decisively anti-Bourbon and constitutional attitude. Their most spectacular achievement was the Neapolitan revolution of 1820 which began, significantly, with a military mutiny. Unfortunately, the successful revolutionaries were unable to remain in agreement among themselves, and the new regime only survived a few months before it was overthrown by Austrian intervention. This action helped to bring to a head another plot in Piedmont. The Carbonari were supposed to be involved in this outbreak (which certainly included members of secret societies known as Federati), but their precise role is uncertain. There had been other examples of Carbonarist activity in Italy (notably in the Legations), but the last kick of the movement came with the revolutions in Bologna, Parma and Modena in 1831. After this, Mazzini founded his own Giovine Italia movement because he was convinced of the ineptitude of the Carbonari. At this point they leave the stage of Risorgimento history.

Outside Italy, a similar movement called the Charbonnerie had taken root in France. It had participated in outbreaks in 1821, and La Fayette himself had condescended to be its head. An international organization called the Charbonnerie Démocratique Universelle continued to operate for a few years after 1830 under the leadership of Filippo Michele Buonarroti (1761–1837), but achieved little. Both the fears of its enemies and the hopes of its friends had always exaggerated the potential of the Carbonarist movement and still make it difficult to discern its true significance. It seems likely nonetheless that, if the Neapolitan revolution of 1820 is excepted, its importance was always mythological and moral rather than practical.

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(J. M. Rs.)

CARBONATED BEVERAGES: *see* SOFT DRINKS.

CARBONATES. Metallic carbonates are the salts of carbonic acid. The carbonates of sodium, calcium and magnesium are particularly important as industrial chemicals. These and other metallic carbonates are described under the various metals. Organic carbonates are the esters of carbonic acid and orthocarbonic acids. Carbonic acid (H_2CO_3) is formed when carbon dioxide is dissolved in water, $CO_2 + H_2O = H_2CO_3$. Being a dibasic acid it forms two series of salts, the normal carbonates (*e.g.*, Na_2CO_3) and the acid carbonates or bicarbonates (*e.g.*, $NaHCO_3$).

Carbonic acid is one of the feeblest of the acids, is very unstable and exists only in dilute aqueous solution. Dissociation constants: primary, 4.3×10^{-7} (25° C.); secondary 4.7×10^{-11}

(25° C.). Attempts to obtain the acid in the free state have not been successful.

Metallic Carbonates.—Many of the metallic carbonates are white solids, but some, such as those of copper (blue or green) and nickel (green), possess colours which are characteristic of the metal concerned. Many are found as minerals, the more important of such naturally occurring carbonates being cerussite (lead carbonate, $PbCO_3$), malachite and azurite (both basic copper carbonates), smithsonite (zinc carbonate, $ZnCO_3$), witherite (barium carbonate, $BaCO_3$), strontianite (strontium carbonate, $SrCO_3$), calcite and aragonite (calcium carbonate, $CaCO_3$) and dolomite (calcium magnesium carbonate, $CaCO_3.MgCO_3$). Sodium "sesquicarbonate," $Na_2CO_3.NaHCO_3.2H_2O$, occurs as a deposit in some playas and is called trona. Most metals form carbonates (aluminum and chromium are exceptions), the alkali metals yielding both acid and normal carbonates of the types $MHCO_3$ and M_2CO_3 (M = one atom of a univalent metal), while bismuth, copper and magnesium appear to form only basic carbonates. The acid carbonates (bicarbonates) of the alkali metals can be prepared by saturating an aqueous solution of the alkaline hydroxide with carbon dioxide, $M.OH + CO_2 = MHCO_3$, and from these acid salts the normal salts may be obtained by gentle heating, carbon dioxide and water being evolved at the same time, $2MHCO_3 = M_2CO_3 + H_2O + CO_2$(*see* ALKALI MANUFACTURE). Because of the slight ionization of carbonic acid, soluble carbonates undergo a significant hydrolysis in water solution and are alkaline, $CO_3^{-2} + H_2O = HCO_3^- + OH^-$; the bicarbonates are much less hydrolyzed and only faintly alkaline. Most other carbonates are formed by precipitation of salts of the metals by means of alkaline carbonates. All carbonates, except those of the alkali metals and of thallium, have low solubilities in water, and the majority decompose when heated strongly, carbon dioxide being liberated and a residue of an oxide of the metal left. Carbonates of the heavy metals, such as silver, yield the metal on strong ignition. Alkaline carbonates undergo slight decomposition, even at a bright-red heat. The carbonates are decomposed by mineral acids, with formation of the corresponding salt of the acid and liberation of carbon dioxide. Many carbonates which are insoluble in water dissolve in water containing carbon dioxide, giving bicarbonates, which cause "temporary" hardness (*see* CALCIUM: *Compounds*).

Organic Carbonates.—The organic carbonates are the esters of carbonic acid, H_2CO_3, and of the unknown orthocarbonic acid, $C(OH)_4$. The acid esters of carbonic acid of the type HO.CO.OR are not known in the free state.

Potassium ethyl carbonate, $KO.CO.OC_2H_5$, is obtained in the form of pearly scales when carbon dioxide is passed into an alcoholic solution of potassium ethoxide, $CO_2 + KOC_2H_5 = KO.CO.OC_2H_5$. It is not very stable, water decomposing it into alcohol and the alkaline carbonate. The normal esters may be prepared by the action of silver carbonate on the alkyl iodides, or by the action of alcohols on the chlorocarbonic esters. These normal esters are colourless, pleasant-smelling liquids, which are readily soluble in water. They show all the reactions of esters, being readily hydrolyzed by caustic alkalis, and reacting with ammonia to produce carbamic esters and urea. Heating with phosphorus pentachloride eliminates an alkyl group and a chlorocarbonic ester is formed. Dimethyl carbonate, $CO(OCH_3)_2$, is a colourless liquid, which boils at 90.6° C. and is prepared by heating the methyl ester of chlorocarbonic acid with lead oxide. Diethyl carbonate, $CO(OC_2H_5)_2$, is a colourless liquid which boils at 125.8° C.; its specific gravity is 0.975. When it is heated to 120° C. with sodium ethoxide it decomposes into ethyl ether and sodium ethyl carbonate.

Orthocarbonic ester, $C(OC_2H_5)_4$, is formed by the action of sodium ethoxide on chloropicrin, $CCl_3NO_2 + 4C_2H_5ONa = C(OC_2H_5)_4 + NaNO_2 + 3NaCl$. It is an ethereal-smelling liquid, which boils at about 159° C., and has a specific gravity of 0.919. When heated with ammonia it yields guanidine, and boiled with alcoholic potash it yields potassium carbonate.

Chlorocarbonic ester, $Cl.CO.OC_2H_5$, is formed by the addition of well-cooled absolute alcohol to phosgene (carbonyl chloride). It is a pungent-smelling liquid, which fumes strongly on exposure to air. It boils at 94° C., and has a specific gravity of 1.138. When heated with ammonia it yields urethane (*q.v.*). Sodium amalgam converts it into formic acid; with alcohol it yields the normal carbonic ester. It is easily broken down by many substances into ethyl chloride and carbon dioxide.

Percarbonates.—Barium percarbonate, $BaCO_4$, is a white solid obtained by passing an excess of carbon dioxide into water containing barium peroxide in suspension; it is fairly stable, and yields hydrogen peroxide when treated with acids. Two potassium percarbonates having the formula $K_2C_2O_6$ are known. One is obtained by the electrolysis of a concentrated solution of the carbonate at -20° C., and the other by the action of carbon dioxide on potassium peroxide; the former liberates iodine from a solution of potassium iodide without loss of oxygen: $K_2C_2O_6 + 2KI = 2K_2CO_3 + I_2$, but the latter suffers loss of a part of its oxygen in the same circumstances. Sodium carbonate is not sufficiently soluble to permit percarbonates to be made by the electrolytic method, but the other method gives rise to a number of percarbonates; *e.g.*, $Na_2C_2O_6$, Na_2CO_4, Na_2CO_5, $NaHCO_4$. The first of these resembles the second type of potassium percarbonate. An attempt has been made to classify percarbonates according to whether they are (1) merely carbonates with hydrogen peroxide in crystallization; (2) permonocarbonates; or (3) perdicarbonates (compare persulfates). Percarbonates find their chief use in bleaching, and the potassium salt is used as antihypo in photography for eliminating excess of hypo. (J. H. Y.)

CARBON BLACK, a generic term for a group of intensely black, finely divided forms of amorphous carbon made by thermal decomposition, or partial combustion, of the vaporizable portion of any carbonaceous material. Common soot produced by a smoky oil or coal fire is a form of carbon black similar to lampblack.

Over 90% of all carbon black produced is used as a reinforcing filler in rubber goods, principally tires. Its use greatly increases the abrasion and wear resistance of rubber articles. A standard passenger automobile tire contains approximately five pounds of carbon black and ten pounds of natural or synthetic rubber. Without the help of carbon black, the synthetic rubber of World War II would have been almost useless for tire manufacture.

The second most important use of carbon black is as a pigment in inks, chiefly newsprint inks. Other uses are in protective coatings, plastics, phonograph records, paper, carbon paper and batteries; in these applications, carbon black may have a variety of functions; *e.g.*, pigment, filler, reinforcing agent, electric conductor or chemical reducing agent.

Types.—Carbon blacks are designated as channel or impingement, furnace, thermal, lamp-, or acetylene blacks, depending upon the process of manufacture. Furnace and channel blacks are the most widely used.

All are fundamentally similar but wide variations in particle diameters occur among the various types. Carbon blacks are among the most finely divided materials known; certain impingement blacks have particles as small as .0000004 in. in diameter. Carbon blacks contain 88%–99.5% carbon, 0.3%–11% oxygen, 0.1%–1% hydrogen, up to 1% inorganic material, small amounts of tarry matter and traces of sulfur. The electron microscope reveals the primary particles to be spherical; diffraction of X-rays indicates a structure similar but less regularly crystalline than graphite. Prolonged heating at the 3,000° C. level changes carbon black to graphite.

Carbon blacks should not be confused with animal, vegetable and mineral blacks, which are in the nature of chars made by heating bones, plant matter or carbonaceous mineral matter in closed retorts. When ground to pass a screen having 325 meshes per inch, these products find limited use as pigments.

Channel (*impingement*) *black* is made by the impingement of smoky flames from tiny gas jets on iron channels; the deposited black is removed by moving the channels over stationary scrapers. A single plant consists of hundreds of sheet-iron "hothouses" enclosing several hundred thousand flames.

Furnace blacks are made by incomplete combustion of gaseous or liquid hydrocarbons in refractory chambers. This process has increased rapidly in importance, largely because of the impact of

World War II. Products with a wide range of particle size can be produced by the furnace process; fuels of all types, even heavy pitches, can be used.

Thermal blacks are produced when hydrocarbons are decomposed by contact with heated refractories in the absence of air.

Lampblack manufacture involves the burning of oil, usually coal-tar creosote, in shallow pans set inside a furnace. The draft is regulated to give a heavy cloud of smoke, which is allowed to settle in large brick chambers. Lampblack is the oldest known black pigment, but has been going out of favour since the development of channel blacks. A deep-black pigment, its principal use is for tinting paints.

Acetylene black is formed when acetylene gas preheated to 800° C. spontaneously decomposes in the absence of air in refractory chambers. Its principal use is in applications where high electrical conductivity is required; *e.g.*, in dry cells.

' *See* R. E. Kirk and D. F. Othmer (eds.), *Encyclopedia of Chemical Technology*, vol. 3 (1949), first supplement volume (1957); A. F. Beede and C. A. Stokes, "Carbon Black," *Petrol. Process.*, 9:1410–16 (Sept. 1954). (C. A. Ss.)

CARBON COMPOUNDS: *see* CHEMISTRY: *Organic Chemistry;* CARBON, OXIDES OF; CARBIDES; CARBONATES; CARBONYLS, METAL; CARBOXYLIC ACIDS; CARBOHYDRATES.

CARBON DIOXIDE: *see* CARBON, OXIDES OF.

CARBON DISULFIDE or CARBON BISULFIDE, a chemical compound with the formula CS_2, is a colourless and extremely volatile liquid with a sweet, ethereal odour and an acrid taste. It is toxic and inflammable. The compound is used in the manufacture of viscose rayon and cellophane. It was discovered in 1796 by W. A. Lampadius, who obtained it by heating a mixture of charcoal and pyrites. In 1802 F. Clément and J. B. Désormes obtained the compound by heating charcoal with sulfur.

Preparation.—The traditional method of preparing carbon disulfide commercially is by the reaction of carbons, chiefly charcoal, with sulfur at temperatures of 800° to 1,000° C. in direct-fired retorts or electric furnaces. In the early 1960s major quantities were also produced from the reaction of methane and sulfur as follows: $CH_4+2S_2 \rightarrow CS_2+2H_2S$. In this process, sulfur and methane are preheated together in a tube furnace, then reacted in catalyst chambers at temperatures of 500° to 700° C. The carbon disulfide is separated from the hydrogen sulfide by absorption in oil followed by stripping and distillation. The process is made economical by the high sulfur recoveries achieved in the associated process for the reconversion of hydrogen sulfide to sulfur by oxidation.

Uses.—Viscose rayon and cellophane have long been principal consumers of carbon disulfide, accounting for about 60% and 15%, respectively, of total carbon disulfide production in the early 1960s. The manufacturing process for both products involves the treatment of wood pulp (cellulose) with caustic soda to form alkali cellulose, which is then treated with carbon disulfide to form cellulose xanthate, according to the formula: cellulose-ONa$+CS_2 \rightarrow$cellulose-OCSSNa. The cellulose xanthate is produced as a viscose solution which is spun into filaments or drawn into films. These are fixed by passing through a bath of sulfuric acid with regeneration of cellulose and evolution of carbon disulfide. The production of carbon tetrachloride consumes an additional 15% of disulfide production. In this process, carbon disulfide is treated with chlorine to produce carbon tetrachloride and sulfur monochloride ($CS_2+3Cl_2 \rightarrow CCl_4+S_2Cl_2$); the sulfur monochloride is then treated with carbon disulfide to give an additional yield of carbon tetrachloride ($CS_2+2S_2Cl_2 \rightarrow CCl_4+6S$). Other chemicals produced from carbon disulfide include the dithiocarbamates, which are used as accelerators in rubber vulcanization and are also popular as organic fungicides. The former application accounts for about 5% of the carbon disulfide consumption. Other chemicals produced from carbon disulfide include ammonium thiocyanate and thiourea, both of which have a variety of minor industrial uses.

Properties.—The compound is composed of 12 parts by weight of carbon and 64.1 parts by weight of sulfur. On aging it acquires a very unpleasant odour and tends to darken in colour. It boils at 46.3° C. and freezes at −112° C. The critical temperature of carbon disulfide is 273° C.; its critical pressure, 75 atm.; its specific gravity (25°/4° C.), 1.2559; and its refractive index (25° C.), 1.628.

The compound is only slightly soluble in water but is miscible in all proportions with absolute alcohol, ether, benzene and various light oils. It is an excellent solvent for sulfur, phosphorus, iodine, rubber, resins, waxes, vegetable and animal fats and oils.

Considerable caution must be exercised in the use of carbon disulfide due to its inflammability and toxicity. Concentrations in air of from 1% to 50% by volume are explosive. Carbon disulfide ignites spontaneously in air at 100° C. The maximum allowable concentration in air for continuous exposure of human beings is 15–20 parts per 1,000,000. Continued exposure to toxic concentrations produces nervousness, insomnia, irritability, excessive fatigue and loss of appetite. For acute poisoning administration of artificial respiration may be necessary. A concentration of 4,000 parts per 1,000,000 may be fatal in one to two hours. (A. G. DR.)

CARBONIFEROUS SYSTEM AND PERIOD. The Carboniferous system consists of rocks formed during the next to last or Carboniferous period of the Paleozoic era. This period lasted about 80,000,000 years and began about 340,000,000 years ago. This discussion of the geologic record of this system and period, sometimes referred to as the age of coal swamps and as the age of amphibians, is divided into three main sections covering the rocks identified with the system, the animal and vegetable life of the period and the economic products, including coal and oil, that provided so much of the power for the Industrial Revolution. For further discussion of the origins and formation of Carboniferous rocks *see* GEOLOGY. Additional information on life in the Carboniferous period may be found in the articles PALEOBOTANY and PALEONTOLOGY. The economic products are discussed also in individual articles, as COAL AND COAL MINING. (X.)

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	Began (Millions of Years Ago)
		CENOZOIC ERA	
Quaternary	Recent (last 11,000 years)		
	Pleistocene	Early man	2+
Tertiary	Pliocene	Large carnivores	10
	Miocene	Whales, apes, grazing forms	27
	Oligocene	Large browsing mammals	38
	Eocene	Rise of flowering plants	55
	Paleocene	First placental mammals	65–70
		MESOZOIC ERA	
Cretaceous		Extinction of dinosaurs	130
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	180
Triassic		Appearance of dinosaurs	225
		PALEOZOIC ERA	
Permian		Reptiles developed, conifers abundant	260
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	300
Lower (Mississippian)		Sharks abundant	340
Devonian		Amphibians appeared, fishes abundant	405
Silurian		Earliest land plants and animals	435
Ordovician		First primitive fishes	480
Cambrian		Marine invertebrates	550–570
		PRECAMBRIAN TIME	
		Few fossils	more than 3,490

Following are the main divisions of this article:

I. Rocks of the Carboniferous System
  A. Classification and Terms
  B. Lower Carboniferous (Mississippian)
    1. Mississippian of North America
    2. Lower Carboniferous of Europe and Asia
  C. Upper Carboniferous (Pennsylvanian)
    1. Pennsylvanian of North America
    2. Upper Carboniferous of Europe and Asia
  D. Carboniferous of Southern Hemisphere and India
  E. Igneous Rocks
II. Life of the Carboniferous
    1. Marine Life
    2. Land Life
III. Economic Products

I. ROCKS OF THE CARBONIFEROUS SYSTEM

The Carboniferous system overlies the Devonian and underlies the Permian system. It was first distinguished in England and Wales and named in 1822 for its important coal deposits. The stratified rocks of this system attain a maximum thickness of more than 40,000 ft. but are much thinner in most areas.

A. Classification and Terms

The Carboniferous rocks generally are divided into two parts representing about equal intervals of time. In North America the term Carboniferous system or period is rarely used and these two parts are considered to be separate systems known as Mississippian (older) and Pennsylvanian (younger) which are approximately equivalent to the Lower and Upper Carboniferous divisions of Europe respectively. This different terminology on opposite sides of the Atlantic results from recognition of a widespread unconformity or break in deposition separating the Mississippian and Pennsylvanian in the central United States, showing that the Mississippian rocks were gently folded and eroded before the Pennsylvanian strata were deposited. The unconformity is particularly pronounced in Illinois where, from south to north, the Pennsylvanian gradually overlaps the truncated edges of 5,000 ft. of older strata and finally comes to rest on the Middle Ordovician. Somewhat comparable breaks are recognized in Europe but no single unconformity there serves to divide the Carboniferous into two such well-marked divisions.

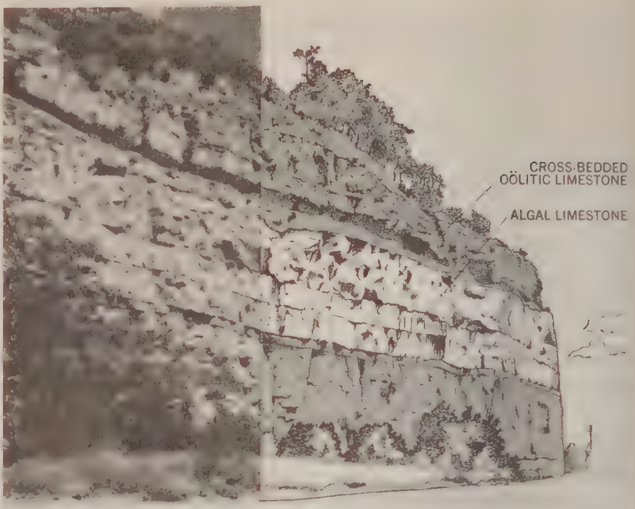
These unconformities and others that vary considerably in importance from place to place record episodes in a succession of late Paleozoic earth movements related to the uplifting and folding of ancient mountains long since destroyed by erosion. The disturbances began in late Devonian time, recurred at intervals throughout the Carboniferous and Permian periods and finally terminated the Paleozoic era. In Europe the remnants of these mountains extend from southern England and Spain through France and central Germany. They are known to geologists as the Hercynian or Variscan ranges (*see* Europe: *Physical Geography*) and are sometimes termed the Paleozoic Alps although they are no longer conspicuous topographically and are quite distinct from the modern Alps. In North America somewhat similar mountains were formed along the Atlantic and Gulf coasts but the remains of the earlier ranges are less clearly recognizable. There these movements culminated in the folding of the present Appalachian mountains and are considered preliminary phases of what is termed the Appalachian revolution which profoundly changed the geography of all eastern North America.

The geological development of Europe and that of North America differed in important respects. In North America, Upper Carboniferous strata pass upward into the Permian system without interruption or any important change in character, and no sharp boundary exists between these systems except in west Texas. For this reason the United States geological survey for many years included the Permian rocks in the Carboniferous system. In some other parts of the world where the Carboniferous and Permian are not readily separable these strata are known as Permo-Carboniferous.

Such differences in the usage of geologic terms occur because classification into geologic systems, worked out in western Europe and Great Britain during the first half of the 19th century, is not entirely satisfactory in other regions where geologic happenings were not the same. The European classification is acknowledged universally, however, as the standard and an attempt is usually made to distinguish the same systems everywhere.

B. Lower Carboniferous (Mississippian)

1. Mississippian of North America.—These Lower Carboniferous rocks were named from the upper Mississippi valley, and the formations distinguished in that area, totaling about 3,000 ft. in thickness, constitute the standard succession for North America. They are nearly continuous and horizontal in most of the United States between the Appalachian and Rocky mountains, but gentle dips carry them beneath younger rocks in the Appalachian basin extending from Ohio and Pennsylvania to Alabama, the Michigan basin, the Illinois basin, including parts of Indiana and western Kentucky, and the western interior basin between the Rocky mountains and Mississippi river. Mississippian rocks also are widely distributed in the Rocky mountains from Alaska to northern Mexico and in the maritime provinces of Canada. They probably occur much altered by pressure and igneous action in New England and in some areas adjacent to the Pacific coast.



ILLINOIS STATE GEOLOGICAL SURVEY PHOTO

FIG. 1.—UPPER MISSISSIPPIAN LIMESTONE IN MISSISSIPPI RIVER BLUFF, ALTON, ILL.

Limestone is the predominant rock of the Mississippian series, and the fossils which it encloses record the presence of an ancient shallow sea which at one time or another during this period covered the greater part of the United States. This sea was bounded on the north by low-lying land in what is now eastern and central Canada. On the east it was bordered by a long, narrow, partly mountainous land near the present Atlantic coast. On the west a similar land area probably extended northward from northern California but its nature and extent are not well known. This Mississippian sea is believed to have had no direct connection with the Atlantic ocean, and the Mississippian rocks of eastern Canada probably never were continuous with those of the United States. Land also lay close somewhere to the south but it is not known if this was continuous with the Atlantic land area.

During Mississippian time these lands, and particularly the higher ones, were eroded; rivers carried sand, silt and mud from them into the central sea where sediments settled to form beds of sandstone and shale associated with the limestone. These lands no longer exist in their original condition and their presence, extent and character must be inferred from the distribution and nature of the sediments derived from them.

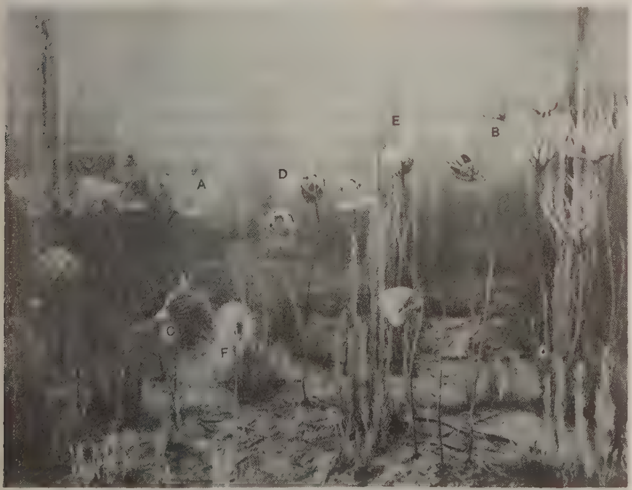
The Mississippian rocks of the Mississippi valley are divided into four series, identified as the Kinderhookian (from Kinderhook, Pike county, Ill.), Osagian (from the Osage river, Missouri), Meramecian (from the Meramec river, Missouri) and Chesterian (from Chester, Randolph county, Ill.). Just as the Carboniferous is a standard division of the world, these are the standard Mississippian divisions of North America.

Kinderhookian Series.—At the base of the oldest or Kinderhookian formation of the Mississippi valley area, and therefore at the base of the Mississippian, is a black shale which overlaps at some places onto much older rocks. Similar shale is continuous from the Mississippi valley to New York, Alabama, New Mexico and Alberta. In most of these regions comparable overlap does not occur and the black shale commonly overlies rocks with Upper Devonian fossils. The shale thickens greatly in New York and Pennsylvania, however, and encloses limestone with Middle and Upper Devonian fossils. Obviously the black shale is not the same age everywhere. It began forming in some areas in Middle Devonian time and was still being deposited in others in the early part of the Mississippian period. The black shale contains few fossils that indicate its age and consequently the exact boundary between the Devonian and Mississippian systems is in doubt in many areas.

In the Mississippi valley the Kinderhookian consists of several locally developed and variable formations. It is separated from the overlying Osagian series by a break in deposition, indicating that the sea withdrew temporarily from that region. Fossils show that Kinderhookian rocks exist both to the east and west, but these strata are different in composition and not readily distinguishable from similar overlying Osagian beds. In the northeastern region the Mississippian is more naturally divisible into two parts, gray sandstone below (equivalent to the Kinderhookian, Osagian and Meramecian series) and red beds above (equivalent to the Chesterian). A short distance southward the middle beds change to limestone and this third division, mostly of Meramecian but partly of Chesterian age, separates the other two. The lower sandy division includes workable coal seams in western Virginia. The western Mississippian also generally consists of two lithologically distinctive parts, the lower being limestone up to 1,000 ft. thick approximately corresponding to the Kinderhookian and Osagian and an upper heterogeneous shaly part of Meramecian and Chesterian age.

Osagian Series.—The Osagian series of the Mississippi valley is mostly coarse crystalline limestone with many flint nodules, and these characteristics persist with little change to New Mexico. Eastward, limestone gives place to shale and sandstone. Limey lenses occur in Indiana, but no limestone is present in Ohio and eastern Kentucky where beds with rounded pebbles make their appearance. In Pennsylvania these beds are mainly sandstone. This distribution of sediments is evidence of the land area that was most elevated or most extensive east of central Pennsylvania. The sands, silts and muds were probably contributed by one or more westward-draining rivers and formed an extensive delta in the shallow sea that was a continuation of and overlay a similar delta built up in the same region during late Devonian time.

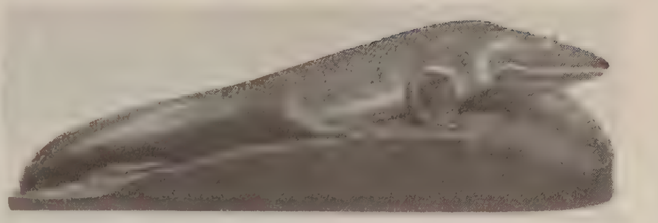
Meramecian Series.—In Illinois and Missouri the Meramecian series consists mostly of fine-grained darker-coloured limestone, some of which is quite bituminous. These beds are more uniformly developed east of the Mississippi river than underlying Osagian limestone and their extension into Ohio and West Virginia demonstrates that the nearby land was contributing much less sediment. This land probably stood less high than formerly, either because it was much worn down by erosion or had subsided. Clay and silt associated with marine limestone in Iowa suggest lowlying land to the northwest where a broad peninsula is believed to have extended from the Canadian land area southwestward from Minnesota to Colorado and separated the interior North American sea from a wide strait occupying the Rocky mountain region northward to the Arctic ocean. Also toward the end of Meramecian time the Ozark area of Missouri became an island and erosion produced sand that was mixed with the limestone deposited on its shores. In several areas Meramecian rocks include light-coloured oölitic limestone indicative of very shallow warm water. Beds of gypsum are much less common, but their occurrence in Iowa, Michigan, Indiana and eastern Canada is evidence of the existence of local basins, cut off at times from the sea, where evaporation greatly exceeded rainfall and the inflow of fresh water.



MUSEUM OF PALEONTOLOGY, UNIVERSITY OF MICHIGAN

FIG. 2.—RESTORATION OF MISSISSIPPIAN CRINOID ASSEMBLAGE ON THE OSAGIAN SEA BOTTOM IN MISSISSIPPI VALLEY REGION

Inadunate crinoids: (A) *Cyathocrinites,* (B) *Barycrinus;* camerate crinoids: (C) *Uperocrinus,* (D) *Gilbertsocrinus;* flexible crinoids: (E) *Forbesiocrinus;* (F) a blastoid



BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

FIG. 3.—RESTORATION OF A SMALL PENNSYLVANIAN AMPHIBIAN (DIPLOVERTEBRON)

Chesterian Series.—The Upper Mississippian or Chesterian is separated from the Meramecian by another unconformity recording temporary but widespread emergence. The Chesterian series consists of a variety of rocks generally including much shale and some sandstone alternating with marine limestone. The sea in which they were deposited was less extensive, particularly to the north, than in earlier Mississippian time. Eight or more fluctuations in its level are shown by the rhythmic recurrence of alternately deeper and shallower water sediments somewhat similar to the more perfect sedimentary cycles of the following Pennsylvanian period. At times the sea completely withdrew from the north and left considerable portions of its former bed as temporary land and some of these areas supported dense growths of vegetation whose remains are preserved as thin local noncommercial coals.

Other Formations.—In southern Arkansas, nearby Oklahoma and west Texas the main part of the Mississippian period is unrepresented in the rocks. A thick flinty formation occurs there in the position of the black shale and is believed to bridge the Devonian-Mississippian boundary. Above it are thousands of feet of shale and sandstone without fossils that may be youngest Mississippian and oldest Pennsylvanian. They are evidence of a southern land area (elevated at this time and rapidly eroded) which is now so completely buried beneath much younger rocks that its exact location is unknown.

The precise upper boundary of the Mississippian system also is uncertain in the eastern United States between West Virginia and Alabama. In much of this region the uppermost Mississippian includes red beds and the Pennsylvanian is generally considered to start with the first massive conglomeratic sandstone. Strata of this type, however, probably are not exactly the same age everywhere and consequently the recognized boundary is not entirely consistent. In Wyoming and Montana unfossiliferous red beds separate known Mississippian and Pennsylvanian rocks. Different geologists refer them to one or the other or divide them between the two systems. In other parts of the west the boundary occurs in the midst of thick shaly deposits that are Mississippian below and Pennsylvanian above.

The Mississippian of New Brunswick, Nova Scotia and Newfoundland consists of sandy and shaly strata, bearing terrestrial and fresh-water fossils including erect stumps of trees, separated into two parts by red beds with layers of marine limestone and gypsum and some rock salt. Intermittent occurrence, coarse conglomerates and considerable variation from place to place suggest that these strata were deposited in restricted intermountain basins.

2. Lower Carboniferous of Europe and Asia.—The general nature of the Lower Carboniferous in parts of western Europe and the British Isles is quite similar to that in the Mississippi valley of North America. These beds are termed Dinantian and are divided into parts named from localities in Belgium, as indicated in the accompanying chart. Older beds known as the Famennian that are transitional with the underlying Devonian in certain areas are included in the Carboniferous by some geologists and the lower boundary is disputed there as it is in parts of North America.

Order and Approximate Equivalence of Main Divisions (Series) of Carboniferous Rocks

		EUROPE		NORTH AMERICA		
		Classified by		Classified by		
		Plant fossils	Marine fossils	Plant fossils	Marine fossils	
Carboniferous	Upper	Stephanian	Uralian	Monongahelan	Virgilian	Pennsylvanian
					Missourian	
		Westphalian	Moscovian	Conemaughan	Des Moinesian	
				Alleghenian	Lampassan	
				Pottsvillian	Morrowan	
		Namurian			Chesterian	Mississippian
	Lower or Dinantian		Viséan		Meramecian	
			Tournaisian		Osagian	
			Famennian		Kinderhookian	

In England, Belgium and northern France the main part of the Lower Carboniferous consists of cliff-forming limestone reaching a thickness of 4,000 ft. in south Wales. Above and below are shales and sandstones that may be coal-bearing. Where dark shaly strata of this type are particularly well developed they are known as the Culm. The Lower Carboniferous limestone accumulated in a bay with land to both north and south. The southern land was more prominent and probably was elevated into mountains like those on the eastern margin in North America. Sediments were washed into the bay from both directions, the lower and upper parts of the limestone grade laterally into shaly and sandy strata and consequently the limestone becomes thinner and represents less time in these directions. Also rise of sea level or sinking of the northern land resulted in shifting of the coast line and Viséan beds overlap the underlying Tournaisian and succeed older rocks, some of which had been folded and deeply eroded, particularly in the northern British Isles. In northern England and the central valley of Scotland the Viséan consists of shales, limestones and sandstones with coal beds arranged in the same general type of cycle that is so characteristic of the Upper Carboniferous.

Carboniferous rocks are widely distributed in Europe except in Scandinavia and the Baltic region. Because of the Hercynian and relatively recent Alpine disturbances, however, they are much more discontinuous and structurally complex than in North America. For these reasons, and also because they are buried beneath younger rocks in many areas, the relations of the several subdivisions to each other and their variations from place to place, as well as the geologic history of the Carboniferous period, are less well known in Europe, especially outside the more intensively studied areas. Both marine and terrestrial beds occur in the Lower Carboniferous, either separately or interstratified. The presence in the same area of coal, produced by compression of partly decayed land plants, and thin limestones or other layers with fossilized marine animals shows that parts of Europe lay very close to sea level and alternately rose and sank with reference to this critical line.

The limestone deposits of western Europe decrease in importance eastward. The Lower Carboniferous of central Germany consists of shale with some limestone lenses. Similar beds, becoming sandy or even conglomeratic and containing plant fossils, extend eastward to the Czechoslovakian border region and into Silesia. Throughout much of this region the Carboniferous is transgressive onto older beds and the Viséan is more extensive than the Tournaisian. Especially noteworthy areas of Lower Carboniferous rocks occur in the U.S.S.R. Near Moscow the Tournaisian consists of shale and sandstone with lignitic coal beds. Limestone becomes important in the Viséan, which also includes coal in its lower part. Both contain abundant marine fossils in some layers.

In the Donets basin of southern U.S.S.R. the thick Lower Carboniferous consists of interbedded marine and terrestrial strata, but there is little coal. On the flanks of the Ural mountains much limestone is present but the middle part is shaly and coal-bearing.

The Lower Carboniferous of Spitsbergen far north of the Arctic circle contains coal and fossil plants very similar to those known from much more southerly regions, showing that a mild climate prevailed in that part of the world during the Carboniferous period.

Several small coal basins in France include only terrestrial strata that accumulated in depressions between mountains that were rising in that region. They are comparable to similar occurrences in eastern Canada. Lower Carboniferous beds in which limestone is conspicuous are present in small areas in the Mediterranean region from Spain to the Balkans and Asia Minor but little is known about the geologic details. Fossils prove the existence of both Tournaisian and Viséan in Morocco and Algeria. Both divisions are also present in Iran and south China but the Tournaisian seems to be unrepresented in many other parts of eastern Asia except possibly Japan. Viséan limestone, however, has been recognized in the Altai and Kunlun mountains, in the T'ien-shan and the Himalayas and in Indochina, Malaya and Japan.

C. Upper Carboniferous (Pennsylvanian)

1. Pennsylvanian of North America.—Profound geographic changes occurred in North America at the beginning of the Pennsylvanian period. Marginal lands, particularly those to the east and south, were uplifted to mountainous heights and rapid erosion began. The central continental area was slightly uplifted and gently warped. The interior sea withdrew from most of the region occupied during Mississippian time. At first deposition was restricted to troughs adjacent to the newly raised uplands, particularly in West Virginia, Alabama, Arkansas and Oklahoma, but as these filled, the sea temporarily returned and sediments were carried farther westward and northward until they blanketed most of the continental interior, including the peninsula projecting southwestward from Minnesota. Pennsylvanian rocks overlap the Mississippian (in which river valleys 300 ft. deep had been cut) and extend beyond them onto older rocks.

The crustal movements which produced these changes were related to part of the Hercynian disturbances of Europe but in the interior of North America they were less complicated and widespread and involved a smaller number of episodes of generally less intensity. In North America the Appalachian revolution, presumably at the end of the Permian period, which followed the Carboniferous, produced folding and overthrusting of the Appalachian mountains in the east and the Ouachita mountains in the interior by forces acting from the east and south. In central and eastern North America little subsequent deformation occurred, and late Paleozoic history is much clearer than in Europe. At the time of the Appalachian revolution rocks of the central United States were gently warped, accentuating older broad folds and intervening basins. Post-Paleozoic erosion removed all Pennsylvanian rocks and some older strata as well from the upwarped areas and the Pennsylvanian is preserved in the four previously mentioned basins east of the Rocky mountains where they are inclined so gently that they generally appear horizontal to the eye.

Pennsylvanian rocks were deposited under a variety of conditions ranging from normal clear sea (limestone with marine fossils) through shallow near-coastal waters (shale with marine fossils), deltas (shale and silt with no fossils or only brackish water fossils) and lowland marshes (coal) to great areas of terrestrial alluviation (shale, silt and sand with poorly preserved plant fossils). In general, terrestrial rocks dominate close to the sediment-contributing uplands, and marine rocks are most important far from these sources. Consequently in passing westward from the Appalachian coal fields, the Pennsylvanian system gradually changes and is quite differently developed in such areas as Pennsylvania to the east and Nebraska to the west.

The Pennsylvanian system was named from the state of Pennsylvania where coal was first mined importantly and where the geology of these rocks was first carefully studied. Although coal seams are distributed throughout the 4,000 ft. of the coal measures in that region, they are thickest and most continuous in two parts separated by less-productive strata. On this basis the system is divided into four parts that are commonly termed groups or series. Important coal beds serve as boundaries and these divisions are recognized by tracing the coals or by correlations based on plant fossils.

Coal beds are present in the Pennsylvanian west of the Mississippi river but they are fewer, thinner and relatively unimportant. Marine limestones are abundant, however, and much more conspicuous. Subdivisions there are based on lithologic differences, and groups with prominent limestones are distinguished from others without them. Correlations are made by tracing limestones, matching sequences of different kinds of strata and by the similarity of marine fossils. These groups continue southwestward to Oklahoma where their relations to several mid-Pennsylvanian disturbances, particularly evident in the Arbuckle mountains, have been determined, and they are combined to form series of historical significance.

In this way two different classifications of Pennsylvanian rocks have been set up in the United States; they are difficult to compare. One is based primarily on terrestrial rocks and land plants while the other is dependent largely upon marine rocks and marine animals. Conspicuous changes in both land and marine organisms rarely, if ever, resulted from the same happenings and consequently conclusions regarding significant stratigraphic boundaries and correlations based on such different evidence are not likely to agree. The Pennsylvanian plants of North America are so similar to those of Europe that these regions are believed to have been directly connected, and intercontinental correlations based on plant fossils are considered most reliable. The seas which flooded portions of these continents, however, were not so closely connected that marine animals could migrate from one to the other easily, and only the marine fossils of the Pacific coastal region are very similar to those of Europe and Asia. Because marine fossils are commoner and more widely distributed in North America, however, than are the plants, these fossils generally are more serviceable for correlation on that continent.

Cycles of Deposition.—The different kinds of Pennsylvanian rocks commonly are arranged in a regular order that is repeated many times. Each of these similar units is known as a cyclothem and records a cycle of deposition. This peculiar and recurring sedimentary pattern and the common occurrence of coal are the two most noteworthy features of the Pennsylvanian.

Pennsylvanian cyclothems vary considerably, depending upon the relative importance of the marine and terrestrial beds which they include. A characteristic intermediate type with both coal and marine limestone well developed is common in Illinois. Such associations show that coal swamps, recording low-lying land, were drowned by advance of the shallow sea, and most coals are immediately overlain by beds with marine or brackish water fossils. About 50 coals, most too thin to mine, are present in Illinois; and alternation between land and sea occurred nearly that many times.

In West Virginia, where about 100 coals occur, marine or brackish water fossils are much less common and obviously many marine invasions of Illinois did not extend much farther eastward. In contrast, coals are scarce in Nebraska but marine limestones are abundant, comparatively thick and pure. Evidently, withdrawals of the sea permitting luxurious growth of swamp vegetation in Illinois did not all continue farther west.

Cyclothems are less readily recognizable where both coals and strata with marine fossils are not associated. Coals are more important than limestones in identifying cyclothems because most cyclothems include only one coal whereas two or more limestones may occur. Also the position of a coal often is identified by an old soil with abundant root markings even if no coal is present. Finally the characteristic relationships of other types of strata marked by individual peculiarities aid in recognizing incompletely developed cyclothems.

Pennsylvanian cyclothems record a rhythmic periodicity in the ebb and flow of shallow seas and alternate rapid and slow deposition of sediments eroded from the higher land. Interfingering of marine and terrestrial rocks is striking in some areas. Coals and limestones accumulated slowly, and their purity shows that erosion of the land was slight. Alternating shales and sandstones were deposited rapidly and record times of much more active erosion.

No entirely satisfactory explanation accounts for cyclothems. Shallow seas may have advanced and retreated because of alternate uplifts and depressions of the continents or the continents may have been stable and sea level fluctuated because large quantities of water were withdrawn from the oceans to form great glaciers in the southern hemisphere and then returned when the glaciers melted. Alternate rapid and slow erosion may record important rising and sinking of mountainous areas or it may have resulted from climatic changes, particularly variations in amount of rainfall. Many uncertainties exist. If, for example, the last explanation is favoured, increased rainfall might have been followed by increased erosion or it might have permitted the growth of sufficient vegetation to protect the land against rapid and severe erosion.

Other Occurrences.—In the United States the Pennsylvanian subdivisions succeed each other regularly and without interruption except in a region extending from western Arkansas to Colorado where several local but noteworthy disturbances produced the first uplifts in the Arbuckle and Wichita mountains and another range near Amarillo, Tex., now completely buried by younger strata. The resulting unconformities, showing angular discordance and much erosion, separate the series of the western dominantly marine Pennsylvanian sequence.

Pennsylvanian strata are widespread in the Rocky mountains, but their interrelations are not well known. Thick arkosic or feldspar-rich sandstone deposits in Colorado and neighbouring states, overlapping at some places onto Pre-Cambrian granite, record nearby mountains first uplifted in the latter half of the Mississippian period. They have been termed the ancestral Rockies although they are structurally unrelated to the present Rocky mountains. Southward and southwestward the Pennsylvanian includes much shale and sandstone, and neither the lower nor upper boundaries are well marked. Salt and gypsum occur in Utah. To the north the Pennsylvanian is largely sandstone enclosed between red beds of uncertain age. In some areas a peculiar rhythmic alternation of sandstone and limestone suggests cyclothems quite different from those of more eastern regions.

Upper Carboniferous rocks in eastern Canada are more than 10,000 ft. thick and consist entirely of terrestrial sandstone and shale with coal seams in New Brunswick and Nova Scotia. They probably accumulated in several disconnected basins separated by mountainous ridges.

Pennsylvanian strata have not been identified in the Pacific coastal belt and Alaska, where rocks bearing fusuline Foraminifera (*q.v.*) fossils are generally considered Permian and transgressive onto older rocks.

In west Texas the Permian overlies folded and eroded Pennsylvanian strata. Elsewhere in North America these systems are not separated by structural discordance or a break in deposition and the boundary is determined by plant fossils in the northern Appalachian region and marine fossils west of the Mississippi river.

2. Upper Carboniferous of Europe and Asia.—In England the Carboniferous is divided into three parts known as the Carboniferous Limestone series (oldest), Millstone Grit and Coal Measures (youngest). The Upper Carboniferous generally is considered to begin at the base of the Millstone Grit, but sandstones of this division appear at somewhat different stratigraphic levels in different areas and consequently the boundary is not consistent and is comparable to that separating the Mississippian and Pennsylvanian in the Appalachian district of North America. In some parts of England and Scotland, however, the two divisions of the Carboniferous are separated by an unconformity and the Upper overlaps onto various zones of the Lower or onto older rocks.

The Millstone Grit is approximately equivalent to the Namurian of the continent. Like the latter it is transitional between the Lower Carboniferous and the Coal Measures (or Westphalian) as it includes both coal seams or beds with plant fossils and thin but widespread marine limestones. The sand was produced by rapid erosion of an upland area in the vicinity of northern Scotland. The Coal Measures of England reaches a thickness of about 7,000 ft. and in some areas grades upward into Upper Carboniferous red beds.

At the end of Lower Carboniferous time in western Europe, folded and faulted mountains known to geologists as the Armorican range extended from western France into southern Germany. Large quantities of sediment washed northward from their slopes into a subsiding basin of which the present important coal fields as far east as Silesia are dismembered parts. These mountains were worn down rapidly and in later Carboniferous time another upland to the north was the principal source of sediments. In part of the great coal basin the Lower Carboniferous passes into the Upper without a break, but sediments spread out over a larger area and overlap onto older rocks much as they do in North America.

Upper Carboniferous coal seams (there are about 300 in Silesia) occur in cyclic arrangement with other kinds of rocks. Cyclothems comparable to those of North America, except that marine strata are much less common, are widely recognized. The marine bands record periodic and temporary submergences that arrived from eastern Europe. These became less and less extensive westward with the passage of Upper Carboniferous time.

The Upper Carboniferous of the U.S.S.R. is dominantly marine. These strata overlie the Lower Carboniferous in the Moscow region, the Donets basin of the Ukraine and the Ural mountains. In the Timan of northern U.S.S.R. they overlap onto the Devonian and record late Carboniferous submergence in that region. The Moscovian formation near Moscow, in the Urals and in northern U.S.S.R. consists of limestone with considerable shale. In the Donets region it is more than 15,000 ft. thick and also includes sandstone and many coal seams. The Uralian formation of the Donets is nearly as thick, but coals become rarer upward. In other parts of the Soviet Union, the Uralian is generally similar to the underlying Moscovian.

Correlations of the Upper Carboniferous are not entirely satisfactory because of the difficulty of comparing marine fossils of the Russian sequence with land plants of the western countries. Also, some of the Stephanian floras of central France which grew in intermountain basins are somewhat different from presumably contemporaneous floras of late Westphalian type to the north. The upper boundary of the Uralian in eastern Europe has been much disputed. Beds included in the upper part of this division by some geologists are classed with the Permian by others who define the Uralian on the basis of marine fossils, chiefly fusulines and ammonoids, best known in the uninterrupted North American sequence. In western Europe the end of the Carboniferous period corresponded with an important change in climate and the overlying Permian, unconformable in some areas, is noteworthy for its red beds and the great salt deposits of Germany which are evidence of arid conditions.

In southern Europe and the Mediterranean region, presumably Upper Carboniferous strata include limestone in several widely discontinuous areas. Coal occurs in the Westphalian of Spain and to a lesser extent in the western Alps. Eastward the distinction between Upper Carboniferous and Permian is somewhat uncertain, but the former is probably present in the Balkans and Turkey.

The Upper Carboniferous is generally less extensive in Asia than the Lower. The Moscovian is not well known except in parts of Iran and China. It probably is present in Manchuria, Korea and Japan and in eastern Asia generally overlies the Ordovician. It has been reported in the Kunlun mountains and in the T'ien-shan overlies folded Lower Carboniferous strata. Limestone of possible Moscovian age occurs in Malaya, and equivalent Culmlike beds have been described in Thailand. Probably much of the supposed Uralian reported from scattered localities in Asia is actually Permian.

The Upper Carboniferous of northern Africa is poorly known. Possibly some limestones of a predominantly sandstone sequence in upper Egypt and the Sahara may be of this age, and its occurrence in Morocco is possible.

D. Carboniferous of Southern Hemisphere and India

The continents of the southern hemisphere were not so extensively submerged by shallow seas during the Carboniferous period, and rocks of this age are largely terrestrial deposits. Most remarkable are tillites, reaching a thickness of 2,000 ft. in South Africa, formed by the action of glaciers. These are similar to boulder-bearing clays in North America and Europe, which record the presence of much more recent Pleistocene glaciers, but they have been indurated to form hard rock. Associated fossils are not abundant or sufficient to date these beds with certainty. For many years they were considered Permian but gradually accumulating fossil evidence, particularly from Australia, suggests late Lower and Upper Carboniferous age.

Similar glacial deposits and other terrestrial beds occur in southern and central Africa and Madagascar, in the Falkland Islands, central Argentina, Uruguay and southern and eastern Brazil, in eastern and western Australia and Tasmania and in India. They record remarkably similar conditions in these widely separated areas and suggest former close association if not direct connection. Two theories postulate the existence of a southern continent, Gondwanaland (*q.v.*), quite different from any existing today. One is that South America, Africa, India, Australia and probably Antarctica were joined by extensive areas of intermediate land which later sank beneath the South Atlantic and Indian oceans. The other supposes that a much smaller Gondwanaland broke apart in post-Paleozoic time, and its fragments separated to become the southern continents. According to both theories, the peninsula of India was a part of Gondwanaland, as its geologic nature and history are similar to the present southern lands but quite different from other parts of Asia.

The orientation and nature of grooves in the underlying rock surfaces produced by grinding of the ice show that late Paleozoic glaciers moved northward in India and southward in South Africa, indicating glacial centres in what is now the equatorial zone. This seems a most unlikely place for great glaciers to originate, and some geologists conclude that Gondwanaland originally lay at or near the south pole.

Late Paleozoic invertebrates and plants have been found in some other parts of the southern hemisphere and in Africa north of the equator, but their geologic relations are poorly known and their ages uncertain. Some are Permian but others are probably Upper Carboniferous. Lower Carboniferous fossils are almost unknown except in north Africa.

E. Igneous Rocks

Igneous and volcanic rocks of possible Carboniferous age occur in several parts of the world but mostly in areas of complex geology where their relations are not well understood. Lava flows and volcanic cones associated with Carboniferous rocks are conspicuous in southern Scotland and presumably related dikes and sills are present in northern England. More limited volcanic activity occurred in Ireland and central France.

Both extrusive and intrusive igneous rocks of Carboniferous age are known in the maritime provinces of Canada. In New England an extensive series of igneous rocks intimately associated with the metamorphic complex of that region is probably Carboniferous. Intrusive granites farther south in several Atlantic states are of uncertain but possibly similar age.

The stratigraphic sequence of the North American Pacific coast is poorly known, but intrusive and extrusive Paleozoic rocks occur from northern California to Alaska and some are almost certainly of Carboniferous age.

In Asia, volcanic tuffs and lava flows of Lower and Upper Carboniferous age have been reported in the T'ien-shan. Late Carboniferous or early Permian eruptive igneous rocks occur in Kashmir and somewhat similar rocks have been observed in southern Malaya.

Volcanic rocks are associated with some glacial beds in Australia, and igneous intrusions of approximately similar age occur in other areas.

II. LIFE OF THE CARBONIFEROUS

1. Marine Life.—Several thousand fossil plant and animal species are known from Carboniferous rocks. They are important because similarity of fossils indicates approximate time equivalence of the rocks containing them. Also they furnish much information concerning some of the conditions prevailing at the time and place where these organisms lived. (*See* FOSSIL.) Marine invertebrates are abundant and occur in greatest variety. As in older Paleozoic systems, fossils of brachiopods are common but there are fewer kinds than in the Devonian. Only one group, the Productidae, shows great advancement and expansion (*see* BRACHIOPODA: *Palaeontology*). Crinoids or sea lilies reached their acme of differentiation and abundance in the Lower Mississippian, particularly in the shallow North American sea. Some limestones consist almost exclusively of the dismembered skeletons of these animals which live today mostly in the deep seas. The related, long-extinct blastoids achieved their greatest abundance in the Upper Mississippian.

For the first time the tiny shells of Foraminifera are abundant as fossils in the Carboniferous. At some places they occur in enormous numbers and constitute the greater part of limestone beds. In the middle Mississippian of Indiana individuals of a single coiled species less than a millimetre in diameter are abundant and easily mistaken for oölites. In the Upper Carboniferous another and larger type represented by many species, known collectively as fusulines, is widely distributed and common in many limestones. They are about the size and shape of wheat grains with complex internal structures demonstrating rapid evolution. They appear in the uppermost Mississippian and continue into the Permian. Several distinctive genera are useful for long-distance correlation because they existed for only a few million years and are therefore excellent guide fossils to restricted time zones.

Among the mollusks, gastropods and pelecypods are abundant, varied and well preserved, especially in the Pennsylvanian shales of the United States. Cephalopods are of great interest, particularly in Europe, because the ammonoids or goniatites began to differentiate importantly in the Mississippian and they, together with the crinoids, are the most reliable fossils for long-range correlation in the Lower Carboniferous (*see* AMMONITE). The simpler nautiloids are less common and smaller than in many older rocks. Bryozoans are abundant and among several distinctive types are some with screwlike axes. Corals are more important in western Europe than in America and trilobites are much less numerous and diversified than in the older geologic systems.

Sharklike fishes were common and are known from teeth often found in limestone. The most important group evidently fed upon shellfish because their teeth are flattened for crushing and grinding. The bones of these fish are rarely found and probably were cartilaginous like those of modern sharks and therefore poorly adapted for fossilization.

Several fresh-water animals are known, including a shark with sharp needlelike teeth, several other kinds of fish, a variety of mollusks and worms that inhabited tiny coiled tubes. This type of fauna undoubtedly was much larger but it lived under conditions generally unfavourable for preservation.

2. Land Life.—Land life was dominated by amphibians which evolved from specialized fish in the Devonian and in turn gave rise to the first reptiles in the Carboniferous. Individuals mostly were small. Complete skeletons are rare, but footprints show that these creatures were abundant in some areas. There were many kinds of insects although fossils are known from only a few localities. The most common are primitive cockroaches; also included are the largest insects ever found, dragonflylike creatures, with wing spans of more than two feet.

The Carboniferous rocks furnish the first evidence of an abundant, diversified and widely distributed land flora. Plants, including trees 40 ft. or more tall, grew during the Devonian; but remarkable advancement occurred during the Carboniferous and a characteristic flora spread all over the earth and provided material for the world's most valuable coal deposits. A variety of drifted stems is known from a few marine formations, but most of the fossils are leaf impressions in terrestrial shales. Many are strikingly similar to modern ferns; they belong to two groups, one the true ferns and another that reproduced by seeds instead of spores. They include small herbs, vines and even trees 50 ft. tall. The giants of the Carboniferous forest, however, were trees 100 ft. high related to the modern club mosses. Their trunks are marked by prominent diamond-shaped scars where narrow straplike leaves had been attached. Another common type is quite similar to the horsetail rushes of today but many times larger. Also the first conifers, the ancestors of present-day evergreens, made their appearance in the Upper Carboniferous. The structure of all these plants shows that they grew rapidly under moist temperate conditions. The general absence of growth rings indicates lack of important seasonal variations and the occurrence of fossils in the far north suggests that the earth was not so distinctly zoned climatically during the Carboniferous period as it is today.

III. ECONOMIC PRODUCTS

Coal is the outstanding mineral product of the Carboniferous, and most of the important coal fields of Europe and North America occur in strata of this age. Regions of particular importance are the eastern and central United States, Great Britain, the Ruhr and Saar areas of western Europe, Silesia and the U.S.S.R. Most of the coal is of Upper Carboniferous or Pennsylvanian age, but Lower Carboniferous coal seams also occur and are mined particularly in Europe.

Large amounts of petroleum are obtained from Carboniferous rocks only in the United States, where oil fields of this age extend from Pennsylvania to Texas.

Many metalliferous mineral deposits were formed at the time of the Hercynian disturbances in Europe, Asia and Australia and date from the mid-Carboniferous into the Permian. They resulted largely from the action of mineral-bearing solutions derived from igneous intrusions and occur in rocks mostly older than the Carboniferous. They include tin in Cornwall and Saxony, silver and gold in France and Germany, copper and sulfur in Spain and platinum in the Urals. Similar deposits occur in China, Japan, Burma and Malaya. Also tin, tungsten, gold and bismuth of this age are mined in Australia and New Zealand. Comparable deposits are almost unknown in the western hemisphere.

Carboniferous rocks also contain mineral deposits of later origin. These include the zinc and lead of Oklahoma and Kansas, the ores at Bingham, Utah, the lead of the old mining district in central England, the fluorite veins of Illinois and Kentucky and many others.

Commoner mineral products of the Carboniferous such as clay, sand, limestone, etc., are too widely utilized to be mentioned individually except perhaps the Bedford limestone of Indiana, which is shipped all over the United States and to some other countries for building purposes.

See also references under "Carboniferous System and Period" in the Index volume.

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(J. M. WR.)

CARBONIZATION, LOW-TEMPERATURE. The term low-temperature carbonization designates processes in which coal is partially coked under conditions such that the temperature of the resulting char or coke does not exceed about 600° C. (1,112° F.). The designation is an empirical but convenient method of roughly characterizing the resulting products and of distinguishing them from those which have been processed under high-temperature conditions, 900° to 1,100° C. (1,652° to 2,012° F.) as in the manufacture of metallurgical coke, or in the intermediate temperature range.

Interest in low-temperature carbonization processes is based chiefly on the production of (1) a readily ignitable and smokeless solid fuel of suitable size and superior value for use in residential or small commercial heating units; (2) a char of suitable properties to serve as fuel for power plants, gasification processes or as an additive or substitute material for use in blends of coal charged to high-temperature coke ovens; and (3) a large volume of tar for by-product credit in the form of liquid fuels, solvents, pitch and a potentially wide variety of commercial chemical products. Substantial effort and large sums of money have been expended over a period of many years in attempts to develop a practical and economic low-temperature process. Out of literally hundreds of proposed processes, only a handful have reached a measure of success on a commercial basis, such as the Coalite and Rexco processes in England, the Krupp-Lurgi process in Germany and the Disco process in the United States. Of those that have failed, many have done so because of practical engineering difficulties and almost all because of economic considerations. Economic difficulties are primarily concerned with the inability to gain sufficient by-product credit from the tars and oils to yield an incentive profit and the inability to overcome the resistance of prospective residential or industrial customers to higher prices on a tonnage basis for the solid fuel, whatever its advantages may appear to be.

Products of Low-Temperature Carbonization.—The yields of solid, liquid and gaseous products when coal is carbonized vary with the temperature employed, the rank and type of coal and the method of carbonization. Temperature is an important factor which determines the extent to which the coal substance is decomposed and the type of product. The effect of carbonizing temperature on the average relative yields of products from a bituminous coal, Pittsburgh bed, are compared in the table.

Effect of Temperature of Carbonization on the Relative Yield of Products

(U.S. Bureau of Mines—American Gas Association Assay Test)

Product	Yield per ton of coal, Pittsburgh bed, at various carbonizing temperatures (° C.)						
	500°	500°*	600°	700°	800°	900°	1,000°
Coke, lb.	1,530	1,064	1,432	1,382	1,350	1,320	1,348
Gas, cu. ft.	2,700	3,050	4,400	6,800	8,600	10,400	11,600
Tar, gal.	24.7	12.1	25.1	24.6	22.1	18.8	16.7
Light oils, gal.	3.5	1.7	3.8	4.2	3.7	3.7	3.9
Ammonia (as sulfate), lb.	3.6	9.2	12.2	24.1	25.3	22.3	17.2
Volatile matter, coke, %	10.4	14.2	6.3	3.1	3.0	1.9	1.4
Hydrogen in gas, dry, %	18.6	21.2	29.2	42.1	50.0	52.3	54.0
Methane in gas, dry, %	53.6	34.7	51.1	37.6	32.2	30.3	29.4
Heating value of gas, B.T.U. per cu.ft.	899	612	805	679	642	609	586

*Subbituminous, Wyoming, as mined. Source: U.S. Bureau of Mines, *Monograph 5*.

In general, carbonization at low temperatures produces a higher yield of coke or char which is more reactive and easily ignited than is high-temperature coke, but which is not suitable for metallurgical uses such as in blast furnaces and foundry cupolas. The percentage of volatile matter remaining in the coke is a measure of reactivity, low volatile-matter content being associated with low reactivity and relative difficulty of ignition. The yield of tar and oil products is considerably higher for a low-temperature process because decomposition has been less severe. At low carbonizing temperatures, the proportions of pitch and aromatic compounds in the tar are lower, but the contents of tar acids and paraffinic neutral oils are higher. A smaller volume of fixed gases is produced, but the gas is higher in methane and ethane which have high heating values, and lower in hydrogen. As a result, the gases produced from many coals at 500° C. have heating values almost twice that of gases produced at 1,000° C., although only about one-fourth as much gas is evolved.

The rank of coal also is a factor in determining relative yields of products. At the same carbonizing temperature, high-rank bituminous coals give higher yields of products than do the subbituminous and lignitic coals, which are much higher in moisture content. This is illustrated by comparing the two 500° C. columns in the table for bituminous and subbituminous coals.

Types of Processes.—Low-temperature carbonization processes may be grouped in two general classes, depending upon whether external or internal heating is used. Methods employing external heating, in which the charge of coal is held in ceramic or metal retorts heated on the outside, suffer from the disadvantage that coal is a poor conductor of heat, and carbonization proceeds very slowly. To overcome this disadvantage, a wide variety of procedures involving stirrers, reciprocal motion, revolving retorts and a multiplicity of heated surfaces have been used. The objective has been to heat the coal in thin layers, or to impart motion and bring fresh coal in contact with the heated surfaces. Obviously, these procedures add to the mechanical complexity of the system. The second general class of processes involves passing heated gases through the charge of coal, usually upward. Thus, the coal is in direct contact with the heated medium, and the rate of carbonization is controlled by varying the quantity and temperature of the heated gases. Difficulties are encountered with coking coals unless a preliminary treatment is used to reduce their agglomerating tendencies.

After World War II, interest centred on heat treatment by fluidization of small-sized coal with heated gases, and a number of processes were developed to the pilot-plant stage. These processes produce char of the same nominal size as the feed coal and suitable for use as a fuel for power plants or gasification. Improved rates of heat transfer were achieved and the yields of primary tar were higher because of improved temperature control. Coking coals were processed more readily because of the dilution effect resulting from the recirculation of heated and partially devolatilized char present in the bed as fresh coal was fed. Because fluidization held promise of reduced processing costs and increased product yields, several large programs of research and development on a pilot-plant scale were carried on in the 1950s, including studies of the properties and potential uses of the tars and oils produced. None, however, reached commercial application, chiefly because the large volume of tars and oils that would be produced could not find industrial chemical markets at prices sufficiently above fuel value. In the 1960s, work at FMC Corporation sponsored by the U.S. Office of Coal Research showed that the fluidization treatment of coal to produce char, gas, and liquid hydrocarbons to serve as feedstock to a petroleum refinery appeared to be economically attractive (COED—char oil energy development—process) at selected mine-mouth locations. Development had reached the pilot-plant stage by the late 1960s. System elements visualized involved a mine, the coal-processing plant, a power plant (using the char), an oil refinery (liquid hydrocarbon fraction as feedstock), and a market for the excess fuel gas and recovered hydrogen, all in close proximity to the processing plant. *See* also COKE, COKING AND HIGH-TEMPERATURE CARBONIZATION; COAL AND COAL MINING. (H. W. N.)

CARBON MONOXIDE POISONING: *see* HYPOXIA.

CARBON PAPER, a tissue of varying weight coated with a colour, generally carbon black, and some waxy medium. It is usually coated on one side but may be coated on both sides for special purposes. For typewriting duplication, which is its chief usage, it is coated on one side only. The paper upon which the coating is applied varies in weight from four to ten pounds per ream of 480 sheets, 20 by 30 in., and is made from fibres such as rag, wood, manila and jute. Since it must be strong and durable it must not contain any ground wood pulp. The coloured waxy material that transmits the duplication is soft so that at least five copies can be made. It is also so strongly coloured and of such durability that a sheet will make at least 12 first carbons that are clear and legible. This coating is composed of waxes such as Japan, paraffin and carnauba, and such oils as olein and rosin thoroughly amalgamated with a colour, which in the case of black paper is always carbon or gas black.

In coloured papers the colour consists of an aniline dye base combined with such fatty acids as stearic and oleic or a fat-soluble dye dissolved in the olein or rosin oil present in the mixture. Copy papers have been adapted to photocopy uses. These papers must be fast to light and are made in various colours including white. The chrome yellows, iron blues and fast coal-tar red pigments are used for the colours and titanium dioxide for the white.

The manufacture of carbon paper embraces two processes, viz., the preparation of the coating material and its application to the paper. The waxes and oils are melted in a steam-jacketed kettle at a temperature of approximately 300° F. and the colour stirred in. Afterward the hot mixture is passed through a steel-plate grinding mill and is then ready for the coating machine. This machine, of web-type operation, takes the paper in roll form, passes it over the coating roller that revolves in a steam-heated ink fountain containing the hot coating mixture and then leads the paper over a spiral-wire wiper that controls the thickness of the coating. The paper then passes over water-cooled rollers that chill and harden the coating. It is rolled upon itself at the end of the machine and cut into proper-sized sheets. (N. U.)

CARBON TETRACHLORIDE (TETRACHLOROMETHANE) is a colourless, mobile, nonflammable liquid; chemical formula CCl_4, molecular weight 153.84, boiling point 76.7° C (170° F), specific gravity 1.595 at 20° C. One volume of carbon tetrachloride dissolves in 2,000 volumes of water, but it is miscible in all proportions with alcohol, ether, benzene, and other organic solvents; it dissolves many oils, greases, waxes, and tars. Carbon tetrachloride is toxic, causing liver and kidney damage. The maximum safely allowable concentration of the vapour in air is probably less than 100 parts per 1,000,000. It is important as a solvent, chemical intermediate, and fire-extinguishing agent.

The solvent properties of carbon tetrachloride have made it useful for commercial dry cleaning of fabrics, but its high toxicity has led to virtual disuse. It has been used for degreasing metal surfaces but is less satisfactory for this purpose than trichloroethylene. Since it readily volatilizes to form a heavy nonflammable blanket of vapour, it is important in fire-extinguishing apparatus, especially for small electrical fires. This may be dangerous since phosgene can be formed under certain conditions. The largest part of carbon tetrachloride production is used in the preparation of chlorofluoromethanes that are used as refrigerants and aerosol propellants.

Carbon tetrachloride was first prepared in the early 1840s by the action of chlorine on chloroform or methane. It is produced industrially chiefly by chlorination of methane or a high-temperature reaction of chlorine with propane. The reaction of chlorine with carbon disulfide has also been used.

See Raymond Eller Kirk and Donald Frederick Othmer (eds.), *Encyclopedia of Chemical Technology*, 2nd ed., vol. v, pp. 128–139 (1964). (K. D. K.)

CARBONYLS, METAL. The metal carbonyls are compounds of carbon monoxide with heavy metals. In general they are produced by direct action of carbon monoxide on the finely divided metal. Some of these unique metal compounds are highly volatile and readily decompose into carbon monoxide and metal. They are used in the preparation of metals of exceptionally high purity and as catalysts in organic syntheses.

Only the transition elements of Groups V, VI, VII, and VIII of the periodic system are known to form metal carbonyls. Metal carbonyls were originally regarded as unique and extraordinary compounds which did not conform to the then known rules of valence. Advances in the understanding of the metal-carbon bond and of the electronic configuration of transition metals have removed much of the mystery that first surrounded this class of compounds. The metal carbonyls and their derivatives are treated as a separate group because their properties and chemistry differ from those of the organometallic compounds and other metal complexes. The first metal carbonyl to be discovered (Ludwig Mond, 1890) was that of nickel, $Ni(CO)_4$.

Composition, Properties and Structure.—In the table are listed all the metal carbonyls known in the early 1970s. Two types of carbonyls can be distinguished: mononuclear carbonyls (containing one metal atom per molecule) and polynuclear carbonyls (containing two or more metal atoms per molecule). Some metal carbonyls form only mononuclear carbonyls, *e.g.*, nickel, $Ni(CO)_4$; some form only polynuclear carbonyls, *e.g.*, cobalt, $Co_2(CO)_8$; and some form both, *e.g.*, iron, $Fe(CO)_5$ and $Fe_3(CO)_{12}$. The composition of the mononuclear carbonyls is governed by a simple rule which states that the effective atomic number (E.A.N.) of the metal in a metal carbonyl is that of the inert gas of the completed period in which the metal is situated. The E.A.N. is the total number of electrons which surround the nucleus of the metal. This number is composed of the electrons belonging to the metal (the atomic number of the metal) and the number of electrons contributed by the carbonyl groups. Each carbonyl group (:C=O)

The Known Metal Carbonyls and Their Properties

Group V	Group VI	Group VII	Group VIII		
V(23)	Cr(24)	Mn(25)	Fe(26)	Co(27)	Ni(28)
$V(CO)_6$ volatile decomp. 60°–70° C blue green	$Cr(CO)_6$ sublimes colourless rhombic	$Mn_2(CO)_{10}$ m.p. 154°C sublimes golden yellow	$Fe(CO)_5$ m.p. −20° C b.p. +103° C yellow $Fe_2(CO)_9$ decomp. 100° C yellow triclinic $Fe_3(CO)_{12}$ decomp. 100° C green monoclinic	$Co_2(CO)_8$ m.p. 51° C sublimes orange-red $Co_4(CO)_{12}$ decomp. 60° C black crystalline $Co_6(CO)_{16}$ decomp. 100° C black crystalline	$Ni(CO)_4$ m.p. −25° C b.p. +43° C colourless
Nb(41)	Mo(42)	Tc(43)	Ru(44)	Rh(45)	Pd(46)
	$Mo(CO)_6$ sublimes colourless rhombic	$Tc_2(CO)_{10}$ m.p. 159° C colourless	$Ru(CO)_5$ m.p. −22° C colourless $Ru_3(CO)_{12}$ decomp. 150° C orange-red	$Rh_2(CO)_8$ m.p. 76° C (decomp.) orange crystalline $Rh_4(CO)_{12}$ decomp. 150° C brick-red $Rh_6(CO)_{16}$ decomp. above 220° C black	
Ta(73)	W(74)	Re(75)	Os(76)	Ir(77)	Pt(78)
	$W(CO)_6$ sublimes colourless rhombic	$Re_2(CO)_{10}$ m.p. 177° C sublimes colourless monoclinic	$Os(CO)_5$ m.p. −15° C colourless $Os_3(CO)_{12}$ m.p. 224° C yellow-orange	$Ir_2(CO)_8$ sublimes yellow-green $Ir_4(CO)_{12}$ decomp. 210° C canary yellow rhombohedral	

donates two electrons (indicated by the two dots) to the metal. The following example will serve as an illustration: the E.A.N. of nickel in $Ni(CO)_4$ is 36; *i.e.*, 28 (atomic number of nickel) plus 2×4 (electrons donated by the four $:C=O$ groups). The rare gas of the completed period in which nickel is situated is krypton, with an atomic number of 36. The composition of polynuclear carbonyls is also related to rare-gas configuration. This relationship is demonstrated by the formula

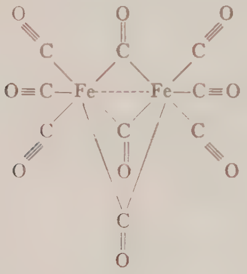
$$G-\frac{xM+2y}{x}=x-1$$

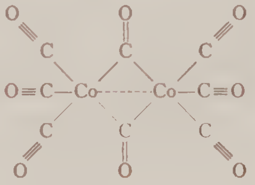
from which the composition of any polynuclear carbonyl may be derived. G is the E.A.N. of the next rare gas, M the atomic number of the metal, x the number of metal atoms and y the number of carbonyl groups.

The concept of E.A.N. correlates the composition of the metal carbonyls on a purely formal basis and also implies a relationship between the carbonyls and the rare gases. This relationship manifests itself in the volatility of the carbonyls as demonstrated in the table.

The volatility of the metal carbonyls is especially impressive when compared with that of other compounds of similar molecular weight. For example, the saturated hydrocarbon, $C_{12}H_{26}$, with a molecular weight of 170 boils at 215° C. while $Ni(CO)_4$ with a molecular weight of 171 boils at 43° C.

In all mononuclear carbonyls the metal-carbon-oxygen bonds extend linearly from the central metal atom. The configuration of the hexacarbonyls of chromium, molybdenum and tungsten is that of a regular octahedron. Iron pentacarbonyl possesses the configuration of a trigonal bipyramid and nickel carbonyl that of a regular tetrahedron. The dimeric carbonyls of iron (I) and cobalt (II) contain three and two bridge carbonyls, respectively. The configuration of $Fe_2(CO)_9$ is that of two octahedra joined face to face (I), while in $Co_2(CO)_8$ two trigonal bipyramids are joined edge to edge (II). Not all binuclear carbonyls contain bridge carbonyls. In the binuclear complex $Mn_2(CO)_{10}$, for instance, the two $Mn(CO)_5$ groups are linked by an $Mn-Mn$ bond.


I


II

The metal-carbon-oxygen bonds may be viewed as a hybrid of the two structures:

$$\overset{-}{M}-C\equiv\overset{+}{O}:\longleftrightarrow M=C=\ddot{O}:$$

A B

The carbon-oxygen bond is thus intermediate between a triple bond as in carbon monoxide and a double bond as in ketene or carbon dioxide.

Reactions of the Metal Carbonyls.—The reactions of the metal carbonyls are characterized by the tendency of the metal atom to retain its rare-gas configuration. They may be divided into reactions involving substitution of one or more carbonyl groups and electron-transfer reactions. Examples of these reactions follow.

Substitution Reactions.—Both terminal and bridge carbonyl groups are in some cases replaceable by atoms or molecules which can provide the same number of electrons as the displaced carbonyl group. Thus two atoms of iodine, 2I, provide two electrons and can therefore replace one carbonyl group to form $Fe(CO)_4I_2$. Other examples are triphenylphosphine, $:P(C_6H_5)_3$, with two, and nitric oxide, $:\dot{N}O$, with three available electrons. One triphenylphosphine molecule replaces one carbonyl group as in $(CO)_3NiP(C_6H_5)_3$, and two nitric oxide molecules replace three carbonyl groups as in $(CO)_2Fe(NO)_2$. An interesting reaction is the substitution of the two bridge carbonyls in $Co_2(CO)_8$ by acetylene to give a dicobalt hexacarbonyl acetylene complex:

$$Co_2(CO)_8+C_2H_2\rightarrow Co_2(CO)_6C_2H_2+2CO$$

Acetylene may be viewed as containing two pairs of available electrons in the two π orbitals of the carbon-carbon triple bond.

In addition to acetylene, a host of other reactive organic compounds are capable of replacing carbonyl groups in the metal carbonyls to give a wide variety of metallo-organic complexes. Some of these complexes are used as catalysts in organic syntheses.

Electron-Transfer Reactions.—When iron pentacarbonyl is treated with a solution of sodium in liquid ammonia, carbon monoxide is evolved and the salt $Na_2Fe(CO)_4$ formed:

$$Fe(CO)_5+2Na\rightarrow Na_2Fe(CO)_4+CO$$

In this reaction two electrons are transferred from the sodium to iron pentacarbonyl. These two electrons replace the two electrons donated by the carbon monoxide group with the result that the E.A.N. of iron in the anion $[Fe(CO)_4]^{--}$ is the same as that in $Fe(CO)_5$; *i.e.*, that of a rare gas.

Dicobalt octacarbonyl undergoes electron-transfer reactions similar to those of iron pentacarbonyl. Sodium in liquid ammonia reacts with dicobalt octacarbonyl according to:

$$2Na+Co_2(CO)_8\longrightarrow 2NaCo(CO)_4$$

The anion $[Co(CO)_4]^-$ is isoelectronic with $[Fe(CO)_4]^{--}$ and the cobalt atom possesses rare-gas configuration.

Reactions of the Metal Carbonyl Hydrides.—The carbonyl hydrides, a group of compounds derived from the metal carbonyls, deserve special mention because of their interesting reactions. These carbonyl hydrides are gases at room temperature and are readily prepared by acidifying an alkaline solution containing the corresponding anions in a current of carbon monoxide and sweeping the liberated carbonyl hydrides into a cold trap.

$$K_2Fe(CO)_4+2HCl\longrightarrow 2KCl+H_2Fe(CO)_4$$
$$KCo(CO)_4+HCl\longrightarrow KCl+HCo(CO)_4$$

Electron diffraction data show that in the carbonyl hydrides of iron and cobalt the central metal atom is surrounded tetrahedrally by four carbonyl groups. The hydrogen is probably bonded by the metal atom as well as by the electron cloud of the carbonyl groups.

In the presence of a base (B) the carbonyl hydrides act as acids,

$$B+HCo(CO)_4\longrightarrow[BH]^++[Co(CO)_4]^-$$

while in the absence of a base they decompose into hydrogen and metal carbonyl:

$$2HCo(CO)_4\longrightarrow H_2+Co_2(CO)_8$$

Having the elements of hydrogen and carbon monoxide built into their molecules, the metal carbonyl hydrides are capable of reacting as transfer agents of both carbon monoxide and hydrogen.

Metal carbonyl hydrides or related compounds are probably catalytic intermediates in certain technically important processes involving the addition of carbon monoxide and hydrogen to a substrate at elevated temperature and pressure. An example is the oxo process; *i.e.*, the conversion of olefinic hydrocarbons to the next higher alcohols:

$$C_7\text{ olefins}\xrightarrow{2H_2+CO}\text{isooctyl alcohols}$$

This process is utilized by the petroleum industry to make alcohols for plasticizers.

Preparation and Industrial Application.—Most metal carbonyls are now commercially available. The carbonyls of nickel, iron, cobalt and molybdenum can be prepared by direct synthesis, *i.e.*, by treatment of the finely divided metal with carbon monoxide; the required temperatures and pressures increase from nickel to molybdenum. The carbonyls of the other transition elements are prepared from the halides at elevated temperatures and carbon monoxide pressures in the presence of halogen acceptors such as silver or copper:

$$WCl_6+12CO+6Cu \rightarrow W(CO)_6+6CuClCO$$

Nickel and carbon monoxide react at atmospheric pressure and room temperature, but the formation of nickel carbonyl is favoured by higher pressures and catalyzed by traces of sulfur. Outside the nickel industry, where nickel carbonyl is an intermediate in the refining of nickel ore, the only commercial use of nickel carbonyl is as a carbon monoxide transfer agent in the synthesis of acrylates from acetylene and alcohols:

$$4C_2H_2+Ni(CO)_4+4ROH+2HCl \rightarrow 4CH_2{=}CHCOOR+NiCl_2+H_2$$

Nickel carbonyl is regenerated from the salt by reduction followed by treatment with carbon monoxide. Iron pentacarbonyl can be formed at temperatures ranging from 15° to 400° C. and at carbon monoxide pressures from 1 to 1,200 atm. The usual temperatures and pressures employed are 150°–200° C. and 10–200 atm.

Iron pentacarbonyl is commercially available and is used in industry for the preparation of iron powder (carbonyl iron), which is obtained by the thermal decomposition of the carbonyl. Because of its high purity and desirable magnetic properties, carbonyl iron is used by the electronic industry for the production of magnetic devices, particularly of the high-frequency type. Carbonyl iron also finds application in powder metallurgy.

Dicobalt octacarbonyl is not available commercially. Metallic cobalt and cobalt salts react very slowly with pure carbon monoxide. In the presence of hydrogen, however, the cobalt salts react rapidly at 200–300 atm. and 150°–160° C.:

$$2CoCO_3+2H_2+8CO \rightarrow Co_2(CO)_8+2H_2O+2CO_2$$

Toxicity and Safe Handling.—Danger from the toxicity of the metal carbonyls and their derivatives is directly related to their volatility. Extreme care must be exercised in the handling of the carbonyls of iron and nickel and the carbonyl hydrides of iron and cobalt. Due to their low vapour pressure the carbonyls of the other transition elements do not present a health hazard. Here the only danger lies in the evolution of carbon monoxide which may be liberated by the thermal or chemical decomposition of these carbonyls. Nickel and iron carbonyl are toxic even when inhaled in small amounts, and the liquid may be absorbed through the skin. There is little information upon which to base an estimate of a maximum permissible concentration. The safe amount for eight-hour exposures is probably below one part per 1,000,000 in the working atmosphere.

With the exception of the carbonyls of chromium, molybdenum and tungsten, all metal carbonyls are more or less readily attacked by oxygen and present a fire hazard. Nickel and iron carbonyl are inflammable and may ignite spontaneously even at room temperature when brought into contact with air.

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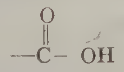
(H. W. Sg.)

CARBOXYLIC ACIDS constitute an important family of organic chemical compounds which contain the acidic carboxyl group,



$$-\overset{\overset{\large O}{\|}}{C}-OH$$

The carboxylic acids are widely distributed in nature, ranging from vinegar, an aqueous solution of acetic acid, CH_3CO_2H, to caproic acid, $C_5H_{11}CO_2H$, the source of the characteristic odour of goats, to citric acid, $HO_2CCH_2COH(CO_2H)CH_2CO_2H$, the chief acid constituent of citrus fruits. The carboxylic acids participate in metabolic processes. They are useful in organic synthesis and have a wide variety of industrial applications. For information on the applications of the various members of the family, see *Specific Carboxylic Acids*, below.

Normal Carboxylic Acids (Fatty Acids)

No. of carbon atoms	Common name	Systematic name
1	Formic acid	Methanoic acid
2	Acetic acid	Ethanoic acid
3	Propionic acid	Propanoic acid
4	Butyric acid	Butanoic acid
5	Valeric acid	Pentanoic acid
6	Caproic acid	Hexanoic acid
12	Lauric acid	Dodecanoic acid
16	Palmitic acid	Hexadecanoic acid
18	Stearic acid	Octadecanoic acid

Those carboxylic acids with straight carbon chains were isolated first from natural sources, particularly from fats, and are frequently called fatty acids. They were originally given common names indicative of their source. More recently the naming of carboxylic acids has followed the nomenclature system set up at the Geneva conference of 1892. The common and systematic names of normal (straight-chain) carboxylic acids are given in the table. It is seen that the systematic names are derived from the names of the corresponding hydrocarbons by dropping the final *e* and adding the suffix *oic acid*.

Preparation.—Sodium formate, the salt of formic acid, is made by a reaction of carbon monoxide and caustic soda at elevated temperature and pressure. This reaction was one of the earliest used commercially for the synthesis of an organic compound from inorganic components, carbon and salt being the ultimate raw materials. Formic acid can be liberated from the sodium salt by adding a mineral acid.

Acetic acid is by far the most important commercial carboxylic acid from the standpoint of the quantity used. It usually is sold as glacial acetic acid, so named because on cold days it freezes to an icelike solid. Acetic acid is the chief component of vinegar, produced by the air oxidation of the ethyl alcohol in fermented fruit juices or fermented malt in the presence of various species of the bacteria genus *Acetobacter*.

$$CH_3CH_2OH + O_2 \rightarrow CH_3CO_2H + H_2O$$

Pyroligneous liquor from the destructive distillation of wood contains 4%–10% of acetic acid which may be recovered in the form of its calcium salt by neutralizing with lime and distilling to dryness. After 1952 increasing amounts of acetic acid were made by the air oxidation of butane in the liquid phase with manganese and cobalt acetates as catalyst. Acetic acid is also prepared industrially by the oxidation of acetaldehyde from calcium carbide.

Propionic acid and butyric acid may be made by the oxidation of the corresponding alcohols or aldehydes, or by special fermentation processes from starch. The higher normal acids having an even number of carbon atoms are obtained by the hydrolysis of fats.

Benzoic acid, $C_6H_5CO_2H$, consisting of a carboxyl group on a benzene ring, can be prepared by the oxidation of toluene, $C_6H_5CH_3$, with potassium permanganate or chromic acid. The procedures given above illustrate the many kinds of oxidation reactions that can be utilized to synthesize carboxylic acids. These synthetic methods reflect the fact that the carboxylic acids are organic compounds in a fairly high state of oxidation.

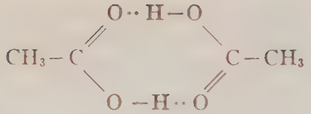
Another general method of preparation of carboxylic acids is the hydrolysis of organic cyanides:

$$RBr \xrightarrow{CN^-} RCN \xrightarrow{H_3O^+} RCO_2H + NH_4^+$$

On a laboratory scale, the use of a Grignard reagent for the preparation of carboxylic acids is convenient.

$$RBr \xrightarrow{Mg} RMgBr \xrightarrow[2.\ H^+]{1.\ CO_2} RCO_2H$$

Physical Properties.—The odour of the lower members of the carboxylic acid family is sharp or acrid and the acids from C_4 through C_8 have a distinctly disagreeable odour. The odour of rancid butter and strong cheese is due to volatile carboxylic acids. The higher acids are practically odourless because of their low volatility. The boiling points of carboxylic acids are abnormally high because dimeric complexes involving two hydrogen bonds are formed:



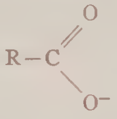
Chemical Properties.—The most important chemical reaction of carboxylic acids is their ionization to produce protons and thus an acidic solution.

$$RCO_2H \rightleftharpoons RCO_2^{\ominus} + H^{\oplus}$$

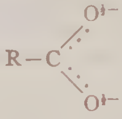
The carboxylic acids up to and including butyric acid are soluble in water, giving an aqueous solution which is acidic and which has a sour taste. The acidity of simple carboxylic acids is less than that of mineral acids such as sulfuric acid, but more than that of most other organic compounds. The neutralization of a carboxylic acid by a standard solution of a base is often used for identification purposes since the equivalent weight of an acid as determined with a standard base, the neutralization equivalent, is a characteristic property of each carboxylic acid.

$$RCO_2H + NaOH \rightarrow RCO_2^- Na^+ + H_2O$$

Up to C_{10} the salts of carboxylic acids, formed by neutralization, are very soluble in water. The salts of carboxylic acids from C_{10} to C_{18} are soaps and form colloidal solutions in water. The structure of the salt of a carboxylic acid illustrates an important structural concept in organic chemistry. Although the structure A implies two different kinds of oxygen atoms in the anion of the salt, it is found that the two oxygen atoms are in fact equivalent as depicted in structure B. Whereas the carbon-oxygen bonds in the hypothetical structure A are single and double bonds, the bonds in structure B are both one and one-half bonds.



A

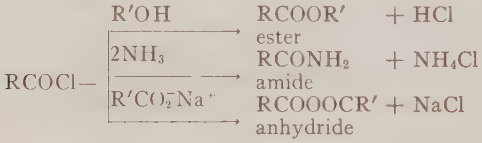


B

There are a number of other important chemical reactions of carboxylic acids. The hydroxyl (OH) group of a carboxylic acid can be replaced by a halogen atom to yield an extremely reactive compound called an acyl halide

$$RCOOH + SOCl_2 \rightarrow RCOCl + SO_2\uparrow + HCl\uparrow$$

The acyl halides are useful in the preparation of a number of derivatives of carboxylic acids called esters, amides and anhydrides.



$$RCOCl \xrightarrow{R'OH} \underset{\text{ester}}{RCOOR'} + HCl$$

$$RCOCl \xrightarrow{2NH_3} \underset{\text{amide}}{RCONH_2} + NH_4Cl$$

$$RCOCl \xrightarrow{R'CO_2^-Na^+} \underset{\text{anhydride}}{RCOOOCR'} + NaCl$$

Esters can also be prepared directly from carboxylic acids by reaction with alcohols with the loss of water. Sulfuric acid or hydrochloric acid is ordinarily utilized as a catalyst for this reaction. Since this is a reversible reaction, esters may be split by water (hydrolysis) to yield carboxylic acids. The hydrolytic reaction is catalyzed by either strong acids or strong bases. When alkaline hydrolysis is used, the process is referred to as saponification because the preparation of soap utilizes this process.

$$RCO_2H + R'OH \overset{H^+}{\rightleftharpoons} RCO_2R' + H_2O$$

$$RCO_2R' + NaOH \rightarrow RCO_2^-Na^+ + R'OH$$

The base-catalyzed hydrolysis goes to completion and requires one equivalent of alkali for each equivalent of ester. The saponification equivalent of the ester (the equivalent weight of the ester as determined by saponification) is a characteristic property of esters of the same equivalent weight.

Carboxylic acid derivatives are, in general, relatively reactive compounds because various reagents can interact with them via addition to the carbon-oxygen double bond to form an unstable intermediate which can decompose to form the products of the reaction.

Carboxylic acids can be decarboxylated to yield an alkane (a hydrocarbon). This process requires elevated temperatures and/or strong alkaline conditions because it involves the scission of a carbon-carbon bond, energetically a difficult process.

$$RCO_2H \rightarrow RH + CO_2$$

The carboxyl group can be transformed to a lower oxidation state by suitable reducing agents. The most efficient agent for laboratory purposes is lithium aluminum hydride which reduces a carboxylic acid to the corresponding alcohol.

$$RCO_2H \xrightarrow{LiAlH_4} RCH_2OH$$

Specific Carboxylic Acids.—Acetic acid is used where a cheap organic acid is required such as in the preparation of metallic salts, of acetic anhydride and of esters; it is also used in the manufacture of cellulose acetate rayon and white lead. It is used as a precipitating agent for casein from milk, and for rubber or synthetic rubber from their aqueous emulsions. Propionic acid and butyric acid are used in the manufacture of cellulose acetate-propionates and acetate-butyrates. Calcium propionate is used in bread to prevent molding and ropiness. Tuberculostearic acid, from the fatty capsule of the tuberculosis bacillus, *Mycobacterium tuberculosis*, is a derivative of stearic acid.

Waxes, fats and oils of natural origin are mainly esters of higher straight-chain carboxylic acids. The waxes are defined as esters of high molecular weight monohydric (one hydroxyl group) alcohols with the common even-numbered carboxylic acids. Carnauba wax, beeswax and spermaceti are three important examples of the wax family. Fats and oils are esters of higher carboxylic acids and a trihydric alcohol, glycerol, $HOCH_2CHOHCH_2OH$. Esters of glycerol, called glycerides, have the general formula $RCO_2CH_2CH(O_2CR')CH_2O_2CR''$, and are differentiated by the fact that fats are solid at room temperature whereas oils are liquid. The chemical difference between fats and oils lies in differences in the carboxylic acid components of the glycerides. The carboxylic acid components of the fats are predominantly saturated (contain only single bonds in the carbon chain), but the carboxylic acid components of oils are predominantly unsaturated (contain double bonds). The lower melting point of oils is also a result of the lower molecular weight of the carboxylic acid components. The drying oils are an important class because they contain carboxylic acid constituents which are highly unsaturated, containing approximately three double bonds per carboxylic acid unit. The drying oils are easily susceptible to autoxidation and polymerization, giving rise to their principal use as film formers in paints and other coatings. (*See* OILS, FATS AND WAXES.)

When the glycerides are saponified, the salts of carboxylic acids are formed. The alkali metal salts of carboxylic acids containing from 10 to 18 carbon atoms are known as soaps. The characteristic of these compounds is a long oil-soluble hydrocarbon chain attached to a water-soluble carboxylate ion, and hence they act as wetting agents, emulsifying agents and detergents. Ordinary soaps usually are sodium salts; soaps made from saturated carboxylic acids are hard whereas those made from unsaturated carboxylic acids are soft. (*See* SOAP.)

A number of substituted carboxylic acids are known, including halogenated, hydroxy and amino acids. The α-halo acids are ordinarily made by the direct halogenation of the carboxylic acid in the presence of a small amount of phosphorus trihalide.

$$RCH_2COOH \xrightarrow[PX_3]{X_2} RCHXCOOH + HX$$

The α-halo acids are more acidic than the unsubstituted acids. Fluoroacetic acid is toxic to mammals, and its sodium salt, known as 1080, is used as a poison for rodents. Trichloroacetic acid and especially trifluoroacetic acid are among the most acidic organic compounds. The α-hydroxycarboxylic acids may be prepared by the hydrolysis of the α-halo acids. The γ- and δ-hydroxy acids form cyclic esters called lactones. Lactic acid, $CH_3CHOHCOOH$, is the acid formed when milk turns sour through the action of *Lactobacillus* on lactose.

The most important class of substituted carboxylic acids are the α-aminocarboxylic acids commonly known as α-amino acids. A general method for the synthesis of α-amino acids in the laboratory is the reaction of α-halo acids with ammonia.

$$RCHXCOOH + 2NH_3 \rightarrow RCH(NH_2)COOH + NH_4X$$

A second method known as the Strecker synthesis consists of the reaction of an aldehyde or ketone with a mixture of ammonium chloride and sodium cyanide, followed by hydrolysis of the amino nitrile. Sometimes α-amino acids are isolated by the hydrolysis of proteins since proteins are high molecular weight compounds consisting of mixtures of α-amino acids in combined form. Several dozen α-amino acids occur in proteins; of these valine, leucine, isoleucine, phenylalanine, threonine, tryptophan, methionine, lysine, arginine and histidine have been shown to be essential amino acids for the growth of rats. Studies so far made indicate that the requirements of other species appear to be similar to those of the rat.

Dicarboxylic acids are of considerable importance. Adipic acid, $HO_2C(CH_2)_4CO_2H$, is the most important of the dicarboxylic acids commercially. It is produced by the catalytic air oxidation of cyclohexane in the liquid phase and by the carbonylation of tetrahydrofuran. Adipic acid is an intermediate for the synthesis of nylon 66 which is a polyamide formed by heating the hexamethylenediamine salt of adipic acid. The number 66 indicates that this particular nylon has two six-carbon substituents.

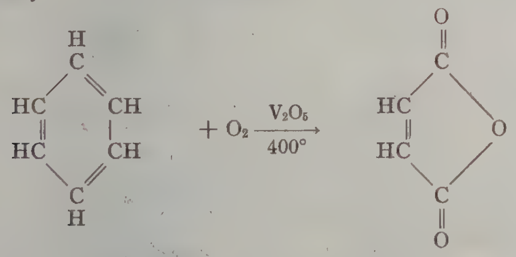
$$\underset{\text{nylon salt}}{^{-}OOC(CH_2)_4COO^{-}H_3N^{+}(CH_2)_6NH_3^{+}} \xrightarrow{200°\text{–}300°}$$

$$^{-}OOC(CH_2)_4CO\Big[\underset{\text{nylon 66}}{NH(CH_2)_6NHCO(CH_2)_4CO}\Big]_x NH(CH_2)_6NH_3^{+}$$

$$+ H_2O$$

Another important technical use for adipic acid is in the manufacture of urethan rubbers.

Maleic acid, *cis*-ethylenedicarboxylic acid and fumaric acid, the corresponding *trans*-isomer, are classic examples of geometrical isomerism. Maleic acid readily yields an anhydride on heating, indicating that the carboxyl groups are on the same side of the double bond. Fumaric acid, in which the carboxyl groups are on opposite sides of the double bond, does not yield an anhydride easily. Maleic acid is obtained in the form of its anhydride by the catalytic air oxidation of benzene



The most characteristic reaction of maleic anhydride is its 1,4-addition to conjugated dienes such as butadiene or cyclopentadiene, reactions known as Diels-Alder syntheses.

Hydroxy polycarboxylic acids are found frequently in nature. Tartaric acid, $HO_2CCHOHCHOHCO_2H$, is one of the most widely distributed plant acids. Its potassium acid salt, found in grape juice, is used as the acid component of some baking powders. Sodium potassium tartrate, known as Rochelle salt, is used as a purgative. Citric acid is the chief acid constituent of citrus fruits.

Carboxylic acids which contain a carbonyl function (C=O) in a position beta to the carboxyl group decarboxylate on mild heating. This reaction occurs readily with malonic acid, $HO_2CCH_2CO_2H$, and acetoacetic acid, $CH_3COCH_2CO_2H$.

$$CH_3COCH_2CO_2H \xrightarrow{\text{heat}} CH_3COCH_3 + CO_2\uparrow$$

Since these carboxylic acids are unstable, they are usually prepared in the form of their respective esters. Ethyl malonate is made from bromoacetic acid through cyanoacetic acid. Ethyl acetoacetate is made by the condensation of two moles of ethyl acetate with sodium ethoxide, an example of the Claisen ester condensation. Both diethyl malonate and ethyl acetoacetate are important synthetic intermediates since each contains an active methylene group, a —CH_2— group which is adjacent to two carbonyl functions. The hydrogen atoms of an active methylene group are easily removed by basic reagents, giving the corresponding organic anion which can then participate in reactions with alkyl halides to form a multitude of derivatives.

$$CH_3COCH_2CO_2C_2H_5 \xrightarrow{\text{base}} CH_3CO^{\ominus}CHCO_2C_2H_5 \xrightarrow{RX}$$

$$CH_3COCHRCO_2C_2H_5$$

Ethyl acetoacetate exhibits a classical example of tautomerism, defined as the dynamic equilibrium between two spontaneously interconvertible isomers. In 1911 L. Knorr succeeded in isolating two forms of ethyl acetoacetate, a ketonic form which reacts with hydroxylamine and hydrogen cyanide, and an enolic form which reacts instantaneously with bromine and with ferric chloride. On permitting either isomer to reach room temperature, the equilibrium mixture was obtained:

$$\underset{\text{ketone}}{CH_3COCH_2CO_2C_2H_5} \rightleftharpoons \underset{\text{enol}}{CH_3C(OH) = CHCO_2C_2H_5}$$

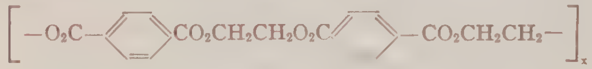
This interconversion is catalyzed by traces of acids or bases, including glass. Pure ethyl acetoacetate contains an equilibrium mixture of 8% enol and 92% ketone.

It has been shown that a number of hydroxy carboxylic acids, α-keto acids and α-amino acids are involved in the metabolism of carbohydrates, proteins and fats in animals. The oxidation of the metabolite, pyruvic acid, CH_3COCO_2H, studied in detail, indicated that the oxidation was greatly increased in the presence of small amounts of fumaric acid, succinic acid, malic acid, oxaloacetic acid, α-ketoglutaric acid and citric acid. H. A. Krebs suggested in 1940 that the oxidation involves a reaction cycle in which the various carboxylic acids are involved as intermediates that are continuously synthesized and destroyed. Likewise in the photosynthetic fixation of carbon dioxide in plants, M. Calvin showed that various hydroxy acids and keto acids including glyceric acid, pyruvic acid, glyoxylic acid and glycolic acid are involved in a cyclical process which converts carbon dioxide and water into carbohydrates and oxygen. Combustion of fat in the body is a rich source of energy. R. Schoenheimer showed that degradation of the carboxylic acids in fats occurs by two-carbon units, which accounts for the prevalence of even-numbered carboxylic acids in nature. In the 1920s it was shown that certain unsaturated carboxylic acids are needed in the diets of rats. These acids lower serum cholesterol and deficiency of them may be relevant to certain conditions such as atheroma and coronary thrombosis.

Benzoic acid, the principal aromatic monocarboxylic acid, $C_6H_5CO_2H$, is manufactured by the oxidation of toluene, $C_6H_5CH_3$, by the hydrolysis of benzotrichloride, $C_6H_5CCl_3$, or by the decarboxylation of phthalic acid. Sodium benzoate, utilized as a food preservative to prevent the growth of microorganisms, is as effective as the parent benzoic acid. Benzoyl peroxide, which is used as a bleaching agent for edible oils and fats and as a catalyst for free radical polymerization reactions, is prepared by the reaction of benzoyl chloride, C_6H_5COCl, and sodium peroxide.

The *o*, *m* and *p*-benzenedicarboxylic acids, known as phthalic acid, isophthalic acid and terephthalic acid, respectively, are important bifunctional organic compounds which are used extensively for the synthesis of polymeric materials. Phthalic acid is easily dehydrated on heating to form the cyclic phthalic anhydride. Therefore, phthalic anhydride is the material ordinarily encountered. It is prepared usually by the air oxidation of naphthalene on a vanadium pentoxide catalyst. Phthalic anhydride is utilized for the production of alkyl esters of phthalic acid which are used as plasticizers of synthetic polymers. It is further used for the manufacture of polyester resins such as glyptal (from glycerol and phthalic anhydride) which are members of the class of polymeric substances known as alkyd resins derived from polyfunctional alcohols and polyfunctional acids.

Isophthalic acid and terephthalic acid are made by the air oxidation of the corresponding dimethylbenzene in the presence of a soluble cobalt or manganese salt. These bifunctional carboxylic acids are also utilized in the production of polymeric esters. Fibres spun from the polymeric ester of terephthalic acid with ethylene glycol, polyethylene terephthalate, have superior properties and are called Terylene or Dacron.



A number of derivatives of benzoic acid are of importance. Saccharin is the imide of the mixed anhydride of *o*-carboxybenzenesulfonic acid. Methyl *o*-aminobenzoate (methyl anthranilate) is used as synthetic grape flavour; *p*-aminobenzoic acid is present in the vitamin B complex and makes up a portion of the folic acid molecule. Although its necessity in the human diet has not been established, it is necessary for the growth of certain bacteria. The effectiveness of the sulfa drugs in combating infections by such organisms stems from the inhibition by the sulfa drugs of essential metabolic processes of the microorganisms because of the structural similarity of the sulfa drugs to *p*-aminobenzoic acid.

Certain *p*-aminobenzoic acid esters have local anesthetic action; for example, benzocaine, the ethyl ester; Butesin, the butyl ester; and Novocaine, the β-diethylaminoethyl ester. Aspirin, the important antipyretic and analgesic drug, is acetylsalicylic acid (*o*-acetoxybenzoic acid).

See A. W. Ralston, *Fatty Acids and Their Derivatives* (1948).

(M. L. B.)

CARCASSONNE, a city of southwestern France, capital of the *département* of Aude (*q.v.*), located 57 mi. S.E. of Toulouse, near the eastward bend of the Aude river, which divides it into two distinct towns, the Ville Basse (lower town) and the ancient Cité. The Cité contains the finest remains of medieval fortifications in Europe. The town lies in the gap between the Montagne Noire on the north and the outliers of the Pyrenees on the south. Pop. (1962) 37,190. It is the seat of a bishop and has a court of assizes.

Carcassonne lies on railways from Bordeaux to Lyons-Geneva and from Hendaye to Marseilles-Ventimiglia (Vintimille) and also on the line Paris-Port Bou-Barcelona. It is crossed by two main roads and is served by numerous motorbus lines. There is an airport.

Ville Basse.—The Ville Basse, at the centre of which is concentrated the town's business, is surrounded by a belt of boulevards embellished by trees and gardens. Its principal ancient monuments are: the church of St. Vincent and the cathedral of St. Michael (both late-13th century); the small chapel of Notre Dame de la Santé (15th century), at one end of the 14th-century Pont Vieux; Neptune's fountain (1770), on Place Carnot; and the Montmorency house (16th century), at the top of the Rue Trivalle. Modern architecture is represented by the Municipal theatre, the town hall and the Monument to the Resistance, by Iché. The town has an art museum and boys' and girls' secondary schools.

The old cloth industry is extinct. The town is an important wine market, and the vineyards of the vicinity are one of the chief sources of its prosperity, which is enhanced by its position on the Canal du Midi. Carcassonne factories produce agricultural implements, molded rubber parts for automobiles and preserved fruits and jams, but because of the Cité and its picturesque location, it is essentially a tourist town. It is surrounded by numerous castles and abbeys, and nearby are the Mediterranean seaside resorts, the Pyrenean winter sports resorts and many spas.

Carcassonne also lies on the "Route Mariale," joining Rome to Lourdes and to Fátima, Port.

Cité.—The Cité occupies the summit of an abrupt and isolated hill on the right bank of the Aude. Its ancient fortifications consist of a double line of ramparts, separated by an outer ward called the *lices*. The walls (the inner 1,200 yd., the outer 1,640 yd.) are protected at frequent intervals by towers, some of which served as watchtowers, and can be entered only by two gates, the Narbonnese to the east and the Aude to the west, both of which are also elaborately fortified. In the interior, and to the north of the Aude gate, the castle, Château Comtal, adjoins the fortifications.

Excavations of 1923 and 1927 show that the site on which the Cité lies was occupied as early as the 5th century B.C. by Iberians, who were followed by Gallo-Romans. The inner rampart of the Cité was constructed during the reign of the Visigothic king Euric I, in A.D. 485. It was besieged, without success, in 508 by Clovis, occupied by the Saracens in 728 and conquered by Pepin the Short in 752.

From 819 the Cité was in the possession of a succession of counts and viscounts. Under the Trencavel dynasty (viscounts of Carcassonne and of Béziers) was constructed the cathedral of St. Nazaire (1096–1150), and about 1125 the Château Comtal was incorporated in the Visigothic rampart.

After suffering badly in the Albigensian wars (*see* CATHARI), the viscounty of Carcassonne, together with that of Béziers, was confiscated to the crown in 1247. A revolt of the city was punished in 1240 by the expulsion of its principal inhabitants, who took up residence on the other side of the river, thus founding the Ville Basse.

With Carcassonne now joined to the French crown, great works were undertaken. The Romanesque transept and choir of St. Nazaire were replaced by a Gothic choir and transept (the nave has remained Romanesque). Beautiful stained-glass windows of the 14th–16th centuries now light the church. In the chapels can be seen the tomb of Bishop Pierre de Rochefort (14th century), statues of SS. Peter and Paul (14th century), Pierre de Rodier's "Stone of the Siege" chapel (13th century), the tomb of Bishop Radulph (13th century) and a *Pietà* of the 16th century. The outer rampart was constructed during Louis IX's reign, and the works were continued by his son, Philip III, who added to the

W. SUSCHITZKY

TOWERS AND RAMPARTS OF 12TH-CENTURY CASTLE ABOVE RESIDENTIAL STREET WITHIN THE MEDIEVAL WALLED SECTION (CITÉ) OF CARCASSONNE inner rampart the beautiful Narbonnese gate and the Tour du Trésaut (or Trésor), immediately to the north of the gate.

The town's importance as a frontier station ended in 1659, when the province of Roussillon was annexed to France. Thereafter the ramparts were no longer kept in repair and gradually were abandoned. In 1844 E. E. Viollet-le-Duc undertook the restoration of the church of St. Nazaire and, from 1852 to 1879, that of the fortifications. The work was continued and by mid-20th century was nearly complete. The Cité, whose narrow streets are still inhabited by a population of about 1,000, may be seen in all its former splendour.

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CARCHEMISH, an ancient city-state near modern Jerablus, Syr., 63 mi. N.E. of Aleppo, in the Aleppo *muhafazet* of Syria, was on the west bank of the Euphrates river, near the Turkish border. It commanded a strategic crossing of the river for caravans engaged in Syrian, Mesopotamian and Anatolian trade. The site, which occupied over 230 ac., included within the inner town (86 ac.) a high citadel overlooking the river, and a larger area of outer town strongly defended by high walls. The principal excavations were conducted between 1911 and 1920, first by D. G. Hogarth, and subsequently by C. L. Woolley, who had the largest share in the work.

The place was first occupied in the Neolithic period, as was proved by the discovery of obsidian and flint blades, together with monochrome black burnished pottery, on pebble floors at the base of the mound. Kilns of the subsequent Chalcolithic stage, in the neighbouring village of Yunus, yielded the famous prehistoric Halaf ware. Later finds from Carchemish include the Uruk-Jamdat Nasr pottery, which was a typical product of the south Euphrates valley in Sumerian cities of about 3000 B.C. The end of the Early Bronze and the Middle Bronze Ages are represented by tombs. Stone cist graves with the dead laid out at full length yielded large quantities of pottery, especially the champagne-glass type with high pedestals, widespread both in northern Iran and in Anatolia, about 2000 B.C. Cast copper weapons, including daggers, poker-butt spears, flat ax blades and elaborate pins, attest a highly competent metallurgy at this period. The so-called Amarna cist graves of the Late Bronze Age produced typical Syrian pottery and metal, toggle pins and some jewelry.

Written records concerning Carchemish first appear in the Mari letters (royal archives of Mari), contemporary with Hammurabi (18th century B.C.), when there is a mention of a king named Aplahanda. At that time the city was an important entrepôt for the wood trade and appears to have been engaged in the transshipment of Anatolian timber down the Euphrates. During the eighth campaign of Thutmose III, about 1470 B.C., it was evidently an independent state. The Hittite conqueror Suppiluliumas (1375–35 B.C., according to some authorities), however, established his son as king of the city, which he used as a buffer state against three potential rivals, Assyria, Mitanni and Egypt. With the fall of the Hittite empire, Carchemish was probably overrun by the "Peoples of the Sea." Cremation burials in urns then occurred for the first time. Subsequently the district became prone to direct attack from Assyria. In the reign of Shalmaneser III (859–824 B.C.) the city was forced to pay a heavy tribute and finally capitulated to Sargon II in 717 B.C. The last important historical event connected with it was the battle fought in 605 B.C. at which Nebuchadrezzar II put an end to the pretensions of Pharaoh Necho to dominate Syria. A house in the outer town provided a dramatic illustration of Egypt's lost prestige: it contained clay seal impressions bearing the cartouche of Necho, a bronze ring with the cartouche of Psamtik I, and Egyptian-style alabaster vases with hieroglyphic inscriptions. Its burnt ruins littered with evidence of a desperate struggle included hundreds of arrowheads of bronze, as well as iron.

The town was defended by thick double walls with sally ports, embankment, fosse and powerful towered gates. Rubble, timber, ashlar masonry and mud brick were used in its construction. Among the buildings a *bit hilani*, or residence with columned portico, a palace and a temple were identified; a broad flight of stairs flanked by sculpture ascended into the citadel. The rich series of carved stone orthostates found on the citadel depicted warriors, hunting scenes, magical winged figures and processions of the gods in an eclectic style peculiar to northern Syria. They were associated with Neo-Hittite hieroglyphic inscriptions which referred to a dynasty of local kings. Many traits of Assyrian art may also be discerned, particularly in the later sculpture when Carchemish became increasingly subject to Assyria. Certain divinities—storm god and mother goddess—appeared to have Hurrian names, and indeed it may be the Hurrians of northern Syria who formed the largest element in the population and were responsible for this art. After the 6th century the site ceased to be important, but there was evidence of Hellenistic occupation. In Roman times Carchemish was known as Europus, and excavations have revealed a number of Roman villas.

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CARCHI, the northernmost of the highland provinces of Ecuador, is bounded north by Colombia, east and south by Imbabura province and west by Esmeraldas province. Area 1,581 sq.mi. Pop. (1962) 94,649. The capital is Tulcán, occupying the basin of Tulcán, in which most of the people are concentrated. In the basin the farms produce wheat, barley and potatoes. At lower elevations there is some production of maize, sugar cane, coffee and fruit, and cattle raising. A large part of the province, however, is high and is used for the grazing of sheep. The chief manufactures of Tulcán are woolen goods, including rugs and ponchos. The province is served by the Pan-American highway. (P. E. J.)

CARCINOGENIC CHEMICALS, or chemical carcinogens, are a diversified group of chemical compounds capable of giving rise to tumours in animals and, in some instances, in man. The term carcinogen strictly implies a compound that can produce a malignant tumour, but it has been used commonly in a loose sense to indicate the production of either benign or malignant tumours in a variety of tissues. The more general terms tumourigen or oncogen have been adopted by some writers; in this discussion the term carcinogen will be used in its broad sense and considered synonymous with these more correct forms.

Although at least 800 compounds are known to be carcinogenic under certain conditions, the majority of them fall into a relatively few chemical classes; many are synthetic analogues of known carcinogens, prepared in an effort to determine the structural chemical requirements of such biological action. The manner in which many of these compounds was discovered is of considerable interest, particularly when assessing their role in human cancer. In the much studied groups of these agents, the polycyclic hydrocarbons and the aromatic amines, observations made clinically in man eventually led to laboratory confirmation of carcinogenic action. Thus the observation by Percivall Pott in the 18th century that soot appeared to be a factor related to a high incidence of scrotal cancer in chimney sweeps led to the experimental demonstration in 1915 by K. Yamagiwa and K. Ichikawa that repeated applications of coal tar could give rise to cancer in the skin of rabbits. That experiment, in turn, provided the basis for the synthesis of the first pure chemical carcinogen, the polycyclic hydrocarbon benzo(a)pyrene, isolated from coal tar.

Similarly the clinical observation in 1895 of a high incidence of carcinoma of the bladder among workmen in the aniline dye industry was the foundation of the later demonstration that dogs would develop cancer of the bladder when fed 2-naphthylamine for several years. In contrast the potent carcinogen N-fluorenylacetamide was discovered in the course of a routine chronic toxicity test. This compound was synthesized as an insecticide and before being allowed to come into contact with a human being was tested by being fed to rats for two years. The development of multiple tumours in these animals prevented this agent from becoming a potential hazard to man. Carcinogens such as some of the dyes of the azo group and certain carbamates have been discovered in the course of basic laboratory investigations. Other leads to the occurrence of carcinogens have come from various epidemiological investigations not only into the distribution of cancer on a geographical basis but into the study of cancer in animals and the occurrence of other manifestations of toxicity. One instance of this is the alkaloids from the *Senecio jacobaea* plant, which was investigated as to its possible relationship to the high incidence of primary liver cancer in the Bantu tribes. Perhaps the most potent of all known carcinogens are the aflatoxins which were discovered initially to be the cause of a rapidly fatal liver destruction in the duck and turkey. The compounds, which are products of the fungus *Aspergillus flavus,* were present, as contaminants, in the peanut meal component of the diet. The aflatoxins were subsequently shown to be capable of inducing liver and other cancers when fed to rats. Later evidence was provided that these same aflatoxins were probably causative agents of an epidemic of primary liver cancer occurring in rainbow trout raised in hatcheries. That cancer seems to have been almost eliminated in those fish by a change in their artificial diet which has eliminated the carcinogen. In yet another instance, an investigation of a neurological disorder, in the island of Guam, resulted in a detailed investigation of dietary items special to this area. In studying the flour made from the cycad nut, a new carcinogenic compound, called cycasin, which is chemically a glycoside, was discovered. This compound induced cancers in the liver and esophagus when fed to rats; its possible relationship to human cancer was still under study in the late 1960s.

Lastly, the occurrence of liver damage in men working in a chemical factory resulted in the discovery of the potent carcinogenic action of the compound dimethylnitrosamine. After that time, numbers of nitrosamines, many of them carcinogenic, were synthesized. Nitrosamines occur in the human environment from various sources but none had been clearly incriminated in the origin of human cancer by the late 1960s.

The major implication of the pattern taken by this research is that the range of activity of these agents is likely to encompass many species and that a positive finding in an animal is likely to have a significance for human beings.

Polycyclic Hydrocarbons.—Of the various groups of carcinogenic chemicals, those most studied have been the polycyclic hydrocarbons. After the synthesis of dibenz(a,h)anthracene and the isolation of benzo(a)pyrene, there was a great desire to establish the nature of the basic molecule necessary to such biological action. This resulted in the synthesis of a large number of compounds, the majority of them derivatives of benz(a)anthracene. It was found that by substitution with methyl groups on various parts of this molecule compounds with vastly different carcinogenic potencies could be obtained. Specifically it was found that 7,12-dimethyl benz(a)anthracene was the most potent compound that could be synthesized.

After a time it became apparent that a whole variety of modifications could be introduced into the molecule and that it would still retain its biological activity; thus a nitrogen-containing acridine nucleus could be substituted for the central ring or a carbazole ring could be used. In either of these instances a new series of carcinogens could be synthesized.

No complete explanation of the nature of the molecular configuration essential to carcinogenic activity has been devised. Certain physiochemical considerations of the electronic densities at specific regions of the molecule have been equated, however, with variations in biological potency. Of all these compounds the most potent, dibenz(a,h)anthracene, benzo(a)pyrene, 7,12-dimethyl benz(a)anthracene, and 3-methycholanthrene, have been used extensively for biological experimentation. It would appear likely that, primarily, these agents act directly on the tissue with which they are placed in contact. Thus when they are painted on the skin, skin tumours (benign papillomas and malignant squamous cell carcinomas) are induced; when they are injected subcutaneously, local connective-tissue tumours (sarcomas) are induced; when they are injected into a variety of different tissues, tumours arise from the tissue of contact. Thus when such a compound is implanted in the brain, brain tumours (gliomas) occur; in bone, bone tumours (osteogenic sarcomas); and so on.

By using specially inbred mice, it is possible to show that these compounds may also have a remote action. Strain A mice, for example, develop lung tumours (pulmonary adenomas) with some frequency without any treatment; when these mice are treated with carcinogens by skin application, by injection, or by mouth, they will develop many more lung tumours and with greater rapidity. Similarly, other mice, such as the Ak strain, have an increased incidence of leukemia under similar conditions.

There is considerable variation in the response of different species to treatment with the polycyclic hydrocarbon compounds. The difference is often one of time; thus it may take mice three months to develop skin tumours when painted with a particular agent whereas guinea pigs require nine months. This difference has often been equated with the life span of the animal; but this concept, although it has some support, is not universally true. In other instances, treatment of different species with the same compound in the same manner may result in the production of a different type of tumour. Thus a single application of 7,12-dimethyl benz(a)anthracene may give rise to few or no tumours in many species; in the Syrian golden hamster it will result in the occurrence of many pigmented (melanotic) tumours. The variety of species known to respond to these carcinogens is large, however, including mice, rats, guinea pigs, rabbits, hamsters, dogs, cats, monkeys, different birds, and amphibians.

In certain occupations where a high incidence of a particular cancer has occurred, association with a single chemical may often be established. Where cancer occurs in whole segments of the population, possibly as a result of contact with a factor generally present in the environment, such an association is far more difficult to establish. A case in point is the increased incidence of lung cancer observed in many countries after about 1930 and associated epidemiologically with both cigarette smoking and atmospheric pollution. Carcinogenic hydrocarbons, notably benzo(a)pyrene among others, have been isolated from tars of cigarette smoke and from soot of polluted atmospheres. Since the entire urban population of the world undoubtedly has contact with these agents, it becomes vitally important to know what quantities constitute a hazard. In experimental efforts to quantify the effects of these compounds, it has been found that they can act at low levels; 0.4 micrograms of dibenz(a,h)anthracene injected once are enough to produce a malignant tumour in a mouse. Other studies have shown that a single application to the skin of an amount of carcinogen inadequate to induce a tumour will produce nevertheless a latent tumour change. Skin so treated will develop tumours if subsequently treated with a secondary agent (promoting agent) that itself is not necessarily carcinogenic. The matter of establishing a tolerance level to these materials is thus complex and quite unsolved.

Aromatic Amines.—The aromatic amine 2-naphthylamine, unlike the polycyclic hydrocarbons, has a restricted organ specificity. Thus in man this compound only gives rise to tumours of the bladder; the same is true in the dog although in the rat, tumours of the liver occur. It would appear that this compound is not directly carcinogenic to the tissue with which it comes into contact, but that it has first to be metabolized to the active form by the organism and that, in the instance of the dog and man, the active product is excreted in the urine, thus producing tumours at the site of maximal concentration, the urinary bladder. The compound N-fluorenylacetamide acts similarly; following feeding this compound gives rise to tumours in many different organ sites. It has been demonstrated that the compound is metabolized by the process of N-hydroxylation to the "proximate" carcinogen N-hydroxy-N-fluorenylacetamide, which can also give rise to potent local carcinogenic effects, unlike the parent compound.

N-fluorenylacetamide is remarkably active at many sites in many different species of laboratory animals. It will induce a variety of tumours in rats, mice, hamsters, and dogs among other species; it is not, however, active in the guinea pig and it has been shown that this species is unable to N-hydroxylate the compound to the proximate carcinogen. It is clearly important to know how to choose the appropriate species for the evaluation of human hazard. An understanding of the metabolic reasons for these differences is a primary aim of much research.

Azo Dyes.—The azo-dye carcinogens are best represented by *o*-aminoazotoluene and *p*-dimethylaminoazobenzene (butter yellow); as with other groups of carcinogens, many analogues of these dyes have been synthesized and tested. They have been studied largely in the rat; when incorporated in the diet (usually at a level of 0.06%) they give rise to tumours of the liver after three to four months. For the most part they are active, although less so, in the mouse; they are active in some other species (the dog, for example) but again only weakly so and would appear to be primarily potent carcinogens to the rat.

These compounds have been used extensively in studies of the biochemical mode of action of carcinogens. One series of experiments showed that the azo-dye carcinogens become bound to proteins in the liver. It was suggested that this is an essential step in the development of tumours by carcinogens, and a general concept, the protein-deletion hypothesis, was based on this work. After the demonstration that the azo-dye carcinogens became bound to protein, it was shown that the polycyclic hydrocarbon carcinogens, too, become protein bound in these latter compounds; however, the specificity of the situation is not so clear.

Urethane.—Urethane (ethyl carbamate) is a simple aliphatic compound that is well known as a hypnotic. It was found to be capable of giving rise to lung tumours in mice following administration by either mouth or injection. Experimental evidence indicated that this compound has to undergo certain reactions within the organism before it becomes active; placed in direct contact with the tissue it does not produce tumours; blood from an animal given urethane by mouth, however, does appear to contain an unknown factor that can act directly. In 1937 A. Haddow developed the theory that agents found to be carcinogenic would also possess the property of inhibiting the growth of tumours. As a result urethane was investigated as a therapeutic agent for certain forms of leukemia and was found to be useful. (*See* URETHANE.) Conversely, nitrogen mustard, a compound originally tested as a chemotherapeutic agent in cancer, was found to be capable of inducing lung tumours in mice following intravenous injection.

Nitrosamines.—Following the discovery that dimethylnitrosamine could cause both liver and kidney tumours in the rat, a variety of related nitrosamines have been synthesized and tested. These compounds have proved capable of inducing a larger variety of tumours than previously known carcinogens. They give rise to tumours in the esophagus, trachea, lungs, and various parts of the central nervous system among other locations. They have been found to be active in several species. In the study of biochemistry of dimethylnitrosamine it has been noted that 7-methylguanine may be isolated from treated animals. The significance of the alkylation has been widely discussed.

Metals.—A variety of metals have been implicated in the occurrence of human cancers. Most notable are nickel and chromium, implicated in the occurrence of nasal sinus and lung cancers, respectively, among men engaged in refining ores. Local tumours have been induced by these metals following injection into rodents. Other metals that have given rise to experimental tumours include cobalt, zinc, and cadmium.

Plastics.—Of the many known carcinogens, none are more puzzling than the various plastics, notably cellophane, that have been found to induce tumours (sarcomas) in rats and mice, when inserted under the skin. A small fragment of any of several plastics will give rise initially to a massive fibrous tissue reaction, and after a few months, in 20% or more instances, this will develop into a malignant tumour. Since powdered plastics are relatively inactive in this situation, it appears that the physical configuration of the material is of much importance. In any event, it is difficult to conceive of a biochemical reaction resulting in degradation of plastics as part of the biological process.

Naturally Occurring Carcinogens.—The group of compounds isolated from the fungus *Aspergillus flavus* and named the aflatoxins is of considerable interest not only in relation to causes of human cancer but as compounds for the study of mechanisms of cancer induction. These complex lactones are active at extremely low doses in rats and in fishes as both liver damaging agents and carcinogens. The compound cycasin has also formed the basis for some interesting studies in the intermediary metabolism of these agents. Other naturally occurring carcinogens that also give rise to liver tumours in rats are the *Senecio* alkaloids and tannic acid. Ergot is known to be able to cause multiple tumours of nerves (neurofibromas) in rats.

Conclusion.—This short survey has not, of course, described all the known carcinogens, but it has encompassed the main groupings. It can be seen that human beings live in a sea of carcinogenic materials, and it is obvious that they must have some tolerance to them. There are great variations in potency among these agents, and toxicological test methods at least can obviate human contact with certain of the more potent compounds. The matter of the less potent compounds and tolerated levels of these materials poses serious practical problems.

In conclusion, a great variety of chemical compounds, undoubtedly with very different biochemical properties, can all bring about the same pathological reaction in animals, namely the induction of benign and malignant tumours. This property is shared with ionizing radiation and certain viruses and hormones (estrogens notably). A final evaluation of this situation must encompass all these facts, and a comprehension of the biological nature of the process may be the major missing link. *See* also CANCER; CANCER RESEARCH. (P. SK.)

CARDANO, GERONIMO or GIROLAMO (JEROME CARDAN) (1501–1576), Italian physician, mathematician and astrologer, was born at Pavia, Sept. 24, 1501, the illegitimate son of Fazio (Bonifacius) Cardano. Fazio, a friend of Leonardo da Vinci, was a jurist and public lecturer on geometry in Milan. Geronimo was educated at the universities of Pavia and Padua, receiving his medical degree in 1526. In 1532 he moved to Milan, where he lived in great poverty until he succeeded in being appointed lecturer in mathematics. In 1536 he violently attacked the practices of the medical profession, particularly in Milan, in the book *De malo recentiorum medicorum medendi usu libellus*. Through the support of prominent sponsors he was admitted to the college of physicians in 1539, and shortly afterward he became rector. His fame as a physician grew rapidly, and many of Europe's crowned heads solicited his services; however, he valued his independence too much to become a court physician. In 1552 he undertook a journey to Edinburgh to treat the archbishop of Scotland, John Hamilton, for asthma; the treatment was successful, and Cardano was richly rewarded by the archbishop. In 1543 he accepted a professorship in medicine in Pavia.

Cardano's numerous medical publications show a tendency to rely more on his own experiences than the tenets of Galen and Hippocrates. He gave the first clinical description of typhus fever, was among the first to write on the treatment of syphilis and had some notion of infection. He made useful suggestions for the instruction of the deaf-mute and blind. He has been called a forerunner of Lombroso in his book on metoposcopy—the determination of character from facial traits.

As a mathematician, Cardano was the most outstanding figure of his time. In 1539 he published two books on arithmetic embodying his popular lectures, the more important being *Practica arithmetica et mensurandi singularis*. At the time it was known that the solution of the cubic equation had been discovered and that Niccolò Tartaglia (*q.v.*), the Venetian mathematician, was in possession of the method. Cardano tried to obtain permission to print it; this Tartaglia refused, but he confided the solution to Cardano, who swore to keep it secret. In 1545 appeared Cardano's book *Artis magnae sive de regulis algebraicis*, one of the cornerstones in the history of algebra. Among many new facts it contained the solution of the cubic equation and also the solution of the quartic equation found by Cardano's former servant, Lodovico Ferrari. The publication led to a bitter dispute with Tartaglia, conducted mainly by Ferrari while Cardano kept aloof. Cardano also wrote other mathematical works. His book on games of chance, *Liber de ludo aleae*, presents the first systematic computations of probabilities, a century before Pascal and Fermat.

Cardano's popular fame was based largely upon his books dealing with scientific and philosophical questions. Most successful and widely pirated by the printers was *De subtilitate rerum*, a collection of physical experiments and inventions, interspersed with anecdotes. Of a similar nature was *De rerum varietate;* more philosophical were *De utilitate ex adversis capienda* and *De comforte.*

Cardano's later life was tragic. His wife died in 1546, leaving him with three children. Giambattista, the idol of his father, studied medicine and practised in Milan. He married a disreputable girl, Brandonia Seroni, who was conspicuously unfaithful to him, and with the assistance of a servant Giambattista finally poisoned her. Cardano made every effort on behalf of his son, but to no avail. In 1560 Giambattista was executed for the murder of his wife, and Cardano never recovered from the blow. In 1562 he received an appointment to a professorship in Bologna, and for a few years he lived fairly undisturbed except for the escapades of his scoundrel son Aldo. In 1570, however, Cardano was suddenly arrested on the accusation of heresy. After several months in jail he was permitted to abjure privately, but lost his position and the right to publish books. He died in Rome on Sept. 20, 1576, after completing his autobiography, *De propria vita.*

See also references under "Cardano, Geronimo" in the Index.

Bibliography.—Cardano's literary production was enormous; his works were published by Sponius in a ten-volume folio edition (1663). *See* also H. Morley, *Jerome Cardan* (1854); W. G. Waters, *Jerome Cardan* (1898); A. Bellini, *Gerolamo Cardano* (1947); Oystein Ore, *Cardano, the Gambling Scholar* (1953). For autobiography *see* J. Cardan, *The Book of My Life,* trans. by J. Stover (1930). (O. Oe)

CARDBOARD: *see* Paperboard.

CÁRDENAS, LÁZARO (1895–1970), president of Mexico from 1934 to 1940, was born in Jiquilpan, Michoacán, May 21, 1895. His formal education stopped when he reached the age of 11, for the town had no secondary school. But Cárdenas was an avid reader, and at 16 he began to write for newspapers. At 18 he joined the revolutionary forces of Guillermo García Aragón and after several campaigns became a brigadier general. At 25 he was appointed provisional governor of Michoacán, and he retained this post in subsequent elections until he became minister of interior in 1931. Two years later he became minister of war and marine. In 1934, while still in his thirties, he was elected president of Mexico.

Cárdenas immediately put into action the National Revolutionary Party's six-year plan for social and economic reform. Pursuing democratic methods and enjoying the support of the great majority of the people, including Communist-dominated labour unions, Cárdenas made radical changes. Public education received a tremendous impetus. By an expropriation law, the government took over many industries that had been closed by strikes and turned them into cooperatives for the workers. With compensation, the oil industry was nationalized on March 18, 1938. Large areas of vast estates were divided among the landless farmers. Between 1934 and 1940 Cárdenas placed about 40,000,000 ac. in peasant hands. He refused to live in Chapultepec castle, the home of Mexican chief executives since the days of Maximilian, and turned it into a museum. President Cárdenas would appear in villages and listen to the peasants' complaints and needs. He piped drinking water into hamlets, built bridges, and established hospitals supported by municipally owned motion-picture theatres.

When his presidential term ended in 1940, Cárdenas retired to private life at Pátzcuaro. Recalled as minister of national defense in 1942, he made sweeping reforms in the Mexican Army. He returned to Pátzcuaro after the war and remained a potent force in behind-the-scenes national politics. Cárdenas died in Mexico City on Oct. 19, 1970. (Hu. St.)

CÁRDENAS, a city in Matanzas province, Cuba, about 75 mi. E. of Havana. It is one of the chief ports of the island, being located on the shore of a large bay and sheltered by the long Hicacos peninsula. The port handles sugar from about 20 sugar mills in its fertile hinterland. Industries include sugar refineries, rum distilleries and plants manufacturing rope from henequen. The city has good transport communications with the rest of the island. Varadero beach, a well-known resort area, is located about 8 mi. N.N.W. of Cárdenas.

Cárdenas was founded in 1828 and grew steadily (pop., [1967 est.] 67,400). The large zone of unhealthful marshes was converted into a well-laid-out city with beautiful plazas, including one with Cuba's first public monument honouring Columbus, given by Queen Isabella II in 1862. Cárdenas was the scene of the first bloodshed in the Spanish-American War, May 11, 1898. (D. R. D.)

CARDIAC CATHETERIZATION, a procedure by which a flexible tube is inserted into a vein and passed along the course of that vein and into the heart. It is used for injecting drugs directly into the heart, for measuring the blood flow and the pressures in the heart and central blood vessels and for studying the physiology of the heart, lungs and other organs, in health and disease. The procedure was originated by Werner Forssmann (*q.v.*), who in 1929 opened a vein in his own arm, inserted the tip of a catheter—a flexible tube about $\frac{1}{8}$ in. in diameter and $2\frac{1}{2}$ ft. long—and passed it up his arm vein, along the intrathoracic veins and on into the right chamber of his heart, taking an X-ray to prove its location. His purpose was to find a safe means of injecting drugs directly into the heart; subsequently the method was adopted for other uses, proving to be safe and painless.

André Cournand (*q.v.*) and Dickinson W. Richards in New York were the first to carry out comprehensive research with this method. They studied patients in wound shock during World War II, and measured effects of plasma and whole blood in treatment. Later the method was widely used in the diagnosis of congenital heart disease, exploring narrowed passages and abnormal communications between heart chambers.

In 1956 Cournand, Forssmann and Richards were awarded the Nobel prize in medicine and physiology. (D. W. Rs.)

CARDIFF (Caerdydd), the capital of Wales, city, county borough, seaport and county town of Glamorganshire, is situated near the mouth of the river Taff, which flows into the Bristol channel, 145 mi. W. of London by rail and 160 mi. by road.

Although the town is old, the development of Cardiff dates from the 19th century and paralleled the development of the south Wales coal and iron fields. In 1801 the population numbered 1,870. By 1861 it had increased to 32,954, by 1931 to 226,937, and by 1961 it had reached 256,582. Originally the borough comprised the ecclesiastical parishes of St. John the Baptist and St. Mary the Virgin, but in 1875 and 1895 it was extended to include Roath and a large part of Llandaff, known as Canton, on the west of the Taff. The whole area was united as one civil parish in 1903 and made a city in 1905. Further extensions included the ecclesiastical city of Llandaff (*q.v.*), with its cathedral, in 1922; Rumney, in Monmouthshire, in 1937; and part of St. Mellons, also in Monmouthshire, in 1950. The city was recognized as the capital of Wales in 1955.

Cardiff is divided into three parliamentary divisions, one of which includes the town of Penarth. The municipal borough consists of 17 wards, each represented by three councilors and one alderman. The chief citizen is styled lord mayor. The county assizes are held alternately at Cardiff and Swansea. Cardiff has a separate commission of the peace, with a stipendiary magistrate, and a separate court of quarter sessions, under a recorder.

The City.—Cardiff is well laid out, with a magnificent group of public buildings in Cathays park. These edifices, mostly of Portland stone, include the law courts (1904); the city hall (1904), whose marble hall contains some fine statues of Welsh heroes; the University College of South Wales and Monmouthshire (founded 1883 and formally opened in 1909), with faculties of arts, education, music, science and theology; the Glamorgan county hall (1912); the Welsh College of Advanced Technology (1916); the National Museum of Wales (1927), housing the valuable Llandinam collection of pictures, as well as collections of rare silver and china; the offices of the ministry of housing and local government and the Welsh board of health (1938); and the Welsh National Temple of Peace and Health (1938). Alexandra gardens, in the centre of Cathays park, contain the Welsh National War memorial.

Cardiff castle was given to the city in 1947 by the 5th marquess

E. W. TATTERSALL BY PERMISSION OF TOWN CLERK, CITY HALL, CARDIFF

CARDIFF CASTLE AS SEEN FROM THE CASTLE GREEN

of Bute, and the rooms, other than the state rooms, are used as the College of Music and Drama. The well-preserved Norman keep of the castle is one of the best of its kind in existence. St. Fagans castle, 4½ mi. to the west, houses the Welsh Folk museum. The Welsh regional headquarters of the British Broadcasting corporation is centred in the city.

The city's parks and open spaces include part of the Heath estate; Roath park, with a lake and botanic garden; and also the Leckwith woods, on the west of the city. The Sophia Gardens field, beside the Taff, is a site for Welsh national shows, and the castle green is ideal for spectacular events, while the castle grounds (outside the castle wall) are used for recreational purposes. Sporting amenities include rugby football and county cricket at Cardiff Arms park, association football at Ninian park, athletics and cycling at Maindy stadium and swimming at the Wales Empire pool.

The castle dominates the centre of Cardiff, of which the main shopping thoroughfares are Queen street, continuing into Duke street, and High street, leading into St. Mary street. Nearby is the parish church of St. John the Baptist, built in Perpendicular style. The fine tower was constructed in the 15th century, supposedly by a mason named Hart (possibly William Hort), who also built the towers of Wrexham and St. Stephen's, Bristol. The sculptured stone reredos by Sir Goscombe John was erected in 1896. A number of stained-glass windows and mural tablets commemorate distinguished leaders of the Order of St. John. The cathedral of St. David, destroyed in World War II but subsequently restored, has since 1916 been the seat of the Roman Catholic archbishop of Cardiff. The Baptist Theological college of Pontypool was transferred to Cardiff in 1895.

The Taff is spanned by two important bridges, one a four-arch bridge, rebuilt during 1858–59, leading to Llandaff, and the other a cantilever bridge with a central swinging span of 190 ft.

Cardiff was badly damaged by air raids in 1941. Comprehensive redevelopment of the city proceeded in the early 1960s, particularly in an area of cottage properties known as Temperance town at the southern end of St. Mary street adjoining the main railway station. The area was laid out as a central bus station flanked by shops and offices, while on the north side was constructed the splendid Wales Empire pool, where the 6th British Empire and Commonwealth games were held in 1958.

Communications.—Bus services connect Cardiff with the whole of south Wales. Cardiff General station lies on the main railway line from London (Paddington) to Fishguard and Goodwick, north Pembrokeshire, express trains covering the distance from London in three hours or less, while other main lines connect the city with the chief towns of the English Midlands.

During the summer a ferry steamer service is operated between Cardiff and Bristol, Weston-super-Mare and Ilfracombe, thus facilitating pleasure travel from south Wales to the coasts of Somerset and north Devon. The city's airport, originally at Pengam Moors, 2½ mi. E., is now at Rhoose, 12 mi. W., and provides services to London, Dublin, Jersey, Paris and Ostend.

Industries and Commerce.—Edward II's charter of 1324 indicates that Cardiff was a trading and shipping centre of some importance, and from 1327 to 1332 it enjoyed a brief existence as a staple town. During the reigns of Elizabeth I and James I it was a notorious resort of pirates. It was for centuries a "head port," its limits extending from Chepstow to Llanelly. In the 18th century it sank to the position of "a creek" of the port of Bristol, but about 1840 it was made independent, its limits for customs purposes being defined as from the Rhymney estuary to Nash point, so that technically the port of Cardiff includes Barry and Penarth.

Until the end of the 18th century there was only a primitive quay on the riverside for shipping purposes. Coal was brought down from the hills on the backs of mules, and iron was carried in two-ton wagons. In 1794 the Glamorgan canal from Merthyr Tydfil to Cardiff (most of which now belongs to the corporation) was opened, and four years later the first dock was built at the canal terminus. With the growth of demand for south Wales steam coal (1850–1914), Cardiff developed rapidly and became one of the greatest coal-exporting ports in the world. During the same period occurred the vast development of the iron industry in the hinterland. Cardiff lay at the base of the mining and industrial valleys, such as that of the Rhondda (*q.v.*), and railways from all directions focused there, the slope from the high-lying coalfields facilitating transport of the heavily laden trains and the returning empty wagons.

The influence of John, 2nd marquess of Bute (1793–1848), can hardly be overestimated. He risked his entire fortune in the promotion of a docks scheme. In 1830 he obtained the first act for the construction of a basin and dock (now known as the Bute West dock), which was opened in 1839. Following the opening of the Taff Vale railway in 1840 and the South Wales railway to Cardiff ten years later, the trustees of the marquess built the Bute East dock and basin, which was completed in 1859. The Rhymney railway to Cardiff was completed in 1858, and the Roath basin was opened in 1874 and the Roath dock in 1887. Other authorities had opened a dock at Penarth (*q.v.*) and obtained powers to build docks at Barry. Subsequently the Queen Alexandra dock was opened in 1907, bringing the whole enclosed deepwater area of Cardiff, Penarth and Barry to about 305 ac. Timber floats occupy about 22 ac., and there are about 7 mi. of quays and 12 dry docks.

The shipment of coal and coke, which totaled about 4,500 tons in 1839, had risen to more than 19,000,000 tons in 1913. The period following World War I saw a great disruption of Cardiff's export trade, and by 1938 coal and coke shipments had risen to only 5,229,000 tons. They fell away again after World War II and were less than 250,000 tons in the early 1960s. Efforts were made to increase trade in general cargo, and many new industries were started. Copper works had already been established in Cardiff (1866), followed long after by tin-stamping and enamel works, and, with the replacement of local by imported ores, the smelting works had migrated to the coastal regions near the city, particularly the east moors stretching toward the outlet of the Rhymney river. In 1888 about 90 ac. were acquired for ironworks, which developed into a vast iron and steel undertaking. There are cattle lairs and abattoirs near the Cardiff wharf, and the King's wharf cold-storage premises are among the most modern in the United Kingdom, while oil and gasoline are distributed over a wide area from a base at the docks. There are also ship-repairing yards, large grain mills and breweries, a biscuit factory, wire and hemp roperies, general foundries and engineering works. Many inhabitants of adjoining areas find their livelihood in Cardiff. (S. T.-J.)

History.—The origin of the name Cardiff is disputed. The early forms Cayrdyf, Kairdif, Keyrdyf seem to derive from Welsh *caer* ("fort") and *tyf*—mutated to *dyf*—from *tami*, the genitive of a primitive form *tamos*, the Old Welsh for Taf or Taff. The name thus signified the fort of the Taff. The modern Welsh form Caerdydd dates only from about the 16th century. The site was first occupied by a Roman auxiliary fort, enclosed by a ditch and a vallum (rampart), and built about A.D. 75 on the left bank of the Taff, at the crossing place of the main Roman road from Gloucester to Carmarthen, in a campaign against the Silures conducted from the legionary fortress of Caerleon (Monmouthshire). By the 3rd and 4th centuries the fort had been strengthened by the construction of a massive stone circuit wall ten feet thick. this to meet the attacks of sea raiders from Ireland. Traces of these defenses are perceptible at various points along the curtain wall of the castle, and a fine stretch of the original Roman wall, 17 ft. high in one section and about 90 yd. long, was uncovered on the southern side.

With the withdrawal of Roman forces from Britain by the late 4th century, the fort was probably abandoned, but of the fate of the civil settlement which had grown up outside the south gate little is known. Not until the coming of the Normans, about 700 years later, were there renewed signs of occupation, though in the intervening centuries Norsemen made sporadic landings and established occasional trading posts along the neighbouring coasts. Though William I passed through in 1081, the first Norman occupation dates from the years 1090 to 1093, when Robert Fitz Hamon, earl of Gloucester, following the course of the Roman road into south Wales, led an expedition to conquer the Welsh kingdom of Morgannwg. The ruined fort at Cardiff offered a defensible site, and within its circuit Fitz Hamon strengthened the existing embankments and raised a moated mound, surmounted with a wooden palisade, to form a shell keep. This was henceforth the *caput* ("head") of the new Norman seigniory (lordship) of Glamorgan and the chief residence of its lords. About 50 years later the keep was reconstructed in stone, much in its present form. Outside the castle arose the borough where the trade was concentrated; this was the nucleus of modern Cardiff. Within ten years of the conquest burgesses had settled there and before 1147 received from the Norman lord a charter of privileges, later supplemented by other charters, notably the charter of Hugh le Despenser in 1340, granting rights of trade and self-government. A charter of incorporation was granted by James I in 1608. By the end of the 13th century Cardiff had about 400 burgesses. It was enclosed first by an embankment and later by a wall entered by four gates, the main axis extending along High street and St. Mary street from the castle to the south gate of the town near the present main railway station. The guildhall stood in the centre of High street on a plot of land granted by the lord to the townsmen in 1338, and in the same and adjacent streets were held the weekly market and the two annual fairs.

Outside the northwest wall of the castle a Dominican friary was founded by the lord, Richard de Clare, in the year 1242, and later a Franciscan friary arose immediately outside the northeast wall. Both houses suffered dissolution in 1538, the latter being acquired by Sir George Herbert of Swansea, whose son William built on the site the Herbert house (*c.* 1570), now in ruins. Within the town, near the south gate and on the left bank of the Taff, stood the parish church of St. Mary, which during the 12th and early 13th centuries served as a priory of Tewkesbury abbey. From 1607, when the church was seriously undermined by the great flood of the Taff, its importance as the parish church declined, its place being taken by the chapel of St. John the Baptist, reconstructed in the 15th century.

On the death of Robert Fitz Hamon, the castle and seigniory passed to his daughter, who by marriage brought them to Robert the Consul, the natural son of Henry I, and it was during his tenure that his uncle Robert Curthose, duke of Normandy, was confined in the castle from 1126 to 1134. Later the inheritance passed through the families of Clare, Despenser, Beauchamp and Neville to Richard III, on whose death at Bosworth it escheated to Henry VII to be granted to his uncle Jasper Tudor, and in 1550, in the reign of Edward VI, to Sir William Herbert, later created earl of Pembroke. In 1766 the estate passed by the marriage of the heiress of Herbert, Viscount Windsor, to John, earl of Bute, who was created Baron Cardiff in 1776 and marquess of Bute in 1796.

In the time of Gilbert de Clare (1263–95) the domestic apartments in the castle keep were rebuilt, and a powerful interior wall linked the keep with the Black tower to enclose the inner and middle wards. The castle was stormed and much of the town burnt by the Welsh (1404) during the revolt of Owen Glendower (*q.v.*). In the Civil War Cardiff was held for the king, but in 1645 it fell by local agreement to parliamentary control, and royalist forces, besieging it from Raglan in 1646, failed to recover it. With the coming of Lord Bute in the latter half of the 18th century, further steps were taken to improve the castle as a place of residence by the removal of the interior walls. Later, in the time of the 3rd marquess and especially during 1865–75, considerable extensions were made to the existing residential apartments, and an elaborate scheme of interior decoration was carried out under the guidance of the architect William Burges.

(W. RE.)

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CARDIGAN, JAMES THOMAS BRUDENELL, 7TH EARL OF (1797–1868), English general, famous for leading the charge of the light brigade, was born at Hambleden, Buckinghamshire, on Oct. 16, 1797, and educated at Christ Church, Oxford. He entered the army in 1824, at a later age than was then usual, and quickly purchased promotion, becoming lieutenant colonel of the 15th hussars by 1832. A martinet of uncertain temper, he quarreled with his officers, illegally placing one in arrest, and was censured by the ensuing court-martial and forced to give up his command (1834). But in 1836 family influence secured him the command of the 11th light dragoons (renamed the 11th hussars in 1840). He inherited his father's earldom and fortune in 1837. By spending an estimated £10,000 a year from his private purse, he made the regiment the smartest in the service; but again there was trouble because of his severity toward his officers, which led to a duel with one of them, Captain Tuckett, who was wounded. Cardigan faced public anger by demanding trial by his peers and won his case on a technical point of law. He retained command of his regiment until his promotion to major general in 1854.

On the outbreak of the Crimean War (1854) he was appointed commander of the light cavalry brigade, under his brother-in-law the earl of Lucan, with whom he was on bad terms. His brigade saw little action before Oct. 25, 1854, when the celebrated charge of the light brigade took place (*see* BALAKLAVA, BATTLE OF). Although Cardigan queried the ambiguous order from Lord Raglan which originated the charge, he did not hesitate when the order was repeated but led the maneuver steadily and gallantly. The charge so struck the imagination of the British public that Cardigan was lionized on his return to England, where he was appointed inspector general of cavalry. Later when Colonel Calthorpe published a book falsely asserting Cardigan had not led the charge, he sued the author for libel but was nonsuited on a technicality. He died at his home at Deene Park, Northamptonshire, on March 28, 1868, from injuries received in a riding accident.

See Joan Wake, *The Brudenells of Deene* (1953); F. E. Whitton, *Service Trials and Tragedies* (1930). (E. W. SH.)

CARDIGAN (ABERTEIFI), a municipal borough and county town of Cardiganshire, south Wales, lies 28 mi. N.W. of Carmarthen, on the river Teifi, 3 mi. from its mouth. Pop. (1961) 3,780. In 1135 the Cymry (Welsh) defeated the Norman-English forces at Crug Mawr-Banc y Warren, and numerous castle ruins in the Teifi valley bear witness to the battles fought there in the past.

An arched bridge which links the town with Pembrokeshire is said to have existed since 1136. Traces of the 12th-century Norman castle remain in the grounds of Castle Green, which stands on the ancient site. Tradition maintains that the first national Eisteddfod (*q.v.*) of Wales was held within the castle precincts in 1176 when Lord Rhys (Rhys ap Gruffydd) sponsored the festival, which was attended by 30,000 people. A few miles south at Pentre Evan is a pre-Roman burial chamber. Cardigan was first incorporated (1284) by Edward I. When the castle fell to the parliamentary forces in 1645 Jeremy Taylor was among the captured garrison. Mrs. Katharine Philips, the "matchless Orinda" of his *A Discourse of . . . Friendship* (1657), lived at the priory built on the site of a Benedictine house and now a memorial hospital. In 1653 the corporation established a free grammar school which moved to its present grounds in 1898. Since then the school has seen many extensions including a Further Education centre catering to the personnel of the Royal Aircraft establishment at Aberporth, five miles away. Cardigan was the scene of the Rebecca riots (1843), a movement of farmers against the existence of the tollgates, which were subsequently removed. In front of the guildhall, built in 1858–60, is a cannon taken during the charge of the light brigade, which was led by Lord Cardigan in 1854. The town has become a tourist centre, with rail and road communications. The Teifi and its tributaries provide good fishing and there is fine coastal scenery. (T. Ev.)

CARDIGANSHIRE (Welsh Sir Aberteifi or Ceredigion), a county of South Wales, is bounded north by Merionethshire, east by Montgomeryshire, Radnorshire and Brecknockshire, south by Carmarthenshire and Pembrokeshire and west by Cardigan bay and the Irish sea. With an area of 692.7 sq.mi. it ranks fifth in size of the Welsh counties.

Physical Features.—The county, composed mainly of Silurian rocks, with some Ordovician in the higher areas of the northeast, may be divided into two major relief regions, both characterized as erosion surfaces, or plateaus. The first is the high plateau, mainly 1,500–1,700 ft. above sea level, forming an arc parallel to the coast on the eastern edge of the county. From this plateau the Plunlumon or Plynlimon (*q.v.*) range rises to form a group of monadnocks which reach a maximum elevation of 2,468 ft. The coastal plateau rises sharply from the coast to heights of 400–600 ft. In the south the area between these regions is occupied by the upper vale of Teifi and the Mynydd Bach upland (1,000–1,500 ft.); in the north it is made up of well-dissected hill country. This northern region contains metalliferous deposits, widely exploited in the 19th century, mainly of lead, but with some zinc and silver. Such exploitation has ceased. Coastal scenery, because of the coastal plateau, is mainly cliffed, but in the south there is a narrow discontinuous lower platform of boulder clay, while in the extreme north the Borth storm beach is fronted by an extensive development of sandy beach.

The river system of the high plateau is orientated to an old north-south drainage pattern, and valleys are open and shallow. The drainage of the coastal plateau is mainly east-west, and there the streams are more vigorous with well-developed youthful or early mature valleys. As a result, some of the high plateau streams have been liable to capture, and of these the Rheidol, with its spectacular elbow at Devil's bridge, is a classic example. On the northern fringe of the high plateau there are evidences of glaciation in the form of cirques, but elsewhere in the county glaciation was depositional rather than erosional in its effects. Thus much weathered material was removed from the higher areas and deposited as boulder clay on the coastal plateau and in the valleys. Glacial deposition is probably also the explanation for the submerged *sarnau* ("causeways"), *e.g.*, Sarn Cynfelin, which run out at right angles from the coast. Two extensive areas of lowland peat bog are worthy of note: Tregaron bog (Cors Caron) in the Teifi valley, probably a postglacial lake bed, and Borth bog (Cors Fochno), the result of silting behind a postglacial storm beach.

Apart from the immediate coastal area, therefore, the county has two distinct landscapes. The coastal plateau is well dissected, with medium quality farmland developed on heavy boulder clay soils, a landscape which is enclosed and well wooded both with hedgerow timber and small plantations. The high plateau, by contrast, is an open, rolling and often bleak landscape, exposed to strong westerly winds and often suffering from indeterminate drainage. Grassland degenerates from mountain fescue to *Nardus* and *Molinia*, and there are frequent patches of heather moor and upland peat bog. In this area the forestry commission's plantation of conifers are making their greatest contributions to the economy and their chief alterations to the landscape.

The coastal plateau is able to support an average-density rural population, mainly dependent upon milk production and stock raising. The high plateau, whose land is suitable for only large-scale sheep farming or forestry, carries a sparse population and suffered severely from depopulation in the mid-20th century. It was the subject of special surveys both by the Welsh Agricultural Land subcommission (1956) and by the Mid-Wales Development association (1960). Their conclusions stressed the need for the establishment in the area of stable economic conditions which would lead to much needed improvement of rural services. Such economic stability might well involve the reorganization of the traditional family farm and its replacement by economically viable and well-equipped farm units, coupled with an extension of forestry. (J. G. T.)

The Nature Conservancy has declared the following areas as nature reserves: Tregaron bog, Derwen woods in the Rheidol valley, and the woods on the east and west banks of the Rheidol river north of Devil's bridge. It has scheduled as sites of special scientific interest: Cardigan Island, Maes Goleu bog, Allt Wen, Towy valley, Craig-y-Filfran, Borth bog, Twyni Mawr and Dovey marshes, Figyn Blaen Brefi, the valley of the Rheidol from Parson's bridge to Ponterwyd, and the Llyfnant valley.

Prehistory and History.—As in other regions of western Britain, the earliest remains of man are found on the high ground, which in the north and south is dotted with tumuli and cairns. The finds of the Bronze Age are not numerous but include a number of stone battle-axes. They are all on the western side, marking possible trackways from the interior as well as ways in from Ireland. One of the most conspicuous features of northern Cardiganshire is the large number of hilltop camps supposedly of the pre-Roman Iron Age "B." They seem to be associated with the metalliferous veins in the north and guard important landing places on the coast; *e.g.*, at Pendinas, Aberystwyth and Llanrhystud. There are traces in the eastern part of the county of a Roman trackway, known as Sarn Helen, which seems to have run via Pontllanio through the hills to Carmarthen. The post-Roman centuries were marked by numerous raids, especially from Ireland upon the open coast, perhaps aimed at the mineral wealth. The place-name "Gwyddel" (Irish) occurs frequently in the region behind the open coast. Raids were long continued and later included Scandinavian elements from their settlement at Dublin.

Counteracting, as it were, this movement of destruction was the civilizing and Christianizing influence of the Celtic saint movement which seems to have been a special feature of this county. Llanddewibrefi, a village in the centre of the county, is said to have been the headquarters of St. David, the patron saint of Wales; while St. Padarn founded Llanbadarnfawr (1 mi. E. of Aberystwyth), which in the 8th century became merged in the see of St. David's. A memorial of these days is the church of Ysbytty Cynfyn (14 mi. E. of Aberystwyth). In its churchyard walls are included megalithic stones which once formed part of a stone circle; this illustrates the continuity of tradition which is an important feature of the far west.

In post-Roman days the whole basin of the Teifi is said to have fallen to the power of Ceredig, son of Cunedda Wledig of north Wales, and the name of the present county was derived from Ceredig's name. Norman penetration of hilly Cardiganshire was slow. The county was granted, it is said, in 1110 to Gilbert Fitz-Richard of Clare, and its history during the 12th and 13th centuries is one of a long series of skirmishes between the Normans, who sought to keep open the valley lines of communication, and the Welsh herdsmen among the hills. The unsettled state was such that in the early 15th century Owen Glendower actually held a court in Aberystwyth castle. The Cistercian abbey of St. Mary at Strata Florida, founded by Rhys ap Gruffydd (first extant charter 1184) continued to be influential during the periods of Welsh independence. By the Statutes of Rhuddlan (1284) Edward I constituted Ceredigion out of the former principality of Wales as a shire on the English model, dividing the new county into six hundreds (ancient territorial divisions) and fixing the assizes at Carmarthen. By the Act of Union, in the reign of Henry VIII, the boundaries of the county were enlarged to their present size by the addition of outlying portions of the marches around Tregaron and Cardigan, and the assizes were assigned to the county town. Under Henry VIII the county was first empowered to send a representative to parliament, and under Mary I the same privilege was extended to the boroughs.

During the Civil War the castles of Cardigan and Aberystwyth were held for Charles I and reduced to ruins by the Cromwellian forces. The county became in the 18th century the centre of the Methodist movement, which seems to have had its greatest influence among the shepherds and cattle herders of the moorland. Daniel Rowlands (1713–90), the curate of Llangeitho, a village almost in the centre of the county, became one of the chief leaders in this important movement.

Population and Administration.—The area of the administrative county is 692.7 sq.mi., and its population in 1961 was 53,648. The municipal boroughs are Aberystwyth (10,427), Cardigan (3,789) and Lampeter (1,855; *qq.v.*). Aberayron (1,209) and New Quay (954) are urban districts, and there are 4 rural districts and 72 parishes.

Aberystwyth is the home of the founder college of the University of Wales, the National Library of Wales, the Welsh secretariat of the ministry of agriculture, fisheries and food, the Welsh directorate of the forestry commission, the Royal Commission on Ancient Monuments in Wales and Monmouthshire and the main offices of the county council. Nearby are the plant breeding station at Gogerddan and the Welsh agricultural advisory service at Trawscoed. Quarter sessions and the assizes for the county are held at Lampeter. There are 11 petty sessional divisions. The county council holds its meeting in Aberayron. The county lies wholly in the diocese of St. David's.

The difficulties of communication between England and Cardiganshire enabled the county to retain the Welsh language to such an extent that it is still predominantly Welsh-speaking. The use of Welsh is encouraged in the schools, and Welsh books are produced in Aberystwyth and Llandyssul. Cardigan, the birthplace of the Welsh Eisteddfod (*q.v.*), holds a seminational Eisteddfod each year in May.

The Economy.—The 17th and 18th centuries saw the coastal towns and villages, especially Cardigan, Llangranog, Tresaith, Aberporth, New Quay, Aberayron, Aberystwyth and Borth, enjoy a brisk coastal trade, chiefly with Bristol. Because of difficult landward communications almost all imported material came by sea. Fishing, always important, continues on a small scale, while many places have become summer resorts for the English Midlands and south Wales. The export trade as well as the general prosperity of the northern half of the county was increased between 1830 and 1880 by the extensive mining of lead. The mines were worked intermittently for centuries, possibly from prehistoric days, but they reached their last maximum about 1870 when, because of difficulties of railway transport, obsolete machinery and the importation of foreign ores, the industry dwindled and almost passed away. Many families migrated to south Wales, and others turned to the scanty pastoral resources of the moorlands.

The unsettled state of agriculture in the mid-19th century produced in Cardiganshire great activity during the Rebecca riots (*q.v.*), as well as political agitation against the payment of tithes and general evictions (1864). The great movements of the Industrial Revolution affected Cardiganshire adversely. It ultimately destroyed local industries and seafaring activity and caused the county's greatest export henceforth to be men and not goods. Many left to become milk vendors and drapers in the cities, particularly London. The only industry that escaped complete extinction was weaving, at Talybont in the north and in the lower Teifi valley, where the water is especially suitable for weaving processes.

The Rheidol Hydroelectric project in the north, the Royal Aircraft establishment at Aberporth, near Cardigan, the Milk Marketing Board factory at Felinfach, Ystrad Aeron in central Cardiganshire, and the Teifi Pools Water scheme, in the Tregaron area, are the most important mid-20th century industrial developments. Continuing depopulation (accelerated by the mechanization of agriculture) is the most serious social and economic problem. The Mid-Wales Industrial Development association, comprising representatives of the Cardigan, Brecknock, Radnor, Montgomery, and Merioneth county councils, and with the co-operation of the University College of Wales, Aberystwyth, has endeavoured to attract light industries into the area of the five counties. The county has long been celebrated for its breeding of Cardiganshire corgi dogs and horses (particularly Welsh cobs). The monthly horse fairs at Llanybyther, just over the border in Carmarthenshire, are well attended by English and Welsh dealers. There are several small packs of foxhounds in the county. Tregaron is a centre for pony trekking. There is considerable fresh-water fishing in the rivers and lakes; coracle fishing is still practised on the Teifi.

Aberystwyth is the terminus of the railway from Shrewsbury, and of that from Carmarthen via Lampeter and Tregaron. Secondary lines for freight traffic run from Pencader to Aberayron. Cardigan town is reached by a branch line from Whitland, Carmarthenshire. There is a miniature line from Aberystwyth to Devil's bridge. (J. E. R. C.)

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CARDINAL, the title of members of the pope's senate; they are his electors, his counsellors, and his immediate collaborators in the government of the Roman Catholic Church, especially those who serve as *legati a latere* (papal envoys; extraordinary legates) or as heads of the sacred congregations, tribunals, or other important departments of the Curia Romana. The cardinals were granted the privilege of wearing the red hat by Innocent IV in 1244 or 1245; it has become their symbol. The scarlet robe, which still forms their costume of ceremony, was already being worn by cardinals performing the functions of legate, and its use was soon extended to all. They were granted the official style of "eminence" by Urban VIII in 1630.

In the early years of the church the Latin word *cardinalis*, from the verb *incardinare* ("to hinge upon"), was adopted to indicate the incorporation of a priest, or a bishop, to a church (diocese in the modern sense of the word) for which he had not been ordained. It is for this reason that the expressions "cardinal bishop" and "cardinal priest" often occur in papal letters and other documents from the 6th to the 8th centuries.

In Rome the first persons to bear this title were the seven regional deacons (bishops of the seven sees surrounding Rome) at the beginning of the 6th century, when the word began to have the meaning (a very different one from the original) of "principal," "eminent," "superior," referring, therefore, to a person in authority. From that time onward, the adjective "cardinal" gradually became a noun.

In the 8th century the Roman cardinals already constituted a privileged class among the Roman clergy, not only because of the important part they took in the administration of the church of Rome and in the papal liturgy but chiefly because, by decree of a synod of 769, only the "cardinal" deacons and priests could become pope. Besides, from the 9th century the ordination of cardinal priests or deacons was performed with special rites not used for their colleagues, priests known as *forenses* ("belonging to the country")—that is, those who ministered outside Rome. The cardinal bishops reached their highest dignity when the power to elect the popes was assigned exclusively to them. The third Lateran Council, in 1179, gave back the right of electing the popes to the Sacred College of Cardinals as such.

In order to enhance the prestige of the cardinals, the popes took care that the Sacred College should be frequently reformed and kept up to date. In this they were helped by eminent saints such as St. Peter Damian, and by the general councils, such as the Council of Trent. The reforms that brought about real development in the history of the College of Cardinals were those of Urban II, Sixtus V, John XXIII, and Paul VI, as described below.

Cardinals of Cities Other Than Rome.—In cities other than Rome, the adjective cardinal began to be applied, at a time when it was losing its original meaning, to certain ecclesiastics as a mark of honour, conferring on them the right to wear certain liturgical vestments and to hold a special place in the local hierarchy. The earliest example of this occurs in a letter sent by Pope Zacharias in 747 to Pepin the Short, which applies the adjective cardinal to the priests of the city of Paris to distinguish them from country clergy, and refers to the garments they should wear "according to their dignity." This new meaning of the word cardinal spread rapidly, and from the 9th century, various episcopal cities had priests, archdeacons, deacons, and subdeacons called cardinal, forming a separate class among the clergy. Such cardinal clergy existed, for instance, at Orléans (871), Milan (879), Nevers (903), Lucca (904), Bergamo (908), and Asti (924); and at Ravenna (998) they even had *tituli* ("titles") as at Rome (*see* below). Letters of Pope John VIII (879) show that at Constantinople and at Milan only a cardinal priest or deacon could be elected patriarch or archbishop, according to the practice established at Rome a century before. In 1012 Pope Benedict VIII honoured the bishop of Magdeburg by including him "among the cardinal bishops to have association with our see," thus putting him on a level with the bishops of Cologne, Mainz, and Trier.

In the second half of the 10th century the adjective cardinal took on a liturgical significance when some churches received from the pope the privilege of having, "as the church in Rome does," a fitting number of cardinal priests, deacons, and sometimes even subdeacons, so as to make their celebration of the papal Mass more solemn, with the wearing of dalmatic, tunic, and sandals. Such "liturgical cardinals" sometimes also had the privilege of a special altar. The earliest references to them are from Magdeburg (968), Trier (975), Aachen (997), Besançon (1051), Cologne (1052), and Compostella (1108). At St. Paul's Cathedral in London, two minor canons with special functions were called "cardinal" from the 14th century.

The title of cardinal in cities other than Rome was abolished, according to V. Martin (see *Bibliography*), in 1567 by Pius V, who reserved it thenceforth for the cardinals of Rome only.

The College of Cardinals at Rome.—The *consortium* or, as it was called by the 12th century, the *collegium* of cardinals, which comprised three orders of cardinals, had its origin in the reform of Urban II. The formation of the Sacred College suffered radical changes during the time when the popes lived at Avignon and during the Great Schism. From this time, the question of the internationality of the Sacred College was imposed with great insistence, and it was especially provided for by Sixtus V and his successors. The qualifications for becoming a cardinal, frequently laid down by popes and councils from the 11th century onward, were codified by Sixtus V in his constitution *Postquam* of 1586 and by the Code of Canon Law (canon 232).

Cardinal Bishops.—The cardinal bishops are the direct successors of the bishops of the sees just outside Rome. There were seven of these sees at about the middle of the 8th century, and their holders had the right to perform the weekly liturgical services in the Church of St. John Lateran. Pope Stephen III (or IV; 768–772) then gave the same seven bishops the right to celebrate the Sunday Mass on St. Peter's altar with the inclusion of the *Gloria in excelsis,* which could normally be sung only by the pope and by bishops celebrating Mass in their own sees. These seven bishops continued to celebrate Mass at the papal altar in the Lateran till the 13th century.

The oldest complete list of their sees is found in the acts of the Roman synod of 745, which mention the bishops of Silva Candida, Nomentum, Praeneste, Porto, Gabio, Ostia, and Velletri. The sees of Nomentum, Gabio, and Velletri soon disappeared, however, and the oldest example of the traditional list of the seven cardinal bishops is in a description of the Lateran church, the first edition of which goes back to the time of Paschal II (1099–1118). It refers to the bishop of Ostia, "who should perform consecrations and give the apostolic benediction before all the others," and to the bishops of S. Rufina, Porto, Albano, Tusculum, Sabina, and Praeneste. The bishop of Ostia (to which see that of Velletri was apparently joined by Eugenius III *c.* 1150) had had since the 4th century the honour of consecrating the pope. (The see of Ostia is now always assigned to the dean of the Sacred College.) Calixtus II (1119–24) joined the see of S. Rufina to that of Porto, so that the seven cardinal sees were reduced to six, the number recognized by Sixtus V in his constitutions *Postquam* (Dec. 3, 1586) and *Religiosa* (April 13, 1587) and in the Code of Canon Law (canon 231).

Up till 1962 each of the cardinal bishops had full jurisdiction in his own see (canon 240). But by the *motu proprio* (*i.e.*, an order issued personally by the pope) *Suburbicariis sedibus* (April 11, 1962) of John XXIII, these bishops preserved only the title without any of the functions, which passed to the suffragan or auxiliary bishop actually resident in each individual see, enumerated thus in the *motu proprio:* Albano, Ostia, Porto and S. Rufina, Palestrina, Sabina and Poggio Mirteto (Mandela), Frascati (Tusculum), and Velletri. Although seven sees are named, there were still only six cardinal bishops, because the dean of the Sacred College always assumes the see of Ostia while retaining the see he already holds.

Paul VI, in a *motu proprio* of Feb. 26, 1965, *Sacro cardinalium consilio,* made new regulations whereby the cardinal bishops elect their dean and subdean, a choice which is then approved by the pope. Further, Paul VI, who decided to create cardinals from among the Eastern Catholic patriarchs, arranged by his *motu proprio* of Feb. 11, 1965, *Ad purpuratorum patrum,* that such patriarchs should become cardinal bishops on the title of their patriarchal sees. The number of cardinal bishops was thus no longer limited to six.

Cardinal Priests.—The second and largest order in the Sacred College is that of the cardinal priests, the successors of the early body of priests serving the church in Rome. They performed on the pope's behalf all the pastoral duties necessary to the spiritual administration of the city, or represented the pope as legates in other churches or before a secular authority. They sat on the synod and carried out their ministry in the *tituli,* which can be best explained as parishes or parish districts in the one great city parish presided over by the pope. The senior priest in the *titulus* was first called prior and then later cardinal in the sense of "principal." The *Liber Pontificalis* mentions 25 *tituli* before the middle of the 6th century, and many of these had been in existence since the 4th or even the 3rd. Pope Simplicius (468–483) entrusted the weekly services of the basilicas of St. Peter, St. Paul, and San Lorenzo, respectively, to the priests of the 3rd, the 4th, and the 6th or 7th ecclesiastical regions of the city; later this liturgical system was extended to Sta. Maria Maggiore, also. In the 12th century there were seven liturgical cardinals in each of the four churches.

Sixtus V by his constitutions *Postquam* and *Religiosa* increased the 28 *tituli* to 50, the number thereafter specified by canon 231. Both John XXIII (Dec. 15, 1958) and Paul VI (Feb. 22, 1965) departed from this canon by increasing the number of cardinal priests and by creating new titular churches in Rome.

The order of cardinal priests since the 11th and 12th centuries has always been much more conspicuously international than the orders of cardinal bishops and deacons, since all the bishops or archbishops throughout the world who are made cardinals become cardinal priests. The bishops formerly proposed as cardinals by the courts of Austria, Spain, and Portugal (the so-called crown cardinals), according to a custom that apparently went back to Clement V (1305–14), were generally created cardinal priests.

The archbishops of certain sees in Italy (*e.g.*, Milan, Venice) and elsewhere (*e.g.*, New York, Paris, Westminster, Munich) are traditionally created cardinal priests, and a cardinal priest is usually made vicar of Rome, to govern the diocese of which the pope is the bishop.

Cardinal Deacons.—The seven regional deacons of Rome are called cardinal deacons in the *Constitutum Silvestri*, a 6th-century apocryphal document purporting to date from the reign of Silvester I (314–335). They cared for the needy in the seven ecclesiastical regions into which Fabian (236–250) had divided Rome. These deacons and their works of charity have nothing to do with the *diaconiae* (deaconries) first established in Egypt in the 4th century and then in the East and in the West up to the 9th. In Rome these were fashionable from the end of the 7th until the 9th century, reaching their full development during the pontificate of Leo III (795–816), at whose death there were 24, including the suburban ones. There were 18 *diaconiae* within the city, and their churches became parish churches in the 10th–11th centuries. The reform of Urban II (1088–99) assigned one of these churches to each of the 18 cardinal deacons, divided at the time into 6 palatine deacons and 12 regional deacons, with an archdeacon at their head. From then onward the Sacred College was definitely constituted from the three orders (*i.e.*, of cardinal bishops, cardinal priests, and cardinal deacons) still existing. Urban II discontinued the cardinal subdeacons, whose names appear in several documents of the 11th century. It is to be noted, too, that some ecclesiastics were created cardinals without being even deacons, as in the case of Jules Mazarin, who was an ordinary tonsured cleric.

The number of cardinal deacons was reduced to 14 by Sixtus V in the constitution *Postquam*, and the 14 churches to which they were attached were decided upon in the constitution *Religiosa*. Previously the order of cardinal deacons had been limited to those who had actually advanced no further than the diaconate, but from then onward priests were also eligible, until by a *motu proprio* of John XXIII, *Cum gravissa* (April 15, 1962), all the cardinal deacons had to be bishops. The last cardinal deacons to be in fact merely deacons were Giacomo Antonelli (d. 1876), secretary of state to Pope Pius IX, and Teodolfo Mertel (d. 1899).

Creation of Cardinals.—Cardinals are nominated by the pope alone, the term "creation" being exactly appropriate to this spontaneous act of the pontifical will. Throughout the centuries the attendant ceremonies have undergone various changes. Paul VI modified the ceremony of investiture in order to give it the religious significance that it had previously lacked. On Jan. 25, 1965, the Vatican newspaper *L'Osservatore Romano* published a list of 27 new cardinals whom the pope was to create in the next consistory. Then on Monday, Feb. 22, the pope held a secret consistory in which he created the cardinals; notice of their nomination was delivered immediately, in the customary manner, to the cardinals elect, who on the same day and the next one received complimentary visits.

Before 1965 the pope held the secret consistory and gave the cardinal elect his biretta on Wednesday and then on Thursday held the public consistory for the bestowal of the red hat; immediately after this, in a secret consistory, he assigned to each one his *titulus* or *diaconia*. In 1965, however, the pope combined Wednesday's and Thursday's events into one large liturgical function in St. Peter's as follows: (1) concelebration of Mass by the pope together with all the new cardinals; (2) after the Prayer of the Faithful, the new cardinals' profession of faith (recital of the Apostles' Creed); (3) the new cardinals' oath of fidelity followed by the granting to each of his *titulus* or *diaconia;* (4) a brief address from the pope in various languages; (5) after the Mass, bestowal of the ring and biretta by the pope, with appropriate formularies; and (6) the singing of the *Te Deum*. The red hat was sent privately to the residence of each cardinal.

Sometimes the pope announces in the consistory that he has nominated one or more cardinals whose names he does not reveal; these are known as cardinals *in pectore* ("in his breast"). When the pope does announce the names, such cardinals date their seniority from the moment they were nominated *in pectore*, but all their other privileges begin only on the day that their names are revealed (Code of Canon Law, canon 233, § 2). If the pope should die before revealing their names, the promotion is void.

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(A. P. Fr.)

CARDINAL (*Richmondena cardinalis*), a favourite American bird of the family Fringillidae (grosbeaks, finches, sparrows and buntings).

The male is a crested red bird seven and one-half to nine in. long, with black at the base of the red bill and a black throat. Its cheerful, varied, whistling song can be heard throughout the year, and in the winter its red plumage makes a startling contrast when snow is on the ground. The female also sings, though more softly. Her plumage is grayish-olive above and pale buff below, with a strong tinge of red on crest, wings, tail and bill. The nest is loosely built at varying heights in a tree, bush or vine and usually has three whitish eggs marked with shades of brown and purple.

JOHN H. GERARD

CARDINAL (RICHMONDENA CARDINALIS) OF EASTERN, CENTRAL AND SOUTHWESTERN U.S.

The type species ranges over most of the United States and southeastern Canada. Six other subspecies range into Mexico. Males in the subspecies differ mainly in size and depth of colour. The females show the greatest variation. In the gray-tailed cardinal (*R. c. canicaudus*) the gray tail is peculiar to the female.

Cardinals feed mainly on seeds and fruits, but almost 30% of their food consists of noxious insects. Cardinals are not migratory. They have been introduced into Bermuda and Hawaii.

(K. P.)

CARDINAL FLOWER (*Lobelia cardinalis*), a late-flowering herbaceous perennial of the lobelia family, widely distributed in eastern North America. It grows in moist rich soil, often on muddy banks, from southern New Brunswick and Ontario westward to Colorado and south to Florida and Texas, blooming in late August or September. The plant, which attains a height of from 4 to 6 ft., bears a large cluster of showy, intensely red flowers, each about an inch long with a three-divided lower lip and a slender upright portion. This plant is one of the most handsome of North American wild flowers.

J. HORACE MCFARLAND CO.

CARDINAL FLOWER (LOBELIA CARDINALIS)

See also LOBELIA.

CARDINALS, COLLEGE OF: *see* CARDINAL; VATICAN.

CARDING, the process of using the card for combing textile fibrous materials. It consists in combing or brushing fibres until they are straight and placed in parallel lines; in doing this, imperfect fibres are separated, impurities are removed and sound fibres are in condition for further treatment. The bracted flowers of the teasel once used gave place to hand cards, which were essentially wire brushes, and these to stock cards. Mechanization of carding began in the 18th century; Sir Richard Arkwright introduced an automatic carding machine, and the process remains essentially the same as established by him.

See COTTON MANUFACTURE; JUTE; WOOL.

CARDOON (*Cynara cardunculus*), a thistlelike perennial herb of the composite family (Compositae; *q.v.*), from southern Europe and north Africa; it is a near relation of the artichoke (*q.v.*). The edible part, the chard (not to be confused with Swiss chard or leaf beet), is composed of the blanched and crisp stalks of the inner leaves. (The common artichoke is also used for the production of chard.) Besides the common and Spanish cardoons, there are the prickly leaved Tours cardoon, the red-stemmed cardoon and the Paris cardoon, all of superior quality, the Paris being the largest and most tender. The species was introduced into South America and spread over great areas of the pampas.

CARDOZO, BENJAMIN NATHAN (1870–1938), U.S. judge and jurist, important for his emphasis upon the role of the judicial process in the creation of law, was born May 24, 1870, in New York, N.Y., where he studied arts and law at Columbia university. In 1891 he was admitted to the bar. For 23 years he practised in court and office with skill matched only by carefulness in matters of fact and decency. Hardly had he been elected justice of the supreme court of New York in 1914 when he was pressed for appointment to New York's highest court, the court of appeals. In 1926 he became chief judge on that seven-man bench. In 1932, on Oliver Wendell Holmes's retirement from the U.S. supreme court, Cardozo was appointed his successor by Pres. Herbert Hoover, who acted upon the advice of Sen. William E. Borah of Idaho in disregarding possible political objections to Cardozo (there were already two New Yorkers and one Jew on the supreme court). Cardozo served through the New Deal turmoil, until his death on July 9, 1938, at Port Chester, N.Y.

Cardozo's influence was powerful in wisely reshaping legal doctrine to modern need. It was even more influential in reshaping the whole manner in which appellate courts in the U.S. handle their vital work. Long before he left the New York bench he had wrought it into the most forward-looking state court, with traditions of outlook and craftsmanship which continued beyond his time. In 1914 it had been standard thinking that a court's business was never to make but only to find the law, and that neither court nor written opinion had any concern with policy. In consequence, the appellate courts' duty to justice was partly concealed and partly botched, and the ongoing job of slow, steady judicial revision, needed to keep law abreast of changing times, had lamed. Cardozo became the most striking single figure in the general recapture by the appellate bench of that grand tradition of conscious and continuous re-creation of legal doctrine which had characterized U.S. law before 1865. Partly he did this by way of general writing. He spoke not as a heretic from outside but from orthodox experience on a respected bench and with constant instances from cases in whose decision he had shared. He examined on four successive occasions between 1921 and 1932 (*see* below) the problems, processes and limits of judicial creation. He not only made such creation respectable and interesting but also showed how to hold it within sharp and needed control.

Two matters his essays missed. Of the first Cardozo was never aware. That is the degree to which a reshaping of authorities takes place in any lawyer's mind without conscious effort, as they simply fall into line to produce an "obvious" result. The second has to do with one of his major labours as a judge, the duty whose performance he lived, but which was to him so obvious that he never developed it in commentary: that is, the burden resting on the sound appellate judge to build the law he works with into a phrased, guiding whole, and to clean up the older authorities behind him, each time, for a neat, fresh start.

In this aspect his teaching must be derived from his opinions. Thus in the famous *MacPherson* v. *Buick Motor Co.*, 217 N.Y. 382 (1916), which established the right of a consumer to sue for injury caused by negligence of a manufacturer with whom the consumer had no "direct contractual" relation, 65 years of confused case authorities were picked up, cleaned up and removed from need of further consultation. Thus again, in *Ultramares Corp.* v. *Touche*, 255 N.Y. 170 (1931), Cardozo limits with candour and clarity that responsibility to third parties for negligent misrepresentation which he had himself initiated in *Glanzer* v. *Shepard*, 233 N.Y. 236 (1922). On the supreme court he voted consistently with the liberal group but with a steady concern for forming and phrasing theory that might guide the court in its future decisions. He built with care and caution and with a passion for the general welfare which few have matched. His theory about legitimate legislative classification was peculiarly valuable. An example is his dissent in *Liggett Co.* v. *Lee*, 288 U.S. 517 (1933). Perhaps his most striking majority opinion was that in the early *Great Northern Railroad Co.* v. *Sunburst Oil & Refining Co.*, 287 U.S. 358 (1932), which followed up his general interest in appellate judging by declaring constitutional a court's following an old authority while announcing that in any future case it will treat that authority as overruled.

Cardozo had a grace, care and power in language which made him one of the few great American legal stylists. He had a personal beauty in his life which has probably never been matched on the U.S. bench. His greatest judicial contemporary, the tough-minded Learned Hand, said: "He was wise because his spirit was uncontaminated, because he knew no violence, or hatred, or envy, or jealousy, or ill-will. I believe it was this purity that chiefly made him the judge we so much revere; more than his learning, his acuteness, and his fabulous industry." Cardozo's writings on appellate judging are *The Nature of the Judicial Process* (1921); *The Growth of the Law* (1924); *The Paradoxes of Legal Science* (1928); and, in culmination, the neglected paper on *Jurisprudence* (1932)—all in Margaret Hall (ed.), *Selected Writings* (1947). He also wrote *Law and Literature and Other Essays* (1931).

See especially the joint issue of the *Columbia, Harvard* and *Yale Law Reviews* (Jan. 1939), and the biography by Felix Frankfurter in *Dictionary of American Biography*, supp. ii (1958). (K. N. L.)

CARDS, PLAYING. For at least 600 years in Europe and for many centuries more in oriental countries playing cards have been a principal implement of gaming, conjuring and divination. They were important in early iconography and have been much used as an aid in education. During the 20th century they have served chiefly as equipment for casual pastimes.

The Origin of Playing Cards.—The history of playing cards has engaged the attention of more or less serious students since the 17th century and there is a large literature on the subject. However, the apparent anxiety of these students to establish a definite time and place for the "invention" of playing cards persuaded most of them to credit legends unduly and construe obscure sources to suit their own conjecture. For example, the assertion has been made that playing cards were invented in China for a concubine of the emperor S'eun-ho, A.D. 1120, the source adduced being a Chinese encyclopaedia of 1678. Yet T. F. Carter in *The Invention of Printing in China* (1925) cites a reference to playing cards in China A.D. 969.

Long before that (early in the T'ang dynasty) the Chinese had paper money which Chinese cards so resembled in design that their respective times of emergence could hardly have been long separated. Originally the cards and money may have been identical or, since in many societies gaming implements preceded money, either may with equal likelihood have engendered the other. In fact, controversy over the origin of playing cards has tended to divert opinion from the logical inference that playing cards were probably coeval, or nearly so, with the graphic arts in all countries where those arts emerged, and so could have originated among any or all the peoples—Egyptians, Arabs, Hindus, Chinese—to whom, variously, their invention has been credited.

The first use of playing cards was at least as much for divination (*q.v.*) as for gaming and may be identified with religious rites and symbols. The passage about playing cards in China referred to by Carter is concerned with an augury drawn from cards. Stewart Culin showed that the designs of the earliest Korean cards —which, he believed, antedated the Chinese "money cards"— were derived from the divinatory use of the arrow. Hindu cards had ten suits, representing the ten incarnations of Vishnu. Through the middle ages playing cards were used in both Europe and Asia for fortune telling, and this practice has continued. Catherine P. Hargrave (see *Bibliography,* below) draws attention to the fact that a Saracen card game introduced into Italy in the 14th century was called *naib* (possibly the etymological source of *naipes,* the Spanish word for playing cards) and that *naibi* in Hebrew means "sorcery."

The time and place of the introduction of playing cards into Europe are no less matters of controversy than the origin of cards. That they were carried home by returning crusaders, or were introduced into Spain or Italy by the Saracens, or were brought into eastern Europe by gypsies or by Tatars are some of the theories that have won support. If any of them is correct Europe has known playing cards since the 13th century.

However, supposed references to playing cards in a German manuscript of about 1300 and a French poem of 1328 are disputed. The earliest undisputed references are of the late 14th century, and at about the same time in different countries: Germany 1377, Italy 1377, Luxembourg 1379, France 1382, Spain 1387. While this does not disprove an earlier existence of playing cards in Europe, it is argued that, for example, Dante's failure to mention them is significant, just as a similar omission by Chaucer indicates a comparatively late start for cards in England.

The Tarot Deck.—It is conceded that the earliest cards made in Europe were the tarots (called also, collectively, the Tarot) and that they were indigenous to Italy. The tarots were picture cards, as distinguished from the cards brought in from the east, which were divided into suits and numbered as are modern cards. There are 22 tarots. Twenty-one of these are numbered, 1 to 21, and are allegorically representative of material forces, natural elements, virtues and vices; the 22nd, unnumbered, is *il matto* (in French, *le mat*), the fool—precursor of the joker. W. M. Seabury in *The Tarot* (1951) related the themes of the tarots to the symbolism of Dante's *Divine Comedy.* If he was correct, the tarots cannot have originated earlier than 1320. A modern instance of the use of the symbolism of the tarot deck is in T. S. Eliot's poem *The Waste Land.*

The tarots were apparently used first for fortune telling and remain the favoured cards of professional fortune tellers. Sometime during the 14th century they were combined with 56 number cards of the oriental kind, making a 78-card deck, with which was played the earliest form of a game (Italian *tarocchi,* German *Tarok,* French *tarot* or *tarau*) still popular in central Europe. The 22 tarots were called *atouts* ("trumps") or *naibes.* The 56-card deck had four suits, probably modeled on the four suits of Chinese cards (coins, strings, myriads, tens of myriads). In each suit there were four coat cards (court cards or face cards), the king, queen, knight and knave or page, and ten numbered cards from 1 (ace) to 10. (*See* also TAROT.)

Later Decks.—From these 56 cards evolved many shorter decks, most of them still in use. In Italy and Spain the standard deck became 40 cards, each suit having ace, 2, 3, 4, 5, 6, 7, knave, queen or knight and king. The Germans developed 32- and 36-card decks, each suit having ace, 7, 8, 9, 10 and, respectively, three or four face cards. The French adopted the 32-card deck plus a 52-card deck (ace to 10, knave, queen and king in each suit) that became standard in English-speaking countries. The suits had different names and often different symbols in the various countries. The English adopted the French symbols but gave them different names; the French ♤ (*pique,* "pike") looked like a spade to the English; the French ♢ (*carreau,* "square") became the English diamond, and the French ♧ (*trèfle,* "trefoil") became the English club. The traditional suit designations are:

English	*French*	*German*	*Spanish*	*Italian*
spade	*pique*	*grün* ("leaf")	*espada*	*spada* ("sword")
heart	*coeur*	*Herz*	*copa* ("cup")	*coppa* ("cup")
diamond	*carreau*	*Schelle* ("bell")	*oro* ("gold")	*denaro* ("money")
club	*trèfle*	*Eichel* ("acorn")	*basto*	*bastone* ("rod")

However, the spread of games such as whist and piquet (*qq.v.*) made the 52- and 32-card decks and the French names current among card players throughout the world.

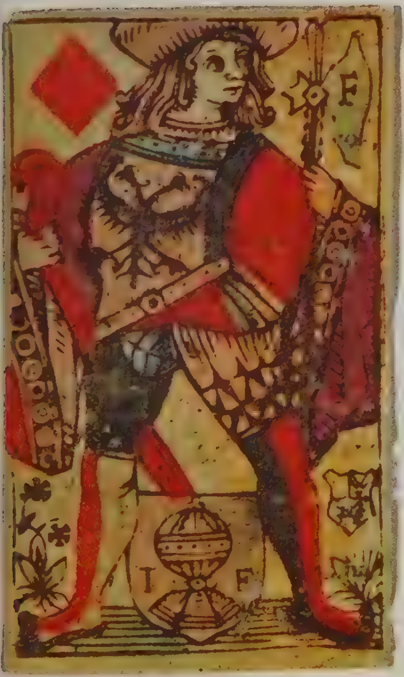
Manufacture and Sale of Playing Cards.—The earliest European cards were elaborately hand painted and were too costly for general use, but early in the 15th century wood engraving found its principal expression in the printing of playing cards, and they spread rapidly among the common people. Games of cards may have been late in reaching England, but by 1463 the English card makers petitioned for and were awarded a prohibition on the importation of playing cards. The wood-engraved cards were often coloured by means of stencils and dyes, a process of manufacture that remained in common use for more than 350 years.

For centuries playing cards have been made of pasteboard, for only the paste can make them properly opaque. In modern plants they are either printed or lithographed (usually the latter) one or two packs to the sheet, each pack comprising 52 cards plus 2 jokers. Early cards were either square, extremely oblong or (rarely) round and, in some cases, as large as 6 × 4 in.; the popular modern sizes are 3½ × 2½ in. and 3½ × 2¼ in. The cards are die cut, with rounded corners, from the large sheet; then scraped, sanded and sometimes lacquered or gilded on their edges. Every card manufacturer employs secret refinements on this process. After 1934 some cards were printed on plastic (usually acetate cellulose) material.

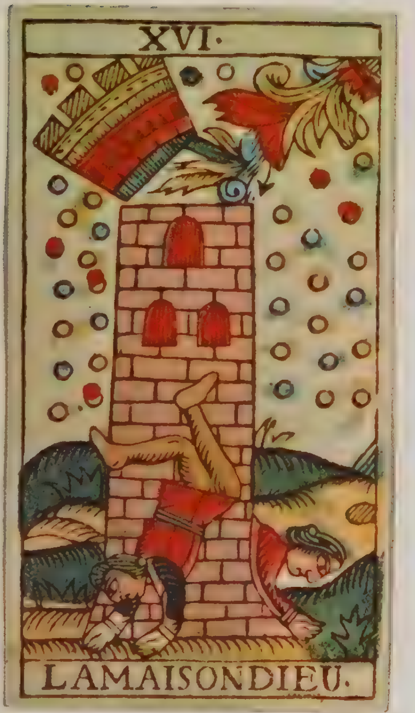
The annual sale of playing cards can be accurately ascertained in nearly every country from tax records, but fluctuations are due more to economic conditions than to the volume of card playing. In the U.S. in the early years of the 20th century, 30,000,000 to 40,000,000 decks were sold each year, with sales reaching 54,000,000 in 1929. During the depression of the 1930s card playing increased (because it was an inexpensive diversion) but the annual sale dropped below 40,000,000, since cards were less often replaced. In 1941 the sale reached 54,000,000 again and during World War II approached 100,000,000, of which about 30,000,000 decks were distributed free to servicemen. After World War II the sale remained fairly constant at 60,000,000 to 70,000,000 per year. In the United Kingdom during the same period the annual sale was 5,000,000 to 11,000,000 decks.

Taxes on playing cards are almost universal. In France and Spain their manufacture is a state monopoly. In England a patent to collect a duty on playing-card imports was granted in 1615 by James I to Sir Richard Coningsby; the first internal tax came in 1628, when Charles I agreed to bar all imports and the manufacturers paid 2 *s.* per gross of packs to the crown and 1 *s.* to the collector, one farthing per pack in all. This tax was gradually increased until in 1828 it had reached half a crown per pack. After 1765 the tax stamp had to be printed on the ace of spades, whence the tradition of the ornate design of that card. After 1828 the tax was reduced to a moderate figure. In the United States playing cards have been taxed since 1894.

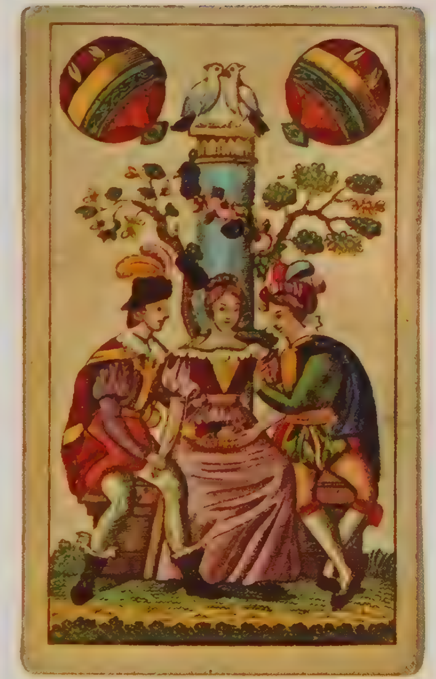
Card Design.—The evolution of playing-card design has been



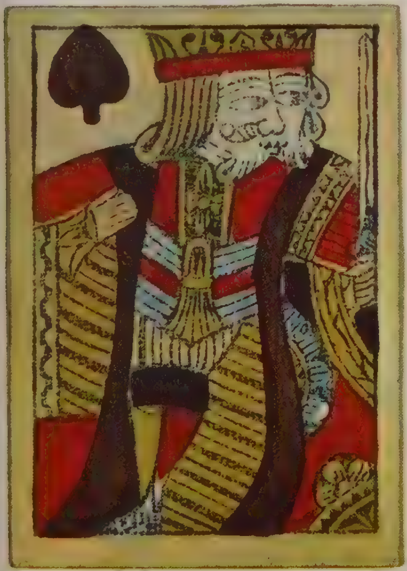
The knave (jack) of diamonds from a French "Portrait de Rouen" deck, 1540. He is here depicted, in woodcut, as a foot soldier



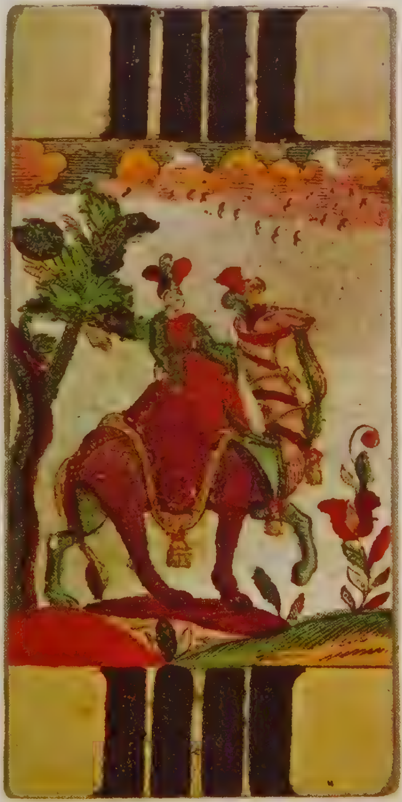
Tarot XVI from a Marseilles pack of 1750. Lightning is shattering the battlements of the tower, tumbling a man and woman to earth



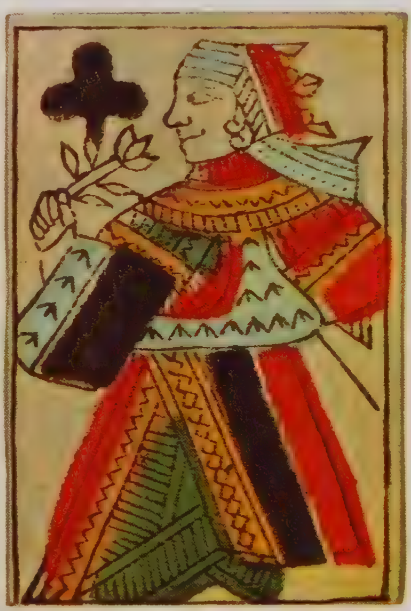
Two of bells from a German deck, Dresden, 1848. The bells are equivalent to diamonds, acorns to clubs and leaves to spades. Hearts are the same in English and German decks



The king of spades from a pack made by Hardy of London, 1800. Modern international packs are based on this design, traceable to the Norman variety of French playing cards



A tarot card from a fairy tale series, Munich, 1780. These decks may illustrate a proverb or show a marriage procession, characters from literature or fairy tales or simply animals. Usually they have no suits

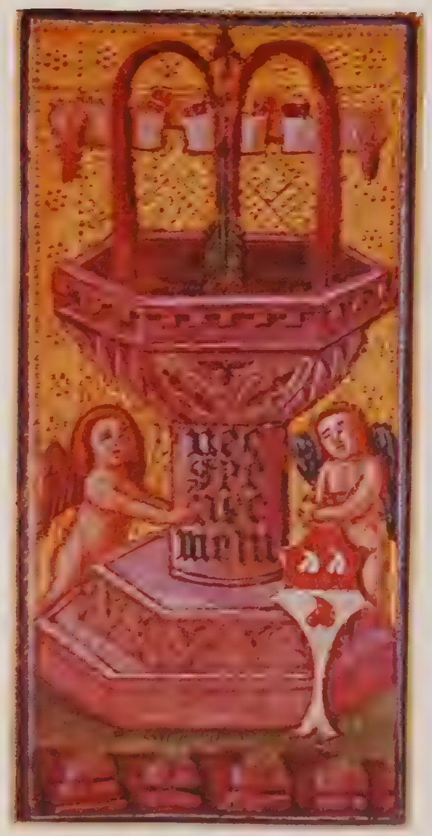


Queen of clubs from a "Portrait de Provence" pack, Montpellier, 1700. The details of the clothing, worked out in woodcut, are outstanding in draftsmanship

EUROPEAN PLAYING CARDS

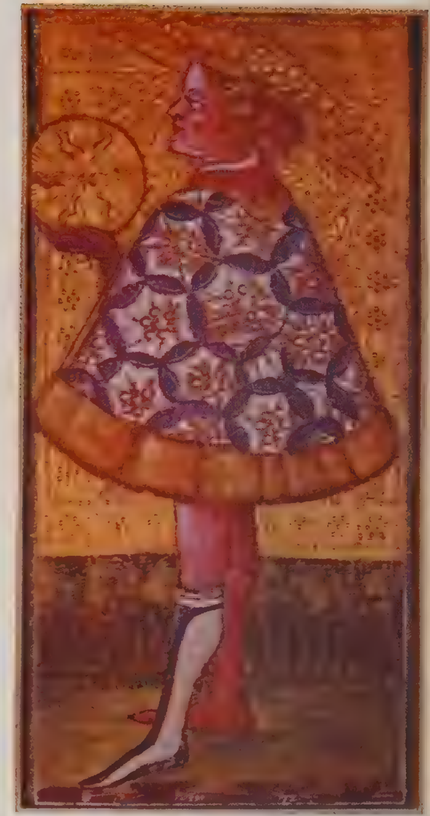
BY COURTESY OF THE DEUTSCHES SPIELKARTEN MUSEUM

CARDS

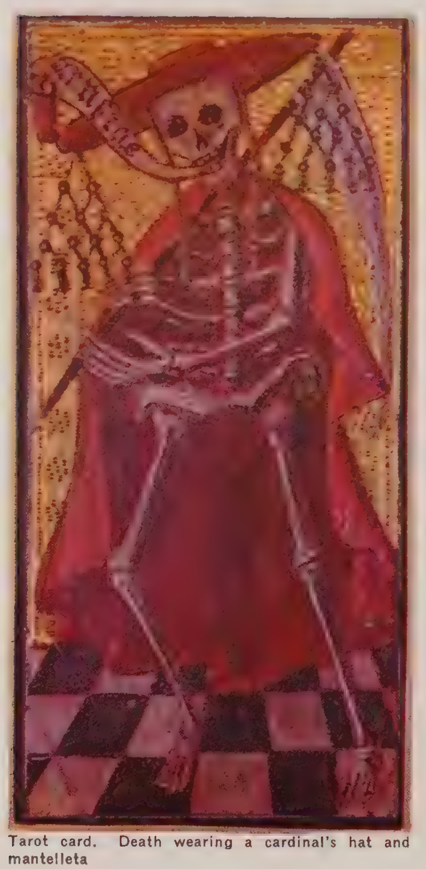


Tarot cards pictured are attributed to Antonio di Cicognara

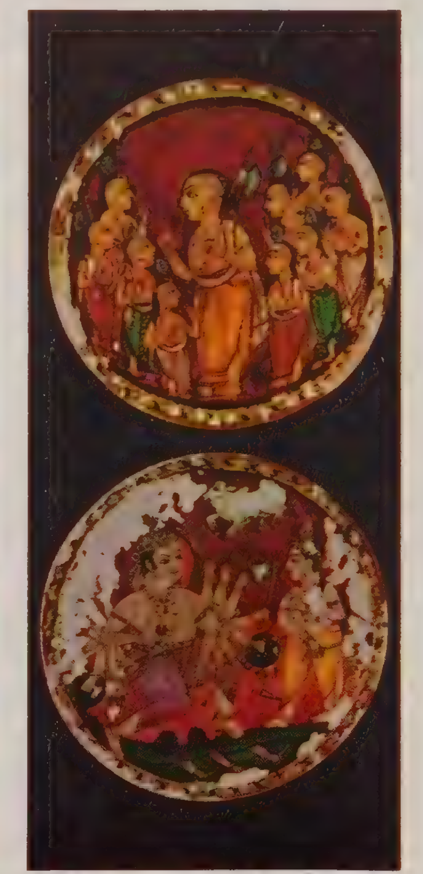
Tarot cards in water colour, varnished, on illuminated background with diaper pattern; from the second half of the 15th century. In the Victoria and Albert museum, London. At left, fountain, flanked by two cupids, the one on the right holding a shield with the arms of Colleoni. At right, the knave of coins



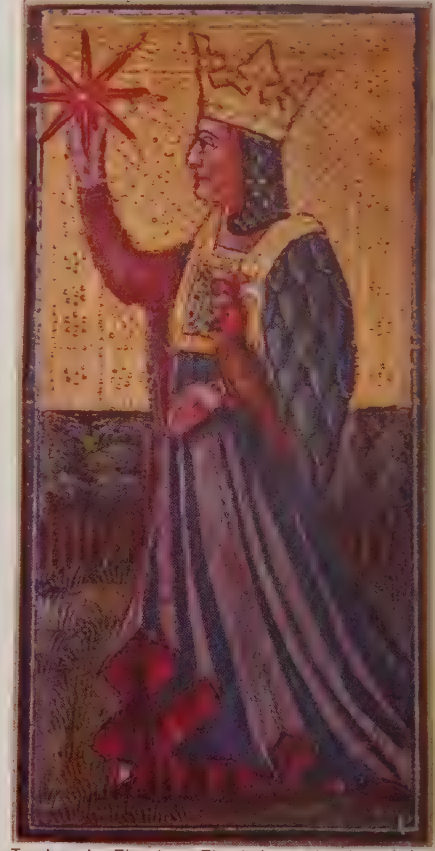
FOUR TAROT AND TWO IVORY PLAYING CARDS



Tarot card. Death wearing a cardinal's hat and mantelleta



Round ivory cards, probably from Deccan, India. Painted in miniature technique; 18th century. The Avatara (top) and ten of Parasurama



Tarot card. The star. The designer also decorated the choir books in Cremona cathedral

BY COURTESY OF (BOTTOM CENTRE) THE DEUTSCHES SPIELKARTEN MUSEUM IN BIELEFELD, (OTHERS) THE VICTORIA AND ALBERT MUSEUM, PHOTOGRAPHED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA BY C. H. CANNINGS

notable but slow. Until the 20th century, playing cards were much used for gambling games, and gamblers' superstitious fear of change delayed improvements. The gambler's fear of being cheated prevented the use of decorative back designs until after 1850, for it was felt that plain white backs could not be marked so easily. Cards depicting national heroes and current events have appeared but have succeeded only as novelties; Soviet Russia's effort to replace traditional royal designs with revolutionary figures was abandoned in 1928, and the figures on British and U.S. court cards are still costumed as of the time of Henry VII and Henry VIII. It was not until after 1870 that double-headed cards (which are right side up either way) with corner indexes became standard. Collections of playing cards may be found in many countries, among the most notable being the one in the British museum.

The Use of Cards.—Cards similar in form to playing cards have been much used for games requiring other than the usual designs and for various other purposes. One of the earliest manuscript references to card playing (1377) was the work of a monk who approved it as a harmless pastime, and through the 16th century several clerics issued playing cards bearing scriptural passages, but after card playing became widespread it was looked upon with disfavour by the church. The Puritans termed playing cards "the devil's picture book," and to them and among many other Protestants it was sinful even to have playing cards in the house. After 1843, especially in New England, cards in various designs dissimilar to those of standard playing cards were produced, and these were frequently deemed permissible in homes where other card playing was not allowed. One of the most popular of these games, rook, consists of four suits of consecutively numbered cards. The disappearance of faro (*q.v.*) and other card games from gambling houses and the fact that in the United States most card games are played without stakes and in Great Britain for insignificant stakes or none have greatly decreased the objections to playing cards per se; contract bridge, for example, is played in many churches. For the history and rules of the various card games *see* BRIDGE; WHIST; and similar articles.

After about 1508 efforts were made to render education easier and more palatable by printing instructive texts on the faces of playing cards. Cardinal Mazarin taught young Louis XIV his geography, history and other studies by this means. There is hardly a subject, from theology to war, which has not inspired a set of educational playing cards.

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CARDUCCI, BARTOLOMMEO (BARTOLOMÉ CARDUCHO) (1560–*c.* 1610), Spanish painter, architect and sculptor, was born in Florence, Italy, where he studied architecture and sculpture under Ammanati and painting under Federigo Zuccaro. He accompanied the latter to Madrid, where he painted the ceiling of the Escorial library, assisting also with the frescoes that adorn the cloisters. Most of his works are to be found in Spain, where he enjoyed continued royal patronage. He died in Madrid.

His younger brother was Vincenzo Carducci (*q.v.*).

CARDUCCI, GIOSUÈ (1835–1907), Italian poet, winner of the Nobel prize for literature in 1906 and one of the most influential literary figures of his age, was born at Val di Castello, near Lucca, on July 27, 1835, the son of a republican country doctor. After a childhood spent in the wild Maremma (southern Tuscany), he studied at the University of Pisa and in 1860 became professor of Italian literature at Bologna, where he lectured for over 40 years. He was a senator of Italy, and revered by the Italians as a national poet. He died at Bologna on Feb. 16, 1907.

Carducci was in his youth the centre of a group of young men determined to overthrow the prevailing romanticism and to return to classical models. Giuseppe Parini, Vincenzo Monti and Ugo Foscolo were his masters, and their influence is evident in his first books of poems (*Rime*, 1857; later collected in *Juvenilia* and *Levia gravia*, 1868). He showed both his great power as a poet and the strength of his republican, anticlerical feeling in his hymn to Satan, "Inno a Satana" (1863), and in his *Giambi ed epodi* (1867–69), inspired chiefly by contemporary politics. Its violent, bitter language, sometimes showing the influence of Hugo and Heine, reflects admirably the virile, rebellious character of the poet. The *Rime nuove* and the *Odi barbare*, which appeared in the 1880s, contain the best of Carducci's poetry: the sensitive evocations of the Maremma landscape and the touching memories of childhood in "Idillio maremmano," "Davanti San Guido," "San Martino"; the sad lament for the loss of his only son in "Funere mersit acerbo" and "Pianto antico"; the inspired representation of great historical events in *Ça ira*, "Sui campi di Marengo," "Comune rustico," "Canzone di Legnano"; and the ambitious attempts to recall the glory of Roman history and the pagan happiness of classical civilization in "Davanti alle Terme di Caracalla," "Nell 'annuale della fondazione di Roma" and "Alle fonti del Clitumno." Carducci's enthusiasm for the classical in art led him to adapt Latin prosody to Italian verse, and his *Odi barbare* are written in metres imitative of Horace and Vergil, sometimes with excellent results, but he reverted to traditional Italian metres in his last book, *Rime e ritmi*, 1899. Carducci was a professor as well as a poet, and when writing about historical subjects he was inclined to indulge in rhetorical tirades and to overcharge his genuine inspiration with detailed erudition. On the other hand, his scholarly research in Italian literature was warmed by his poetic imagination and style, so that his best prose works (especially his essays on Parini, on Politian (Poliziano) and on the minor 18th-century Italian poets) equal his poetry. For a portrait of Carducci *see* ITALIAN LITERATURE.

BIBLIOGRAPHY.—Carducci's complete works, including letters, were edited by L. Federzoni (1935–57); G. L. Bickersteth translated and edited a selection from his poems (1913). *See* also O. Williams, *Giosue Carducci* (1914); G. Papini, *L'uomo Carducci* (1918); B. Croce, in vol. i of *La letteratura della nuova Italia* (1914–45). (F. DI.)

CARDUCCI, VINCENZO (VICENTE CARDUCHO) (1578–1638), Spanish painter, born in Florence, Italy, was the brother of Bartolommeo Carducci (*q.v.*), whom he accompanied to Spain in 1585. Vincenzo succeeded his brother in 1609 as court painter to Philip III. Trained by his brother in the style of Italian mannerism, he was one of the leading artists in Madrid until the arrival of Velázquez, by whom he was soon overshadowed. Under his direction, Carducci painted three battle scenes for the Buen Retiro palace (now in the Prado museum), but he was chiefly a religious painter. He is also known as the author of the *Diálogos de la Pintura* (1633), an academic treatise on art. He died in Madrid. (E. HS.)

CARDWELL, EDWARD CARDWELL, VISCOUNT (1813–1886), English statesman, famous for his reform and reorganization of the army, was born in Liverpool on July 24, 1813, and educated at Winchester and at Balliol college, Oxford, where in 1835 he followed the example of his later leaders Sir Robert Peel and W. E. Gladstone by obtaining a double first. Elected a fellow of Balliol, he was called to the bar in 1838; but his ambitions were political. Cardwell entered parliament as Conservative member for Clitheroe in 1842; he became member for Liverpool in 1847 but lost the seat in 1852 because he had supported repeal of the navigation acts; from 1853 until the end of his political career he represented the city of Oxford.

Personally as well as politically an admirer of Peel, whose friend and literary executor he subsequently became, Cardwell was appointed financial secretary to the treasury in 1845. After the Conservative schism over the repeal of the corn laws, he was prominent as a Peelite and, on the formation of Lord Aberdeen's ministry in 1852, became president of the board of trade, though without a seat in the cabinet. Cardwell's administrative talents were soon displayed in a major reorganization of his department and an important codification of merchant shipping law in 1854. Resigning with the rest of the Peelites after the breakup of the coalition in 1855, he refused Lord Palmerston's offer of the chancellorship of the exchequer but entered the cabinet in 1859 as chief secretary for Ireland. He became chancellor of the duchy of Lancaster in 1861 and secretary for the colonies in 1864, remaining at the colonial office until the fall of Lord John Russell's ministry (1866). At the colonial office Cardwell consolidated his reputation as an able, liberal-minded minister, encouraging greater colonial responsibility for defense and in commercial policy, and preparing the way for the federation of Canada. In divided cabinets he had become the close associate and main ally of Gladstone, who appointed him secretary for war in 1868. In this office, during the next five years, Cardwell made his name.

Despite bitter opposition, the purchase of commissions was abolished, thus permitting the selection and promotion of officers by merit. Improved conditions for the ordinary soldier stimulated recruitment, and the introduction of the short-service engagement made possible the creation of an effective reserve. Regular regiments were regrouped on a county basis, in conjunction with volunteer units, and organized on the system of "linked battalions," one at home matching another in foreign service. Progress was made in modernizing arms and equipment, while the structure of the war office was much improved, notably on the staff side. The commander in chief was subordinated to the secretary of state. These reforms enhanced the strength, efficiency and flexibility of the army and saved money. However, cabinet dissension over Cardwell's demand for larger military estimates in 1874 was one reason for the premature end of Gladstone's first government.

Undermined by overwork in the face of prolonged hostility, Cardwell's mental and physical health broke down; he took no further part in politics after 1874 when he was made a viscount. He died at Torquay on Feb. 15, 1886. Lacking the parliamentary gifts of his colleagues among the Peelites, Cardwell had proved a versatile administrator of unusual capacity. With sympathetic leadership he was always an excellent department head; under Gladstone he attained greatness as the most successful military reformer of the 19th century, who laid the foundations for the 20th-century development of the British army. (A. F. T.)

CAREW, RICHARD (1555–1620), English poet and antiquary, known for an early history of Cornwall, was born on July 17, 1555, at East Antony, Cornwall. At the age of 11, he entered Christ Church, Oxford, and when only 14 was chosen to carry on an extempore debate with Sir Philip Sidney in the presence of the earls of Leicester and Warwick and other nobleman. On leaving Oxford he spent three years at the Middle Temple and later traveled abroad. He entered parliament in 1584, was appointed high sheriff of Cornwall in 1586 and served under Sir Walter Raleigh, then lord lieutenant of the county, as treasurer. His erudition was praised by Ben Jonson and John Dunbar, and he was a friend of William Camden and Sir Henry Spelman. His enduring work, begun about 1589, is the *Survey of Cornwall* (1602; reprinted 1769 and 1811). A modern edition was edited by F. E. Halliday (1953). It is interesting for the picture it gives of the life of a country gentleman at the end of the 16th century. Carew's other works are a translation of the first five cantos of Tasso's *Gerusalemme*, originally published without the author's knowledge and entitled *Godfrey of Bulloigne, or the Recoverie of Hierusalem* (1594); *The Examination of Men's Wits* (1594), a translation of an Italian version of Juan Huarte's *Examen de Ingenios;* and *An Epistle Concerning the Excellencie of the English Tongue* (1595–96?; printed 1614). Carew died on Nov. 6, 1620.

His son, Sir RICHARD CAREW (d. 1643?), was part author of *The True and Readie Way to Learn the Latin Tongue* by writers of three nations, edited and published by Samuel Hartlib (1654).

CAREW, THOMAS (1594 or 1595–1640), English poet and the first of the Cavalier song writers, was born in 1594 or 1595, probably at West Wickham in Kent, the son of Sir Matthew Carew, master in chancery, and his wife Alice Ryvers, daughter of Sir John Ryvers, lord mayor of London. He was educated at Merton college, Oxford, graduating in 1611, and at the Middle Temple. After a period in the service of the ambassador Sir Dudley Carleton at Venice, he continued as Carleton's secretary on an embassy to The Hague in 1616 but was discharged for traducing Sir Dudley and Lady Carleton in some "idle writing." His next employment was with Sir Edward Herbert (later Lord Herbert of Cherbury) on an embassy to Paris in 1619. Subsequently he enjoyed the important patronage of Christopher Villiers, earl of Anglesey, the duke of Buckingham's younger brother. In 1630 he received a court appointment as gentleman of the privy chamber and at about the same time was made "sewer in ordinary," or server at table, to the king. Clarendon recalls him as "a person of a pleasant and facetious wit" among a brilliant circle of friends that included Ben Jonson. In 1634 his masque *Coelum Britannicum* was performed in the banqueting house at Whitehall by the king and his gentlemen, and it was printed later in the same year. His poems circulated in manuscript, and some were set to music by Henry Lawes and other composers. There is a well-authenticated tradition that he died with expressions of remorse for a life of libertinism. He was buried on March 23, 1640, in the Church of St. Dunstan's in the West, London. His collected poems were published a few weeks after his death.

Most of Carew's work consists of amatory or occasional lyrics, notable for their ease of language and skilful control of mood and imagery. His brilliantly sensuous poem "A Rapture" is his longest. He was a meticulous workman, and his friend Sir John Suckling bantered him on the "hard bound" Muse that made him write with such "trouble and pain"; but Carew's own verses addressed to Ben Jonson show that he was proud to share Jonson's creed of painstaking perfection. Though he greatly admired Donne, whom he called king of "the universal monarchy of wit," Donne's direct influence is apparent only in an occasional phrase or image. There is a larger debt to Italian poets, particularly Giambattista Marino, on whose work Carew bases several of his lyrics. His masque derives much of its substance from philosophic dialogues by Giordano Bruno.

See the poems and masque, ed., with an introduction and notes, by Rhodes Dunlap (1949); Edward I. Selig, *The Flourishing Wreath* (1958). (R. Dp.)

CAREY, HENRY CHARLES (1793–1879), U.S. economist and sociologist, often called the founder of the U.S. school of economics, was born in Philadelphia, Pa., Dec. 15, 1793, the son of Mathew Carey, Irish-Catholic political refugee, writer and publisher. Henry Carey became a partner in Carey, Lea & Carey, a leading U.S. publishing house, and later its president. His education, though informal, resulted in a cursory acquaintance with many fields of learning.

After 1835 he devoted himself to writing sociological and economic books and pamphlets. Among his more important works are *Essay on the Rate of Wages* (1835), *Harmony of Nature* (1836), *Principles of Political Economy* (1837–40), *The Past, the Present, and the Future* (1848), *Principles of Social Science* (1858–60) and *The Unity of Law* (1872). His works were translated into at least eight languages, many persons finding in them a foil to *laissez-faire.*

He became increasingly critical of English classical political economy. An optimist, he looked upon nature's laws as conducive to steady economic progress and to the harmony of diverse economic interests. A Republican and a nationalist, he believed protection initially essential to the industrial development of rising nations. His home served as a *salon* to disciples and visitors, and his reputation was perhaps greater abroad than at home. Carey died in Philadelphia, Oct. 13, 1879.

See Arnold W. Green, *Henry Charles Carey* (1951); A. D. H. Kaplan, *Henry Charles Carey: a Study in American Economic Thought* (1931). (J. J. S.)

CAREY, MATHEW (1760–1839), publisher and publicist, who is best remembered as an early expositor and advocate of measures for U.S. national economic development, was born in Dublin, Ire. He was crippled by an accident in infancy, which perhaps induced his studious habits. He apprenticed himself to a printer, published his first article at 17 and soon was persecuted for his expressions of resentment at English oppression of Catholic Ireland. Fleeing to Paris, he worked for Benjamin Franklin, knew the marquis de La Fayette and learned of American ambitions. He sailed for Philadelphia, Pa., in 1784. With letters from Franklin and a timely loan from La Fayette, he published a succession of journals, of which the *American Museum* was of enduring value. Financial success came when he abandoned journalism for the book trade. He reprinted European works and promoted the sale of books by American authors. His own *Olive Branch* (1814) sought to reconcile Republicans with Federalists. A charter member of the Philadelphia Society for the Promotion of National Industry, he wrote most of its *Addresses,* which revived Alexander Hamilton's arguments for tariff protection. Canals, turnpikes and railroads owed much to his propaganda. (B. Mi.)

CAREY, WILLIAM (1761–1834), Baptist minister, was a pioneer of modern missionary enterprise in India and a noted Orientalist. He was born on Aug. 17, 1761, at Paulers Pury, Northamptonshire, the first child of Edmund Carey, a weaver and schoolteacher. After joining the Baptist Church in 1783, he served for several years as a pastor in Moulton, Northamptonshire, while continuing his trade as a shoemaker, and also teaching school. A move (1789) to the Baptist church at Leicester was followed by the publication of his *An Enquiry into the Obligations of Christians to Use Means for the Conversion of the Heathens . . .* (1792) which led to the formation of the Baptist Missionary Society. A doctor, John Thomas, and he, selected as its first missionaries to India, reached Calcutta in November 1793. From 1794 Carey superintended an indigo manufactory at Mudnabati (Bengal) while preaching, teaching school, and beginning his first translation of the Bible. For political reasons the East India Company refused to allow any more missionaries into British India; so early in 1800 he settled with his family at Serampur, a Danish colony near Calcutta. There Carey, together with Joshua Marshman and William Ward (the "Serampore trio") began the mission which William Wilberforce called "one of the chief glories" of the British nation, because of its visionary and enlightened approach to the spreading of the gospel, which set the pattern for modern missionary endeavour.

In 1801 Carey was appointed teacher (later professor) of Bengali, Sanskrit, and Marathi at the new government college of Fort William. There, and at Serampur, he seriously began the work for which some have called him the "father" of Bengali prose. As well, he translated the entire Bible into Bengali, Oriya, Marathi, Hindi, Assamese, and Sanskrit; and parts of it into 29 other languages and dialects. He also prepared, with the assistance of various learned Indians and Europeans, grammars in Bengali, Sanskrit, Marathi, Panjabi, Telegu, and Kanarese; edited (with J. C. Marshman) a grammar in Bhotia; and compiled dictionaries in Bengali, Sanskrit, and Marathi. In addition, he translated into English (with Joshua Marshman) three volumes of the Hindu epic poem *Ramayana,* as well as editing and publishing the horticulturist William Roxburgh's *Hortus Bengalensis* (1814) and *Flora Indica* (1832). Carey took a subdued part in the Baptists' educational operations, devoting more time to urging the government to outlaw such practices as infanticide and suttee, succouring the sick and poor, pleading for increased cooperation among missionaries and for the use of Indians as missionaries, helping to expand the Serampur Mission until it included 19 stations, and, among a multitude of other actions, taking the leading role in the formation (1820) of the Agricultural Society of India. Carey was three times married. He died at Serampur on June 9, 1834.

See S. P. Carey, *William* Carey (1923); E. D. Potts, *British Baptist Missionaries in India 1793–1837* (1967). (El. D. P.)

CARGO CULTS are religious movements which have as their most characteristic feature the belief that spiritual agents will divert tremendous cargoes of the most sought-after manufactured wealth into the hands of the cult members. Thus the cults have been labeled messianic; *i.e.,* concerned with a utopian future brought about by intervention of a messiah. Their typical manifestations have occurred in New Guinea and the islands of Melanesia, among peoples of recent or marginal contact with Western civilization. The distribution of the cults, recorded since the 19th century and noticed in considerable number since World War II, suggests that they are a response to the confusions and insecurities brought about by limited understanding and participation in Western society, religion and economy. The participants do not understand the nature of manufacturing or commerce and have limited purchasing power: they seek to rationalize their situation by reference to religious and magical symbols derived from Christianity and from indigenous Melanesian belief.

Within this framework there are numerous variations. Some movements have been labeled nativistic or revivalistic, since the dominant theme is a turning away from Western society and an affirmation of Melanesian independence. In some cases this involves a belief in a reversal or drastic revolution in the social order, including a rearrangement of sexual mores, the dominance of Melanesian over European, and the destruction of money and existing forms of wealth. In numerous recent examples, the participants have built airstrips and immense warehouses to receive the expected cargo. A typical version of the central myth is that God (or Jesus or angels) has been labeling crates of produce with the addresses of the Melanesians but the avaricious Europeans have been intercepting the ships and altering the addresses.

Such movements can readily develop political overtones. Despite their widely different and largely independent geographic origin, there have been instances of the movements organizing across cultural boundaries. The anti-European flavour and the evident capacity for organization have suggested that the movements can be interpreted as quasi-nationalistic. Governments, concerned with this aspect and with the disruption of life occasioned by large emotional meetings, destruction of resources, and utopian fantasies, have endeavoured to ban the movements. Such policies have not been successful and have now given way to attempts at political and economic education and reform.

The modern elements in the movements should not blind us to their traditional basis of operation. Dreams, prophecies, ritual experiment and many other features seem typical of Melanesian traditional cults, as is the concern with material well-being. Even so, much of the symbolism represents a syncretism of elements in Western behaviour, attaching, for instance, a ritual importance to flags, military drill and rules of club organization.

See also MYTH: *Millennialist Myths and Cargo Cults.*

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CARIA, an ancient district of southwestern Asia Minor, roughly corresponding to the modern Turkish districts of southern Aydin and western Mugla. Extending to the Maeander (Buyukmenderes) river in the north, it bordered on Ionia and Lydia, in the east on Phrygia and Lycia, and in the southwest on the Aegean Sea. Much of the coast was Greek, the most powerful cities being Cnidus and Halicarnassus (*qq.v.*); from the 4th century B.C. the southwestern corner of Caria belonged to Rhodes. The region that was Caria is mountainous (rising to 7,570 ft. near the Lycian border), with extensive scrub and pine forests and abundant pasturage for goats; but it also provides arable land in the valleys and small plains in the tableland. The coast is formed of promontories separated by the Gulfs of Mandalya, Kerme (Cos), and Sombeki (Syme).

The ancient Greeks believed that the Carians originally inhabited the Aegean archipelago and retired thence into Caria, and it is true that the interior of what was Caria appears almost devoid of prehistoric remains. The Carians, however, considered themselves indigenous and claimed brotherhood with the Lydians and Mysians, whom they admitted to the worship of Carian Zeus at Mylasa (now Milas). A number of Carian inscriptions are preserved, and the language seems to have been in use until the 3rd century B.C., when it was effectually superseded by Greek. It was probably not Indo-European, and the script, though mainly alphabetic, is still imperfectly understood. In early historical times the Carians lived in hilltop villages grouped by the rule of local dynasties and by common worship at the principal sanctuaries. Archaeological survey has shown that the ancient village pattern was transformed into a network of cities designed and built in Greek fashion. The most important city was Mylasa, though Stratonicea (about 16 mi. E) came to rival it in the 3rd century B.C. (Jo. M. Co.; X.)

CARIB, the warlike and cannibalistic Indians who at the time of the Spanish conquest occupied the Lesser Antilles and parts of the adjoining mainland of South America. Their practice of eating their enemies so captured the imagination of the Europeans that the Caribbean sea was named for them. The English word "cannibal" is derived from one of the terms used by the Arawak to refer to the Carib. Today the term "Carib" or "Cariban" is used to designate a linguistic family which includes not only the language of the Antillean Carib but also many related Indian languages spoken in South America.

The Antillean Carib, who originated in northern South America, had seized the Lesser Antilles from Arawakan tribes only a short time before the arrival of the Spanish. Their raids, made over long distances in large dugout canoes, had as their main objective the taking of captives. Women became the wives of their captors, while the men were tortured, killed and eaten during an elaborate victory celebration.

Most of the Cariban-speaking tribes lived in the Guianas and in the area south to the Amazon river. Although some of these tribes were warlike and practised cannibalism, most of them seem to have been less aggressive than the island Carib. They lived in small settlements, grew manioc and a variety of other crops and hunted with blowgun or bow and arrow. Like most peoples of the tropical forest, they used little if any clothing but decorated their bodies with painted designs and a variety of ornaments. Each village, which was composed of several extended families, had a headman or chief with little real authority and was ordinarily politically independent of all other villages. Religious practices included few large or intricate ceremonies, and in their beliefs they stressed a great number of spirits which were thought to be malevolent and responsible for illness. The religious leader, who claimed control over certain of these spirits, used his power primarily in curing.

Other Cariban tribes lived far to the west on the wooded slopes of the Andes along the boundary between Venezuela and Colombia. Little is known of these tribes, but they seem not to have been very different from the Guiana Carib. To the southeast, in the headwaters of the Xingú river in central Brazil, the Kuikuru, Bacairí and other Cariban-speaking tribes lived in close association with tribes of other linguistic stocks. They seem to have been influenced by their neighbours to the extent of borrowing such traits as ceremonies featuring masked dances and an elaborate art style.

See also West Indies: *Anthropology and Archaeology;* for the Cariban languages, *see* Indian, Latin-American; South American Languages.

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CARIBBEAN FREE TRADE AREA (CARIFTA), a trading association of 12 Commonwealth countries in the Caribbean, established by Antigua, Barbados, Guyana, and Trinidad and Tobago on May 1, 1968; and joined by Dominica, Grenada, St. Christopher (St. Kitts)-Nevis-Anguilla, St. Lucia, and St. Vincent on July 1; by Jamaica and Montserrat on Aug. 1; and by British Honduras on April 26, 1971.

After the dissolution in 1962 of the Federation of the West Indies (*q.v.*), further attempts at regional cooperation were made, one of which was the first CARIFTA agreement signed between Antigua, Barbados, and Guyana on Dec. 15, 1965, on which the 1968 association was broadly based.

Like that of its predecessor, the main objective of the 1968 association was to facilitate the economic development of the member countries through the expansion and diversification of trade within its area. To achieve this aim and to ensure that the benefits of free trade would be distributed equally therein, all barriers to the movement of commodities between member countries were to be removed. (Although it was not explicitly stated in the agreement, there are implications that the intention is for the free trade area to develop into a common market.)

CARIFTA functions thus: broad resolutions, passed at the annual Heads of Government Conference, are referred to the Council of Ministers (meeting as often as is necessary) for formulation into specific policies. These policies are then implemented by the Commonwealth Regional Secretariat, made up of two divisions, Trade and Integration and General Matters, and headed by a secretary general. The government of Antigua acts as a depository for documents and a clearinghouse of information for the other members. The secretariat is based in Georgetown, Guyana.

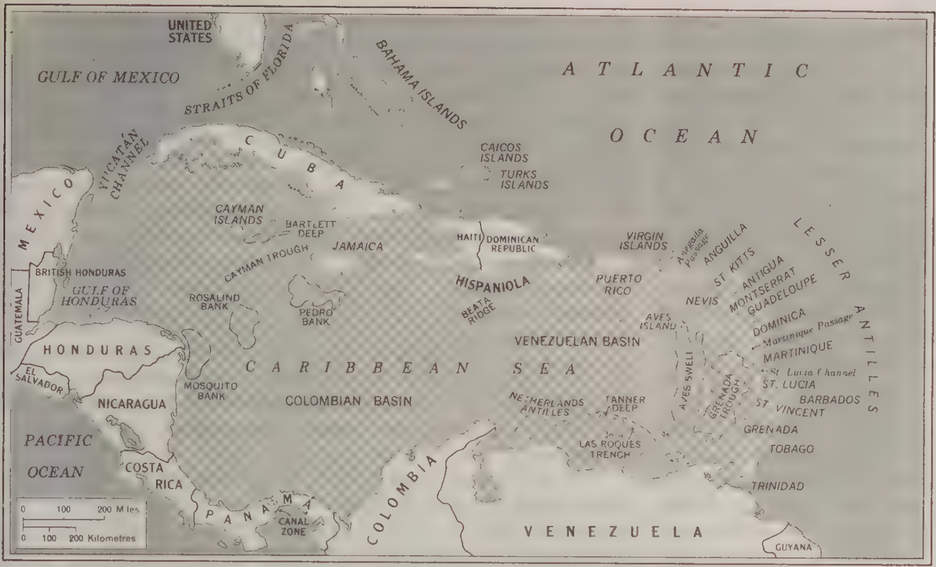
Any territory that is not an original signatory to the CARIFTA agreement may apply to join nevertheless, if the Council of Ministers approves. Any member territory may withdraw from the agreement provided the government concerned gives 12 months' notice. The council may terminate the membership of any country the activities of which it considers detrimental to the benefits other member countries may expect to derive from the agreement. The council cannot take decisions against member countries on its own initiative but must await an official complaint from the member whose benefits are frustrated. (W. McC.)

CARIBBEAN SEA, an overdeepened, suboceanic basin, including all water north of Venezuela, Colombia, Panama and Costa Rica, east of Nicaragua, Honduras, Guatemala, British Honduras and the Yucatán peninsula of Mexico, south of the Greater Antilles and west of the Lesser Antilles of the West Indies. Its north-south width ranges from 380 mi. to about 700 mi., and its maximum length is more than 1,500 mi.; its total area is approximately 1,049,500 sq.mi. The Caribbean sea and the Gulf of Mexico (*see* Mexico, Gulf of) have been considered together, especially by German oceanographers, under the name of the American Mediterranean sea because of the largely enclosed nature of these water channels between North and South America.

Oceanography.—The Caribbean sea has the shape of a wide and somewhat irregular channel, with a protuberance toward the northwest where it connects to the Gulf of Mexico through the Yucatán channel. The eastern end opens toward the tropical part of the North Atlantic ocean through the Lesser Antilles (latitude 10° to 18° N.). The opening to the Atlantic is partly closed by the submarine ridge on which the Lesser Antilles lie. The numerous small islands of the Lesser Antilles, or Caribbees, are somewhat regularly spaced along the ridge, whose saddles between islands rise to less than 2,000 ft. below sea level. The greatest depth of passage connecting the eastern Caribbean with the Atlantic is Anegada passage, whose submarine channel across the Caribbean submarine ridge south of the Virgin Islands is more than 6,000 ft. deep. Windward passage between the eastern end of Cuba and northwestern Haiti has a threshold depth of 5,500 ft. below sea level. The highest elevation of Yucatán channel is 6,800 ft. below sea level directly west of the western end of Cuba.

The Caribbean consists of a series of elongate depressions separated by submarine ridges. In this respect, the Caribbean is like the Mediterranean sea; however, the Caribbean is deeper, though smaller than the Mediterranean, and has deeper connections with the Atlantic ocean. The Caribbean is not a continental sea by origin, nor is it entirely oceanic, though it is more like an ocean basin in structure (*see* Ocean and Oceanography: *The Ocean Basins*). On the basis of geological structure, the Caribbean consists of two major parts—the large eastern region and the small western region, also called the Cayman sea. These two regions are separated by a broad submarine platform, extending from Honduras and Nicaragua northeastward to Jamaica and thence to the southwestern tip of Haiti. Upon this broad platform lie the shallow banks Mosquito, Rosalind and Pedro. Within these complex and deformed basins the bottom in the western region shows southwest-northeast trending troughs and ridges, whereas the eastern region's ridges and troughs trend nearly north-south in alignment with the Caribbees arc.

The major basin southeast of the Jamaica rise is divided into a western half (Colombian basin) and an eastern half (Venezuelan basin) by Beata ridge which extends southwestward from Hispaniola. Beata ridge decreases in elevation toward the south until a connection between western and eastern halves is made at a depth of more than 13,000 ft. In the southern part of the Venezuelan


UNITED STATES
GULF OF MEXICO
STRAITS OF FLORIDA
BAHAMA ISLANDS
A T L A N T I C
O C E A N
CAICOS ISLANDS
TURKS ISLANDS
YUCATÁN CHANNEL
C U B A
M E X I C O
CAYMAN ISLANDS
BARTLETT DEEP
CAYMAN TROUGH
JAMAICA
HAITI
DOMINICAN REPUBLIC
HISPANIOLA
BEATA RIDGE
VIRGIN ISLANDS
Anegada Passage
ANGUILLA
ST KITTS
NEVIS
ANTIGUA
MONTSERRAT
GUADELOUPE
L E S S E R A N T I L L E S
PUERTO RICO
BRITISH HONDURAS
GULF OF HONDURAS
GUATEMALA
ROSALIND BANK
PEDRO BANK
AVES ISLAND
DOMINICA
Martinique Passage
MARTINIQUE
VENEZUELAN BASIN
H O N D U R A S
C A R I B B E A N S E A
AVES SWELL
GRENADA TROUGH
St Lucia Channel
ST. LUCIA
EL SALVADOR
MOSQUITO BANK
NICARAGUA
COLOMBIAN BASIN
NETHERLANDS ANTILLES
TANNER DEEP
ST VINCENT
BARBADOS
GRENADA
LAS ROQUES TRENCH
TOBAGO
PACIFIC OCEAN
COSTA RICA
TRINIDAD
0 100 200 Miles
0 100 200 Kilometres
P A N A M A
CANAL ZONE
C O L O M B I A
V E N E Z U E L A
GUYANA

CARIBBEAN SEA AND ADJACENT COUNTRIES

basin, within 200 mi. of the coast, is Tanner deep—about 17,000 ft. below sea level. An east-west fault trough less than 100 mi. S. of Hispaniola and Puerto Rico also drops to 17,000-ft. depths. To the east of the Venezuelan basin lies Grenada trough, bounded on the east by the Lesser Antilles and their supporting ridge and dropping to more than 13,000-ft. depth in the south. Aves swell, trending north-south like Grenada trough, separates the latter from the Venezuelan basin and rises to Aves Island in the north and to a threshold of 5,200 ft. The main channels from Grenada trough to the Atlantic are Martinique channel (3,450 ft.) and St. Lucia channel (3,550 ft.).

The western or Cayman sea part of the Caribbean contains the Caribbean's greatest known depth—Bartlett deep at approximately 23,750 ft. below sea level between Cuba and Jamaica. The western region is divided into two parts by Cayman ridge, which lies more than 9,000 ft. below the surface water in places. The long ridge separates the Yucatán basin to the north from Cayman or Bartlett trough to the south; all three features trend nearly east-west. Between Cuba and Jamaica, Bartlett trough is everywhere more than 15,000 ft. deep and its margins are steep, straight escarpments. This great fault trench consists of a number of tilted fault blocks, though the floor is relatively broad.

The topography of the Caribbean basins is in general very rugged, with deep trenches adjacent to steep-sided ridges. Many of the ridges rise above sea level, though only a relatively short height when compared with the depths. The mountainous backbone of Puerto Rico, for example, rises to 4,400 ft. above sea level, but the ridge slopes steeply down into the Caribbean to a depth of 17,000 ft. within 55 mi. of the coast line and slopes steeply down into the deepest deep in the Atlantic (27,498 ft. below sea level) within 75 mi. of the north coast. The escarpment north of St. Croix Island descends to more than 14,000 ft. in a distance of less than five miles.

The continental shelf, except for the broad swell northeastward from the boundary of Honduras and Nicaragua, is narrow. It encompasses Trinidad and other islands off the northeastern coast of Venezuela but hugs the coast line from Venezuela to the Costa Rica-Nicaragua boundary, being less than 30 mi. in width throughout that long stretch of coast. Again, the continental shelf narrows to less than 30 mi. along the north coast of Honduras and continues around the Gulf of Honduras to the northeastern tip of Yucatán.

The entire Caribbean area appears to have been extensively intruded by large bodies of basaltic magma which developed deep within the mantle of the earth and moved upward. Active volcanism around the margins of the sea and constant seismic disturbances represent continuous readjustment of the crust. Coral growth and limestone formation are also found in the warm waters.

Tidal movements in the Caribbean sea are small, partly because of the enclosed nature of the region. The tide ranges up to two feet, averaging one foot.

Surface ocean currents pass strongly through the Caribbean sea from the Atlantic and continue with increasing speed through the Yucatán channel. There a significant portion turns sharply to the right and flows with great velocity out through the Straits of Florida into the North Atlantic. Water tends to build up in front of the narrow Yucatán channel because of the prevailing easterly winds. The upper waters are mainly of North Atlantic origin but contain a considerable admixture of South Atlantic origin. Below the upper water a considerable amount of South Atlantic water enters the Caribbean. Numerous eddies are present on the flanks of the main current, which flows essentially through the middle of the Caribbean at an average speed of about one mile per hour. The most conspicuous countercurrents are the one flowing counterclockwise in the southern part of the Colombian basin and the one flowing back eastward along the southern coast of Cuba.

Waters from the Atlantic ocean can pass somewhat freely through the Caribbean at depths less than about 2,500 ft., this being the sill control depth of the Straits of Florida, but communication with large water bodies of the Atlantic at greater depths is largely restricted. Water masses entering the Caribbean sea from the tropical North Atlantic have a thin homogeneous top layer of warm water, below which is a nearly discontinuous decrease in temperature. The water shows a streaky distribution of salinity when it enters between the Lesser Antilles, but bands of alternating salinity are smoothed out rapidly in the Caribbean because of intense mixing. Salinity of the deep water is uniform. Deep water in the eastern part of the Caribbean sea is renewed by inflow across the Lesser Antilles sill and is therefore of lower density than that of the adjacent Atlantic ocean.

The prevailing winds over the Caribbean sea are the very persistent northeast trade winds. Except for diminishing slightly in constancy and force from September to November, the winds blow consistently from the east or northeast more than 70% of the time at mean velocities of about ten miles per hour—gentle to moderate breezes. Fog is rare over the ocean in this area. Average air temperature varies from about 78° F. in February to 83° F. in September over most of the region, and the surface-water temperature averages practically the same. The Caribbean region is visited each year, generally from August to October, by terrific hurricane storms which usually move from east to northwest.

History.—The location of the Caribbean sea—a large, deep, tropical sea between North and South America—has had varied effects upon the inhabitants living close to its shores and upon peoples in more distant places. The Isthmus of Panamá, less than 35 mi. wide at its narrowest point, and in fact the entire isthmus of Central America, narrowly separates the Caribbean, as a part of the Atlantic system, from the Pacific ocean. Part of the historical significance of the Caribbean stems from its position between North and South America and part is related to its location between the Atlantic and Pacific oceans.

The Caribbean was discovered by Columbus in his search for a passage to the lands of the far east. Its name—Mar Caribe—stemmed from its characterization as the sea of the fierce Carib Indian natives who inhabited the Lesser Antilles. Spanish control of the Caribbean after discovery was practically undisputed during the first century of development. Spanish adventurers searched for quick fortunes, and the discovery of gold and silver around the Caribbean resulted in a steady flow of treasure from the new lands back to Spain. Permanent settlement was insignificant during the 16th century. Spanish conquest, centred first at Santo Domingo on Hispaniola, reached out to the other large islands, then to the highlands of Mexico and Central America and to South America. Balboa's discovery of the Pacific in 1513 led to the eventual conquest of Andean South America and to the use of the Isthmus of Panamá as a route for transshipment of goods from Peru and Argentina. Such advanced civilizations as the Incas in Peru and the Aztecs in Mexico were brought under Spanish control.

The importance of the Caribbean as a trafficway for convoys of Spanish treasure ships soon led to raids by pirates, freebooters and buccaneers. Fortified cities on the "Spanish Main," the mainland bordering the Caribbean, and on the islands were raided by English, French and Dutch pirates, privateers and warships. The Lesser Antilles, having been passed over by the Spanish because of lack of treasure, became objects of conflict, especially between Britain and France. The 17th century witnessed settlement of the Lesser Antilles by British, French, Dutch and Danish colonists and the wresting of Jamaica from Spain by Britain in 1655. Thereafter, inroads were made against the strong mercantilist policy that Spain had been enforcing for its colonies. Spain suffered from contraband trade and from the capture or sinking of many treasure-laden ships.

The tropical possessions of western European powers in the Caribbean began to yield great wealth in the form of sugar and other plantation products as the era of slavery developed and many thousands of Negroes were brought over from Africa. During the 18th century tropical American colonies were considered much more valuable than the recently established colonies in temperate North America. France, having taken over the western part of Hispaniola from Spain in 1697, lost the colony when the Negroes revolted successfully during the French Revolution and Haiti became independent in 1804. Shortly thereafter, the Spanish possessions began to break away from Spain's control, and new nations appeared on the borders of the Caribbean. By 1850 the independent nations of Mexico, Guatemala, Honduras, Nicaragua, Costa Rica, Colombia, Venezuela, the Dominican Republic and Haiti faced the Caribbean. It remained for Spain to lose Puerto Rico to the United States and Cuba to independence and for Colombia to lose Panamá to independence around the turn of the 20th century.

The value of the narrow isthmian section between the Caribbean and the Pacific was considerably heightened after the discovery of gold in California in 1848. The trip from the Atlantic seaboard of the United States to Panamá, thence across the isthmus to the Pacific and on by ship to California was less arduous than the long trek across the plains and mountains and deserts. A railroad was constructed across the isthmus and talk of an isthmian canal increased. Several possible routes to connect the Caribbean and Pacific were discussed, including one through Lake Nicaragua. A French company began construction of a canal across Panamá (Colombia) in the 1880s, but the venture failed because of financial difficulties and disease. A treaty signed between the United States and Great Britain in 1901, guaranteeing British use of the canal, provided that the United States should build and fortify it. After the failure of negotiations with Colombia and the Panamá revolution in 1903, canal construction was assumed by the U.S.

The opening of the Panama canal (*q.v.*) in 1914 proved to be a boon to the western coast of South America as well as to the two coasts of the United States. It made the long, dangerous voyage around the southern tip of South America unnecessary. In effect, construction of the canal extended the southern boundary of the United States. Certainly foreign policy was conditioned by the canal situation. United States naval bases in Cuba and Puerto Rico were augmented by the purchase of the Danish West Indies in 1917, making possible the use of the valuable harbour at St. Thomas in the Virgin Islands to safeguard Anegada passage, the shortest route from Europe to the canal. Evidence of continued concern for the strategic importance of the Caribbean was shown during World War II, when the United States negotiated for additional naval bases and for air bases in a number of places. There remain in the Caribbean region, in addition to the independent nations, possessions of the United States, Great Britain, France and the Netherlands, and the West Indies islands of the Commonwealth of Nations.

The strategic significance of the Caribbean has resulted in a policy of paramount interest of the United States in the region. Such interest was manifested from time to time by direct intervention in certain countries on the grounds that, if the United States did not step in and temporarily administer the affairs of countries which could not govern themselves, European nations would seek to do so. Financial intervention, aggravated by default on foreign loans and threatenings by European creditor governments, occurred in the Dominican Republic in 1907, when the United States assumed control of customs collections, in Nicaragua in 1912 and in Haiti in 1915. The United States sought to strengthen its position in the Caribbean by trying to establish political and economic stability in the chaotic countries, and financial control continued for many years, accompanied by military intervention.

The development of an aggressive interpretation of the Monroe Doctrine in the Caribbean resulted in increasing objections by the larger Latin-American nations. After about 1930, therefore, United States policy began to shift toward an attitude of "good neighbourliness." The Platt amendment, which had ensured the right of the United States to interfere in Cuban affairs, was abrogated in 1934. Control of the affairs of Haiti, Nicaragua and the Dominican Republic was relinquished in the 1930s. After 1945 the United States and the Caribbean nations began to co-operate in mutual-aid programs, especially in public health, agriculture and education.

The Caribbean washes the shores of 13 independencies and many small islands. In general, the West Indies are very densely populated as a result of the development of plantation agriculture. In contrast, Caribbean coastal regions of the mainland countries are sparsely populated, largely due to difficulties of settlement in the dense tropical forest areas. The tropical highlands of those countries are more densely settled. Generally regarded as underdeveloped, these countries nevertheless provide a significant part of the world's supplies of sugar, bananas, coffee, cacao and hard fibres. Moreover, oil, produced in great quantities in Venezuela and in lesser amounts in Colombia and Trinidad, and iron ore from Venezuela and bauxite from Jamaica move across the waters of the Caribbean. The strategic significance of the Caribbean waterway was apparent during World War II when German submarines sank hundreds of freighters and tankers and even shelled the large oil refinery on Aruba. The United States, as the great consumer of most of the commodities moving across the Caribbean, is concerned about the sea—not as an American lake or a closed sea, but as an open highway with the United States in charge of traffic.

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CARIBBEE ISLANDS, generally known as the Lesser Antilles, though sometimes applied to the whole of the West Indies. The name was derived from the Caribs, the native peoples occupying most of the small islands at the time of discovery. The group includes islands belonging to the United States, Great Britain, France, the Netherlands and Venezuela. They compose a long arc of small islands extending from Puerto Rico to the northern coast of Venezuela. *See* ANTILLES; BARBADOS; CARIBBEAN SEA; CURAÇAO; LEEWARD ISLANDS; MARGARITA ISLAND; TRINIDAD AND TOBAGO; VIRGIN ISLANDS; WEST INDIES; WEST INDIES (FEDERATION), THE. (D. R. D.)

CARIBOO MOUNTAINS in southeastern British Columbia, Can., form the most northerly subdivision of the Columbia mountains. Lying within the area enclosed by the great bend of the Fraser river and its tributary the North Thompson, they extend for about 190 mi. and constitute a rugged and scenic area. Highest in the southeast where they form serrated ridges reaching 11,750 ft. (Mt. Sir Wilfrid Laurier), they rise sharply above the Rocky Mountain trench but decline gently northward and westward, merging with the eastern edge of the Interior plateau.

The Cariboo mountains are well mineralized and lode gold is mined near Barkerville, once a bustling city of 10,000 during the Cariboo gold rush in the 1860s. Aside from mining, the only significant economic activities are forestry, a little cattle ranching and some tourist catering (mostly to sportsmen). All of them (including mining) are confined to the more subdued western part of the mountains. Wells Gray Provincial park, a recreational area, lies in the southern part of the range. (A. L. Fy.)

CARIBOU, the name of the North American reindeer. There are two species, the larger woodland caribou and the barren-ground caribou. *See* Reindeer.

CARICATURE AND CARTOON. Caricature, cartoon (in the satirical sense), comic strip and animated film cartoon are a linked series of para-artistic creations. Historically they arose in the order given, but they all have flourished together. All use artistic means or mediums; caricature, which has been described as a counterart, underlies the others and is present in each.

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I. DEFINITIONS

1. Caricature.—Caricature is the distorted presentation of a person, type or action. Commonly a salient feature is seized upon and exaggerated, or features or members of animals, birds or vegetables are substituted for parts of the human being, or analogy is made to animal actions. Generally we think of caricature as being drawn in line and meant for publication to people to whom the original is known; the personal trait is usually present.

Satirical deformations and comic analogies in sculpture, the drama and vase painting are older than purely graphic caricature. The ancient Egyptians represented men as animals; Greek comedy had by-products in burlesqued figures on vases and in terra-cotta statuettes; Romanesque and Gothic sculptors made fun of human failings in stone capitals and wood miserere-seat carvings all through the middle ages. The marginal flourishes of illuminated manuscripts contain grotesque faces and occasional exaggerated scenes from daily life, or references to the morality plays which have the same relationship to those plays as Greek clay representations have to the stage. All such works verged upon caricature in the narrow personal sense; some were caricature in a broad sense. In the generations since caricature became a clearly defined idea, there have been occasional examples in painting and sculpture alongside the more usual drawing for reproduction.

The word caricature derives from the Italian verb *caricare* ("to load," "to surcharge" as with exaggerated detail) and seems to have been used first by Mosini in *Diverse Figure* (1646), which appeared in the same year as a series of engravings after the Carracci drawings of Bolognese street types. The sculptor-architect Bernini, who was as skilled a pioneer caricaturist as Annibale Carracci, seems to have introduced the word *caricatura* into France when he went there in 1665. There is perhaps, in the choice of the verb *caricare* as a source for the noun, some influence from the idea of *carattere* ("character" in Italian) or even from *cara* ("face" in Spanish). At any rate the face is the point of departure for most caricatures. It is conceivable that underlying the series of overlapping profiles with varieties of extraordinary noses and chins and brows which Leonardo da Vinci and Albrecht Dürer drew independently about 1500 was an observation not only of contemporary human types but of the fact that the heads of rulers on coins and medals, when worn with age, often became ridiculous. A latter-day case is the penny showing Queen Victoria, whose coiffure began to look like an elephant's head when the coin was well worn down.

Caricature, after its spread as idea and practice from Italy and France to Britain in the 18th century, became rather a broad term. In the late 19th century Gilbert and Sullivan spoke of an operetta subheroine as having "a caricature of a face." Perhaps, therefore, it is not surprising that, although cartoons as we now know them developed gradually out of caricature from the 15th century, the word cartoon is a 19th-century word. A London 18th-century alehouse sign, which was still in existence in 1857 and attributed to Hogarth, was the "Man Loaded With Mischief, or Matrimony," which showed a man carrying his wife on his shoulders. The use of "loaded" may indicate a knowledge of the source of caricature.

2. Cartoon.—A cartoon originally was and still is a drawing, a full-size pattern for execution in painting, tapestry, mosaic, etc. The cartoon was the final stage in the series of drawn preparations for painting in classic Renaissance studio practice. In the early 1840s, when that studio practice was rapidly decaying, cartoon rather suddenly acquired a new meaning: that of pictorial parody, almost invariably a multiple-reproduced drawing, which by the devices of caricature, analogy and ludicrous juxtaposition sharpens the public view of a contemporary event, folkway or political or social trend. It is normally humorous but may be positively savage. The British comic weekly *Punch* was born (1841) in the years when the new Palace of Westminster (Houses of Parliament) was under construction. Prince Albert and his team of artistic advisers, wishing to revive fresco painting as a means of decorating the vast wall spaces of the new buildings, opened a competition. When the cartoons of the proposed compositions were exhibited, it was evident that many of the painters were unfamiliar with work on so heroic a scale, and some of their designs were ludicrous. *Punch* was quick to satirize them in a series of "*Punch*'s Cartoons," and thus the name was reborn. *Punch* became as powerful a vehicle of political and social comment as the *Charivari* (a French daily founded by Charles Philipon in 1832), whose name it had borrowed as a subtitle. Since that time, the cartoon has depended upon the weekly and daily press for the wide circulation called for by the cartoon's recognition value. Just as the personal caricature was for an audience which knew the original, so the cartoon was and is based on wide acquaintance with the subject. It serves as a capsule version of editorial opinion when it makes political satire, and it is a running commentary on social change, sometimes a corrective to social inertia.

3. Comic Strip.—The comic strip, which developed out of the editorial cartoon in the last years of the 19th century, is a pictorial anecdote or a serial story from contemporary anonymous history. It uses the methods of the caricaturist, the cartoonist, the dramatist and the raconteur. It depends not only upon the daily press but upon syndication (*i.e.,* simultaneous presentation in a large number of newspapers, under franchise or contract with a syndicate which acts for the artists, receiving their drawings far in advance of publication dates, making the photomechanical reproductions and selling the matrices to subscribing newspapers). The indispensable features of the comic strip are: a sequence of pictures (usually 4 on weekdays and 8 or 12 on Sundays or in comic-book assemblies); the use of "balloons" of speech (though there are a few silent strips); and a cast of characters whose appearance and behaviour are stylized and predictable and therefore comfortable to the reader, and who provide daily surprise, suspense or laughter. Though occasionally a real person may appear among these characters (as the president of the United States appeared in "Joe Palooka"), they have not as a rule the personal nature of political caricature. Rather they typify currently admired categories of people, or comic-contemptible people whom one is glad not to be, or run-of-the-mill neighbours whose activities form a sort of continuous genre painting, or people from such special fields as sports, the business office, the armed forces or certain age groups. The attachment of readers to these characters is of enormous value to the artists and the syndicates. The death of an artist who has developed a successful family of comic-strip personages seldom means the death of the strip; rather it is carried on by an assistant or imitator, and it may gradually assume a new "handwriting." Division of labour is also practised. The continuity writer is almost as important in the comic-strip field as in motion pictures or television, and he often collaborates with more than one draftsman.

4. Animated Cartoon.—There have been numerous cases of interaction between the comic strip of the newspapers and the film cartoon. The drudgery of animating (filling in the stages of motion between key frames drawn by a head designer) has been the training ground of many comic-strip artists. (*See* MOTION PICTURES: *Animated Cartoons.*)

5. Relationship of Caricature and Cartoon.—It will be seen that caricature, cartoon and comic strip are often inextricably mingled. The caricaturist develops a sort of shorthand for a public man, and almost every good cartoonist develops at least one type which, despite copyrights, etc., comes like the public man into the public domain, thus enriching the political or editorial cartoon and the nonpolitical single-picture cartoon and eventually the comic strip. Conversely, such types as John Q. Public, Britannia or Peace or Labour or the Trusts may be affected by a Milquetoast, a Gibson girl, a Hokinson dowager, a John L. Lewis or a Jack Dempsey. Superman and Penny's father both have a family resemblance to the caricaturists' convention for Franklin D. Roosevelt.

The caricature and the cartoon give the reader a sense of wider reach or firmer grasp of the essences of persons, types and actions. There lies the power and popularity of the whole field of pictorial satire. Just as a member of a primitive tribe might fear to be photographed lest the possessor of his image have control over his life, so the public person must be swayed by the knowledge that a caricaturist may reveal something about him which the less observant would not have noticed. The portrait drawn by a caricaturist is an "antiportrait" belonging to a "counterart," but it is a portrait nonetheless. The caricature may be more like the man than a photographic resemblance. A public figure for whom the caricaturists have made a good symbol may wisely try to look more and more like his comic image. The public image of such a personality is to a very real extent created by political cartooning, even as the majesty of Louis XIV was largely created by Le Brun and his apparatus.

The cartoonist's skill in penetrating to the essence, in nailing down the important differentiating characteristics of people, is an eye opener to our own likes and dislikes. The uncanny eye of W. E. Hill for the cliché face and costume of the middle class, as well as his ear for the verbal cliché, would have been terrifying if it had not been of such an amiable intent. As an old verbal cliché reminds us, the gruesome and the funny are very close together. Explorations of the grounds for the power of caricature suggest that the art is akin to black magic, to hanging one's victim in effigy or sticking pins in the effigy. Perhaps it is encouraging that, in our century, most caricature is more genial than diabolic.

It is remarked both by W. Hofmann and by E. H. Gombrich and E. Kris (see *Bibliography*) that the middle ages were strong on irreverent mimicry, comic profanations of great mysteries and licentious acknowledgments of authority; and yet when personal caricature came in the high Renaissance, there was a reluctance to use so dangerous a weapon. Hofmann quotes "Jean Paul" (Johann Richter) as saying, "One's friends and relations may lead one in front of a distorting mirror, but not one's enemies." Dictators have been so aware of the power of caricature that political cartoons have often been among the early victims of censorship.

As caricature and cartoon are para-artistic, not expected to be beautiful in the conventional sense and not concerned with elegant subjects except to parody them, they have shown a certain affinity at times for forbidden subjects, erotica and pornography. From Pompeian sgraffiti and Bosch and Brueghel to Daumier, Toulouse-Lautrec and modern comic strips there have been privately circulated or at least somewhat covert variants of published material.

II. HISTORY

A. ORIGINS OF CARICATURE AND CARTOON

1. Individual Satire.—Caricature was a product of the Renaissance and Reformation emphasis on the importance of the individual. If a man was seen officially as an emperor, he was seen unofficially to have feet of clay or to be wearing no clothes. From about the first third of the 16th century the emphasis on decorum was so strong in Italy, and spread so fast northward and westward, reinforced by a still more solemn decorum from Spain, that it produced a reaction. Erasmus' *Praise of Folly* was both a Renaissance effort and a carry-over of medieval mockeries; the marginal drawings made in one copy of it by Hans Holbein the Younger (1497?–1543) are neither caricature nor cartoon in the modern sense, but they are in the same stream of subjective comment on objective observation as Leonardo's and Dürer's exaggerated profiles. Brueghel's work is full of near caricature, as in the familiar drawing of an artist who is troubled at his easel by a nosy peering connoisseur behind his shoulder. Brueghel's and Bosch's witty and sometimes horrendous dislocations of parts of the body, their combinations of human anatomy with fishes, birds, animals and windmills, and their exaggeration of obese or emaciated physical types are likewise near cartoons.

Yet true caricature in the sense of the satirical portrait of an individual is almost impossible to identify before Agostino Carracci (1557–1602). The first caricatures of persons whose names we know are by Giovanni Lorenzo Bernini (1598–1680). The Carracci workshop in Bologna and its wider circle were full of artists who possessed all the materials for a synthesis of Renaissance, Reformation and Counter-Reformation, classic, mannerist and baroque currents. They created not only a proto-Bohemian sort of artists' caste but also an academic standard for the baroque period. They could at last afford to be easy about their position and occupation, about what was objective and what was subjective. They impartially caricatured one another in the studio and the types in the street. The rise of connoisseurship and collecting in the 17th century soon produced appreciation of these caricatures outside; hence Mosini's book of 1646, the early gathering of caricature drawings into albums and the transformation of such unique sheets into multiple etched or engraved publications.

2. Social Satire.—The less personal and caricaturelike features of the modern cartoon were being slowly prepared all through the 16th century and up to the last third of the 17th. In part consciously based on Bosch and Brueghel, in part an autonomous protest against the Renaissance belief in order, symmetry and fixed canons of beauty, there rose a European family of grotesqueries with sources as mixed as its appearance. Its only visible over-all characteristic might be said to be that it reacted, from the depth of old folkways, against the novelty of the Renaissance, the new world and the various hierarchies. Echoes of the dark Gothic forests mixed with fantastic reports of travel (some of them not really new but rehashed from Marco Polo) and with travesties of the Renaissance ornament of such works as Raphael's loggias of the Vatican. One of the results was the mannerist strapwork which became international by the third quarter of the 16th century. Another was the double images of faces and landscape or of human figures built of books, fish or pots and pans by Giuseppe Arcimboldo (1530–1593). In a slightly different area lay two sorts of pictorial comedy. The first sort was the conscious satire by professional print makers, illustrating such works as Sebastian Brant's *Ship of Fools* or issued as independent prints. Some of them were tendentious to the point of libel (such were Cranach's attacks on the papacy, inspired by Luther); others were merely mockery, such as Hans Sebald Beham's satirical view of mercenary soldiers and their camp followers. The second sort was the unconscious pictorial comedy by comparatively untutored practitioners of woodcut or etching, hastily made and issued as newspaper extras might be issued now. These were the ancestors of the 18th- and 19th-century broadsides and *images d'Épinal*.

If caricature deals with the individual and with what makes him individual, cartoons may be said to deal with groups and with their corporate characteristics; both are connected with the Renaissance love of classification and categorizing. Up to the time in the mid-17th century when both caricature and cartoon jelled in forms which answer to the modern definition, caricature had been prepared on the whole by knowledgeable artists; and cartoons had been prepared (though often with the assistance of professional artists) at a somewhat lower level. Cartoons were created in response not merely to artistic impulses but to the same sorting-out impulses which were creating the modern state and its society, its science and its religion. Besides the sublime/ridiculous and the artist/laymen dualisms in this field, there is a sort of class dualism which is a result of historical factors rather than of general human disposition. The history of caricature and cartoon is intimately connected with the history of the way in which one class has looked at another. Although a Marxist would say that class warfare grows more bitter all the time, in cartooning it has grown less bitter. In the mid-20th century the political caricature or cartoon was much less libelous than it was in the mid-19th, and the most successful comic strips are often those which make us laugh at ourselves or our very near neighbours rather than scowl at a distant scapegoat. The shrinking world and the increasingly tight law of libel may have something to do with this.

Dürer looked down on the heavy-bodied man whom he called "farmerish"; yet within two generations Brueghel was drawing peasants in a sympathetic manner. Jost Amman (1539–91) made dispassionate woodcuts and engravings of trades and professions, as did Abraham Bosse (1602–76), although Bosse did utter some lampoons on unpopular types and callings. Wenceslaus Hollar (1607–77) made endless prints of types all over Europe, with considerable attention to class but without much visible prejudice. Jacques Callot (1592–1635) satirized dandies, beggars and all classes between, and he even made the generally detested gypsies (who were not yet romantic) almost sympathetic. Rembrandt was not a caricaturist or cartoonist, but there was certainly never an artist with more sympathy for the submerged part of the population. The 17th-century Dutch in general had, as a prosperous middle-class society, little pictorially expressed opinion about class, but only about behaviour (excessive drinking was merry but unsuitable). These and many other possible examples suggest a rather comfortable social climate in the 17th century: the wars of religion had quieted in France and the Low Countries, though civil war occupied Britain in the middle of the century. But by the time the Restoration had quieted Britain, a general European threat appeared in the form of Louis XIV. Against his absolutism and against his influence through agents in Britain and the Netherlands, the first modern cartoon campaign was made. It was modern in that it was on a large scale—cartoons were published on a fairly regular serial basis much like that of the modern daily newspaper's editorial cartoon (though the newspaper was still in the letter-and-gazette stage); and it was based on a fairly large and general acquaintance with the persons satirized if not always with the literary analogies used. The cartoons, which as yet made no particular use of personal caricature (that was still on a friendly studio footing), were prints made in Holland by a group of artists of whom Romeyn de Hooghe was the chief, and they were sold cheap. There had been Dutch political cartoons, but they were laborious and appeared irregularly. The Dutch-English connection in the person of William III, the continuing threat of Louis XIV and a succession of shattering events in various spheres stimulated a vast production of cartoons from the 1680s on. The South Sea Bubble, the unpopularity of the Hanoverians in England, the increasing contact of the people of capital cities with assorted foreigners and the rise of pretensions to culture all offered butts for satire. The multiplication of images, first in the coinage, then in broadsides of military or theatrical heroes and heroines, then in the reproduction of portraits of merely "beautiful people," led rapidly to the insertion of personal caricature into what would otherwise have been simply cartoons of situation. In Britain the Georges and the Jacobites were good butts, in France the profiteering ministers and such half-admired enemies as Marlborough and Prince Eugene.

The satirical print was thus in its first political maturity a way of complaining against absolutism and bad government and corruption; to put it more broadly, it was a way of rebelling against heavy-handed control and the exclusive philosophy of conduct which says, "Either. . . or." The cartoonist was already speaking up for "Both. . . and" or at least registering his "But. . . ."

As the cartoon spread—along with its almost indispensable element, caricature—it began to divide; and although the periodical carrying cartoons was not to appear regularly until the third quarter of the 18th century, nor the true comic periodical until early in the 19th, the divisions were real enough to follow from that time.

B. Personal and Political Satire (Pure Caricature)

1. 18th Century.—About 1740 the English print maker Arthur Pond published together 25 *caricaturas* after original drawings by Annibale Carracci, G. F. Barbieri ("Guercino"), Pierfrancesco Mola, Ghezzi and even Watteau (a drawing of a Huguenot physician made during Watteau's short English visit in 1719–20). This collection must have been effective in spreading the idea and the word, for it was an excellent performance. Pier Leone Ghezzi (1674–1755) was probably the first professional caricaturist, for he made a living with his pen portraits of Romans and visitors to Rome, many of which he engraved. He was a minor master in comparison to Giovanni Battista Tiepolo (1696–1770), yet the caricatures by the greater man, delightful though they are, appear to deal with types or at least with anonymous individuals rather than with namable ones. Tiepolo's pen-and-wash drawings were a small side issue in his enormous production, nor were they engraved or otherwise multiplied in his lifetime. Both artists had an eye to ungainly legs and posture, and to the odd behaviour of clothes to suit the wearer, as well as to the obvious features of the face.

On the heels of Pond's reproductions came the handbill-like personal caricatures circulated from time to time. Apparently begun in the 1760s by George Townshend (later Marquess Townshend), these were comic portraits with punning titles or accessories, intended by disingenuous means to avoid being outright libelous. A flood of imitations followed, and it was not long before Townshend's cards became comic illustrations in magazines such as the *London Magazine*, the *Political Register* and the *Town and Country Magazine*. William Hogarth produced an unforgettable half-caricatured portrait of Simon Fraser, Lord Lovat, on trial for his complicity in the Jacobite rising of 1745.

2. Early 19th Century.—*Great Britain.*—Thomas Rowlandson (1756–1827), one of the few who approached Hogarth and Daumier as a satirist, created the comic images of a great many public characters in his day: royal dukes, actresses, auctioneers, Grub street men. He was the perfect professional to carry on what the amateur Townshend had begun. Like Tiepolo he was able to make the person and the costume assume a homogeneously ludicrous or pathetic-bathetic look, with factitious coiffures, wildly frogged uniforms, enormous bosoms and bottoms and the dejected attitudes of trailing handkerchiefs.

It is interesting that the silhouette portrait (which was seldom caricatured) had its greatest flowering in the first quarter of the 19th century when costume was so picturesquely top-heavy.

Both Rowlandson and the silhouettists had lots of competition in such sound provincial caricature-portrait men as the two Dightons, father and son. Townshend's punning titles may have been transmitted to the late-19th-century "Spy" and "Ape" by the Dightons (a portrait of a broad-beamed town councilor is labeled "A View From Bladud's Buildings, Bath").

Rowlandson's contemporary James Gillray was less of an artist and more of a professional cartoonist in the modern sense. Coming from the theatre to the political scene, he brought a highly dramatic sense of situation and analogy, but he was peculiarly violent and often scurrilous or scatological. His pleasantest gift was with patterns and ornaments of costume, which he would allow to take on a luxuriant life of their own, almost foretelling Saul Steinberg's ornament. The Swiss-born English painter and teacher Henry Fuseli (1741–1825), though hardly a professional caricaturist, stood halfway between the painted italianate caricature groups of Sir Joshua Reynolds and the Rowlandson-Gillray drawings and etchings; he had something of Gillray's theatrical manner, but his satirical drawings were more often sensual than scatological.

France.—Philibert Louis Debucourt (1755–1832), coming to maturity in the days of the *merveilleuses et incroyables*, might have equaled Rowlandson if he had not been so occupied with the intricacies of colour prints; but he produced a few superb cartoons of the Paris of his day, full of caricatures of fashionable personages.

The whole Napoleonic period gave rise to such passion that, besides the British caricaturists of "Boney," a school of French caricature was generated, the effect of which was to come after the Restoration. Two members of an older generation, Louis Léopold Boilly (1761–1845) and Jean Baptiste Isabey (1767–1855), really began the work. Boilly, starting where Debucourt left off, satirized the modes and manners of the French, often reflecting in his caricature the wide general interest in the physiognomical publications of Lavater (*q.v.*). He was not in the direct sense a political caricaturist but frequently used portraits.

Isabey was primarily a portrait painter, but he was in contact with all the great continental political personalities of the first half of the 19th century, and he caricatured many of them privately. Most of the caricatures were not published, but they had an effect among artists, as did those of Goya's prints which made their way to France.

The tendency of the Restoration to suppress Napoleonic enthusiasms provided another rich ground for cartoon as political complaint. As soon as the first stage was over (in 1830), a change of administration was accompanied by the appearance of Charles Philipon's periodical *La Caricature*, the first great vehicle of Honoré Daumier (1808–79), Henri Monnier (1805–77), Grandville and others. The presiding genius had great politico-legal skill, and knew exactly how far he and his artists could go. The famous likening of Louis Philippe to a pear, which was both a visual and a verbal pun, was not the least of *La Caricature*'s successes. Daumier's colossal gifts included personal caricature, though in his later life he dealt almost entirely in more general social satire. In the early '30s he created for Philipon "Le Ventre législatif," at once a political indictment, a rogue's gallery of caricatures and a monumental composition; not to mention a long series of more detailed single antiportraits. Daumier's composite sociopolitical villain, Robert Macaire, and Monnier's Joseph Prudhomme, the sum of bourgeois pettiness, served as butts of satire when censorship caught up with directly personal caricature in Philipon's three or more overlapping papers.

3. Middle 19th Century.—*Great Britain.*—The specifically cartoon-bearing journal was at this time an established fact. The *Monthly Sheet of Caricatures* had begun publication in London in 1830, lithographed like Philipon's journals. In these and other of his ventures, the publisher Thomas McLean issued hundreds of political caricatures during a great formative period of modern legislation; his artist Robert Seymour was in the Gillray line rather than the later one of John Doyle, who also worked for McLean. There were naturally transitions: George Cruikshank, though he continued to use etching as Rowlandson and his own father Isaac Cruikshank had done, was Dickensian, not Sheridanlike; Seymour used lithography. John Doyle's son Richard became one of the masters of the mid-century British school of subtler cartooning. The younger Doyle was one of the initial staff of *Punch* when Henry Mayhew started it in 1841; others were John Leech and—later—Charles Keene, Sir John Tenniel and George du Maurier.

Punch began as a fiercely democratic weekly which applied to the young Queen Victoria and her growing family, as a matter of course, the same savage treatment that had been given by caricaturists of the previous hundred years to the Hanoverians. One of the reasons for "*Punch*'s Cartoons" on the Westminster hall exhibition was that the unpopular foreign Prince Albert had fomented the competition. But *Punch* was not so much merely antiroyal as it was antihumbug (Thackeray after all was another of the staff). Though its first few years were marked by some of the worst puns in a punning age, it not only kept up, with its fairly small fixed staff, a remarkable fire of lampoon but soon developed the weekly full-page political cartoon, certainly one of the chief ancestors of the modern editorial cartoon. Nineteenth-century British and general European politics might be briefly comprehended in a few dozen of these. The most famous is probably still that farewell to Bismarck, "Dropping the Pilot," by Tenniel.

The woodcut technique used for many decades in *Punch* caused the cartoons on the political page, the largest in scale of the cartoons, to be almost invariably dull in surface. The speed required of the divided-labour teams which produced the cuts from the artists' drawings did not allow for the subtleties possible in such collaborations as Tenniel's *Alice in Wonderland* illustrations, which were almost as much a creation of the Dalziel shop as of Sir John. The political page, however, even when artists and woodcut technicians were far below the brilliance of a Daumier, kept even Disraeli and Palmerston sufficiently under surveillance to have a strong effect. Yet the tone of *Punch*, once it had reconciled itself in 1851 to Victoria and Albert, was marked by aptness rather than pungency, and social satire was its best field in cartoons. A sometimes neglected source for the rather cool pictorial manner of *Punch*'s artists was the etched portrait caricatures of Alfred d'Orsay, belonging in style to the Regency generation but much reprinted in book form in the mid-century. They were thin lined, very open and white and elegant, the heads always a little too large.

The United States.—The young United States began to produce caricature and cartoon in good time. At first there was not quite enough objectivity of observation to allow the right balance with subjective opinion and interpretation; to some extent this was compensated for by the unconscious humour of comparatively untutored artists. Paul Revere's engraving of the Boston Massacre is certainly not a cartoon; it has proper political passion—something important to say—but no caricature except what lies unconsciously in the rather stiff drawing. The founding fathers were almost too sacrosanct to caricature, though Burr and Hamilton caught the eye of budding American cartoonists in the Gillray vein, and the War of 1812 brought out some good sheets of the same sort. Andrew Jackson, though on the whole a well-liked president, had so roughhewn a head that he became one of the best subjects for caricature, and Abraham Lincoln's great height and gauntness would doubtless have made him a cartoonist's favourite even without the passions of civil war.

Yet there was not a cartoon periodical in the manner of *La Caricature* and *Punch* until after the American Civil War. Single-sheet cartoons, usually lithographed, were common; the publishers, among whom were N. Currier (later Currier & Ives) and H. R. Robinson, overshadowed the artists at first. Two circumstances may have combined to delay the appearance of a great caricaturist: first, the fact that above all in the United States the middle third of the 19th century was an age of oratory; second, that the combination of the telegraph with the facilities of the daily paper made news, especially during the war, even more desirable than opinion. The great fighting words of the time (*e.g.*, "copperhead") came from editorial writers rather than artists. The earliest really impressive makers of personal caricature and political cartoon were David Claypoole Johnston (1799–1865) and Thomas Nast (1840–1902). Nast first made his name with war cartoons in *Harper's*

Weekly, which like *Punch* used the woodcut process, with an elaborate division of labour in the back shop for the rapid reproduction of cartoons and correspondents' drawings.

Italy and Germany.—The middle and late century produced in Italy so brilliant a political caricaturist as Virginio, who was to the rise of Italian nationalism what Nast had been to the North in the American Civil War; he worked for *Il Fischietto* of Turin. In 1848 *Kladderadatsch* started in Berlin. Munich had *Fliegende Blätter* and *Punsch. Punsch* was more political than the others, which were long-lived comic weeklies in the social-comment style. Schleich's *Punsch* cartoons were a running Bavarian comment on Prussianism.

4. Late 19th Century.—*The United States.*—In the boom days of the 1870s Thomas Nast became a master of personal satire; his long practice in dealing with the professional wood engravers gave him at last a style and scale that triumphed over finicky cross-hatching and gave full effect to his ruinous attacks on "Boss" Tweed and other grafters; he was one of the most fertile of symbol makers outside the personal field, and is probably the creator of the Democratic donkey as well as of the New York tiger, the label for Tammany Hall.

In 1876 *Puck* was founded. It presently developed new artists, notably Joseph Keppler (1838–94) and Bernhard Gillam (1856–96). They worked in a lithographic style of considerable artistic competence, without the force of Nast or the effortless flow of Daumier, but with plenty of clever analogies and with an understanding of the sort of likeness required in caricature. The oratorical heritage caused a certain amount of literary reference not unlike that of the *Punch* political cartoons.

England.—*Punch* meanwhile had settled into its richest period, with Sir John Tenniel and Harry Furniss as political cartoonists. *Vanity Fair* (from 1868) offered some competition, especially at first with its regular coloured lithographic antiportraits. These were signed "Ape" (Carlo Pellegrini) and "Spy" (Leslie Ward, later knighted); they kept up a steady supply of big-headed comic figures against an almost invariably blank background. They also kept up the old device of never quite naming the subject in so many words, but as they were directed at a public which was "in the know," this was part of the fun. These colour caricatures, though they lacked the elegant line of a Gavarni and the occasional stabbing trenchancy of a Nast, were much loved, and were often framed and hung on private walls. Max Beerbohm (1872–1956; knighted in 1939) devoted himself largely to social and literary satire but almost always on a basis of personal caricature. His deceptively understated outlines and pallid washes, the latter used as local colour for the sake of the over-all design, were the perfect means for parodying the good taste of the *fin de siècle.* His symbols for Chesterton, Shaw, Conrad and Maugham have become almost the standard views of those writers.

Technical Developments.—Toward the end of the century there was a rebirth of personal satire which accompanied new techniques of reproduction and perfected enrichments of such older techniques as colour lithography. Photomechanical reproduction, especially after its loosening through the development of halftone, allowed direct reproduction of the artist's drawing without personal interpretation by wood engravers or other technicians. Colour lithography, which had been either limp or turgid on the whole, found in the train of Impressionism a blond new life. The caricaturists who had been able to draw directly on the stone, as Daumier did, had always had more freedom and better control over results than those who worked with pen and paper; now the latter could depend upon themselves and a photomechanical servant. *Le Rire* in Paris (from 1894), the *Yellow Book* in London (same year), *Simplicissimus* in Munich (from 1896) and *Judge* and *Life* in New York (from the early 1880s) showed the work of Jean Louis Forain (1852–1931), Henri de Toulouse-Lautrec (1864–1901), "Caran d'Ache" (Emmanuel Poiré; 1858–1909), Max Beerbohm, Aubrey Beardsley (1872–98), Olaf Gulbransson (1873–1958), Thomas Theodor Heine (1867–1948), Rudolf Wilke (1873–1908), Eduard Thöny (1866–1950), Charles Dana Gibson (1867–1944) and dozens of others.

France.—Toulouse-Lautrec produced large-scale posters and, earlier, polychrome lithographs for *Le Rire* and for independent distribution. He created a new style of informal composition, somewhat influenced by Japanese prints, with bright clear colour, broad, rather casual outlines drawn largely with the brush, a trick of making tone by means of spatter and a wit which saw through ugliness to a new sort of eloquence. His view of Oscar Wilde was more economical and even more devastating than Beardsley's, and his caricatures of theatre and music-hall personalities are unmatched. Caran d'Ache worked on a smaller scale with pen and brush, and was one of the most effective continental commentators on the South African War.

Germany.—The *Simplicissimus* men were all somewhat influenced by Toulouse-Lautrec in their use of white space, spatters and often random outline; they all commented on those features of German life which were most disliked outside Germany—the didactic professor, the tourist and the military dandy. Their caricatures in the last field were very thinly veiled; Eduard Thöny, one of this group, had a mixed feeling for the dash and style of uniforms and against the upper-class boorishness of Prussian officers; his very large-scale brush drawings would seem to leap from the page if they were not so carefully hung up by their heads in a manner deriving distantly from Whistler.

5. 20th Century.—*The United States.*—Charles Dana Gibson was a virtuoso of the pen, using the manner of *Punch*'s Phil May as a point of departure. He used the pen as he pleased, sometimes in a direct descriptive manner, sometimes with colouristic suggestion, sometimes almost antigraphically. Though he helped to create the caricature types of Theodore Roosevelt and Woodrow Wilson, he was more a social than a personal caricaturist. He is mentioned here chiefly because of his introducing to the world American physical types called "Gibson girls" and "Gibson men." He was not really very funny but was a good editor of *Life.*

A position much like that of *Simplicissimus* was occupied in the years 1911–17 by *The Masses* of New York, which had an editorial policy based on old-fashioned socialist idealism. It was served by a remarkable group of artists whose fine drawing made their often sharp propaganda for reform tolerable in quarters where they might not otherwise have gotten a hearing. John Sloan (1871–1951), George Bellows (1882–1925), Boardman Robinson (1876–1952) and Art Young (1866–1943) were as likely to deal in general social terms as in personal ones, for by this time personal, particularly political, caricature was tending to move into the newspaper editorial cartoon or the pages of theatrical or sporting news. Bellows and Sloan were not only excellent painters but also independently lithographers, and Robinson was a fine mural painter and teacher; Art Young lived to work for the *New Yorker.* Will Dyson and (earlier) Walter Crane were British equivalents.

Photomechanical reproduction not only allowed greater freedom for comic artists; it made possible the daily newspaper cartoon and later the syndicated editorial cartoon and the comic strip. From about the same time as the new generation of weeklies we can see a rise in the use, the autographic character and the influence of pictorial journalism. John T. McCutcheon (1870–1949) of the *Chicago Tribune,* though he used a rather dry and old-fashioned pen technique, was able to range over a world that included politics, the "good old days," the mores of the moment and sports, as well as over a great network of newspapers to which his work was syndicated. His cartoon world, like that of *The Masses,* was almost entirely urban, but he was one of the first of a generally imperturbable type of American cartoonist, whose view is amused rather than aroused. And his career ran from before Theodore Roosevelt to after Franklin D. Roosevelt's time. In his line of succession stood such men as Edwin Marcus and S. J. Woolf in the *New York Times,* Oscar Cesare of the *Sun,* Herbert Block ("Herblock") of the *Washington Post,* Daniel Fitzpatrick of the *St. Louis Post-Dispatch,* Rollin Kirby of the *New York World-Telegram,* Tom Little of the *Nashville Tennessean* and others too numerous to list.

England and the Continent.—Though *Punch* continued to have first-class draftsmen in the 20th century in the daily-life sort of cartoon, Sir Bernard Partridge was not a very exciting political caricaturist. His ponderous allegories used twice as much ink as

Charles Keene would ever have needed, and three times as much as Phil May. May, who was to the aging Gladstone what Tenniel had been to the young Disraeli, could do in a few zigzags what Leech had had to hatch in with more evident labour. Phil May had served an apprenticeship in New South Wales and was in a sense the forebear of David Low (1891–1963), a New Zealander who worked for the *Sydney Bulletin* before going to Britain. Low was perhaps the best all-round man in the field since Daumier. His brush drawing was of an oriental economy, his invention of analogy gleeful without being really outside the classic British educated tradition, and his hatred reserved for a few needful occasions. Like many before him, he employed hackneyed devices (*e.g.*, the heads of a pack of British politicians on dogs' bodies), but by slyness of expression always managed an original twist. In the *Manchester Guardian* and the *Evening Standard* he was the outstanding political commentator of the first half of the 20th century. Indeed there was almost no one in the political field to touch him except for the Dutchman Louis Raemaekers during World War I, and Raemaekers, for understandable reasons, was bitter where Low was dry and crisp, with footnotes of rumbling laughter. Sennep of the Paris *Figaro* and Fritz Meinhard of the *Stuttgarter Zeitung* may be mentioned in the same breath, and that is about all.

C. Comedies of Manners (the Cartoon)

Modes and mores are among the outward and visible signs of anonymous history. Each one of us is in the midst of them, and therefore when the cartoonist invites us to back away and look, we look at ourselves, not at an alderman or a queen or an eminent musician. Types and groups rather than politics and the politician or any namable individuals are the concern of the comedian of manners. He may love mankind for its imperfections, or set out to seek improvement, but his method will be much the same. He does not need, as the political cartoonist does, to set up allegories and analogies or to write names on labels, but he may sometimes sharpen his comment by treating human beings as animals (monkeys and apes for obvious reasons have long been the favourites, along with dogs and birds). If the personal caricature is an anti-portrait, the cartoon on human foibles is often a sort of anti-sumptuary law or a countergrammar which says, "The exceptions are more fun than the rules."

1. 16th to 18th Century.—Brueghel and Callot were certainly comedians of manners. Brueghel's picturizing of Flemish proverbs, themselves often comments on foibles, and his prints of the seven deadly sins with satirical examples filling the backgrounds combine a bit of moralizing with a delighted participant's empathic sense of the *flagrans delictus*. Callot is a shade more detached, possibly because of his more conscious style and because he was himself the print maker (Brueghel drew for professional engravers and woodcutters); but in the catalogues of byplay in his panoramic scenes of fairs and in his trick of making the beggar wear his rags handsomely he is always balancing and measuring.

Parallel to two-dimensional comment in this vein ran the theatre, notably the puppet theatre, and the performances of the jester and clown. The jester, to all intents and purposes, disappeared into such things as Rabelais's *Pantagruel* before the cartoon had acquired its modern form, though the clown certainly did not disappear into Molière. Both appeared, however, in the rather courtly comic drawings of Claude Gillot (1673–1722), Watteau's predecessor. These are not really comedies of manners, for the clowns are used as if they were monkeys aping human ways at a remove toward greater elegance rather than toward apishness. They point the way to a good many 18th-century practices: Gillot and Watteau both made decorations which included monkeys, just as Boucher and later artists were to use pseudo-Chinese scenes occasionally as ways of commenting on contemporary European life.

The *singerie, turquerie* and *chinoiserie* were all in the line of succession from medieval morality plays and their underlying folk wisdom, as well as more immediately from the *commedia dell' arte,* the formalized successor to the moralities. Harlequin, Columbine and the other characters of the *commedia* gave rise to a vast body of popular caricature.

Hogarth.—It is with Hogarth that the cartoon of manners reached great stature. His series "Marriage à la Mode," the "Rake's Progress," the "Harlot's Progress," the "Four Stages of Cruelty" and the unfinished "Industrious and Idle Apprentices" were loaded with observation not only of human beings but of objects and their ecology, as if he were using his own proliferation of comic images in protest against waste of time, talents, life and pride. Hogarth, like Reynolds after him, even painted comic subjects, but he kept to social satire and avoided personal caricature. His pictures of depravity and ferocity are hard to beat, but he could put an expression of by no means unholy delight on a wicked face. In the "Laughing Audience" he gave a full measure of laughter. Hogarth's engravings ran to very large editions, and were recut and reissued and then copied at reduced scale for books of the *Complete Works*.

2. 19th Century.—*Rowlandson and Cruikshank.*—Rowlandson, as we said, was a political caricaturist part of the time, but above all he was a lampooner of ludicrous and excessive behaviour. He created almost unaided a gallery of types missed by Hogarth, many of which persist in British life—the antiquarian, the old maid, the harried foreign servant, the pleasantly blowzy barmaid, the decent old parson. He was by no means as bawdy as he is supposed to have been, but he liked to push action, like appearance, to an extreme. His Dr. Syntax may be called an ancestor of the comic strips.

George Cruikshank (1792–1878) carried Rowlandson's methods almost beyond extremes in his youth. He used superfantastic costume and sometimes that device of enormous heads which some 17th-century caricaturists used and which is still used by sports-page cartoonists and comic advertising artists.

Goya.—Francisco de Goya (1746–1828) of Spain is hard to place. His "Caprichos," etchings prepared by some of the most simple and trenchant brush drawings ever made, appeared in the last years of the 18th century, and can be called comedies of manners only insofar as they are related to folk sayings and the bittersweet Spanish folk wisdom. Thus they stand in the line of Bosch and Brueghel, so many of whose paintings were in Habsburg collections in Madrid. The "Proverbios" of 1815–19 are even more monumental transfigurations of various states of the human condition. Like the "Caprichos," they used the caricaturist's means for irony and satire, but there was little of the comic left in them, and none at all in the "Désastres de la Guerra," which used the Peninsular phase of the Napoleonic Wars as a point of departure. They are closer to universality than even Callot's similarly inspired series and are searching comments on more stages of cruelty than Hogarth covered. In them, Goya was really a political cartoonist using no names; yet he was hardly a public cartoonist in the normal sense because censorship and other factors allowed only a very small circulation of his later work until a sizable edition was printed a generation after his death. The earlier work, which contains elements of comedy, did get abroad, and had influence in France and England probably before Goya's death. Artistically if not politically his work would have had the same powerful effect whenever "discovered" or circulated.

Gavarni, Guys and Grandville.—"Gavarni" (Sulpice Chevalier; 1804–66) was more purely a comedian of manners than Daumier. Though more tender with his lithographic crayon, he was no less perceptive, no less sympathetic with the *petit parisien.* At the same time he had a grace derived from his apprenticeship in fashion illustration (which he and Eugène Lami practically invented) that produced enchanting jokes on young people in love, dandies and the theatre and circus. He worked late in life for the *Illustrated London News,* as did Constantin Guys (1802–92), the foreign correspondent who reported the Crimean War. Guys, a prolific draftsman who always kept a comic touch, was peculiarly subtle in reporting the great but contrived elegance of Napoleon III's court. He helped both British and French to see themselves as others saw them. "Grandville" (J. I. I. Gérard; 1803–47) was a comic artist on *La Caricature* who recalled some of the complicated inventions of Arcimboldo; his big-headed people seen as if in distorting mirrors and his animal analogies have been considered among the sources for *Alice in Wonderland*.

Daumier.—Daumier was of course the great master of social comedy with or without political content. His series of affectionate if disenchanted comments on married life, the theatre, the courts, concierges, musicians, painters, bluestockings, bathhouses and children constitute as full a report on Paris in his time as Rembrandt's drawings were for his Amsterdam. The words were often important, especially when Daumier was indicating in his text the unspoken thoughts of his characters (thus anticipating the 20th-century cartoon in which a thought or vision is indicated as a "balloon" with cloud-scalloped edges and a picture rather than words inside). His often untidy line and knowingly casual accents of tone produced (at will) sensations of chill weather, of ecstasies of gluttony, of juvenile pride or of legal craftiness.

Punch.—With the longest continuing habit and tradition of humorous comment on the passing world, *Punch* is the only institution that approaches Daumier's personal accomplishment. Though it began in puns and peevishness, it warmed up with John Leech (1817–64), Charles Keene (1823–91), George du Maurier (1834–96), George Belcher (1875–1947), "Fougasse" (Kenneth Bird, 1887–1965), H. M. Bateman (1887–1970), Nicolas Bentley (b. 1907); E. H. Shepard (b. 1879) and Osbert Lancaster (b. 1908). Leech was in a sense the pictorial equivalent of Thackeray (Thackeray was an excellent comic draftsman, but better at getting the feel of past time with a comic flavour than at considering his contemporaries other than in words). Leech and Keene belong to the era of wood-engraved reproduction; when we see their original drawings and manuscript captions or dialogue, we see that something was lost in detail and finesse of line, but nothing in sense of comedy, in the affectionate tone. The enormous afflatus of the optimistic Victorians, expressed at first through the violent or bumptious Regency manner of the young George Cruikshank, was tempered by the staff-meeting or meeting-of-minds conduct of *Punch,* perhaps by Arnoldian and other outside influences. The "manners" part of the phrase "comedy of manners" became subjective as well as objective. *Punch* became and continued for three or four generations an upper-class weekly, reflecting the large knowledge of all classes which it was possible for its staff to offer its readers, and the large delight of the upper class in seeing its own foibles and those of its servants, tradesmen, lame ducks and "climbers" exposed. C. R. Ashbee (see *Bibliography*) has remarked on the importance of representing and manipulating dress in the 19th-century cartoon. There may have been more nuances in dress from du Maurier's to Belcher's day than we now know, but dress is still certainly one of the quickest and most comedy-susceptible points by which an artist may identify his subject. The swing of a crinoline by Leech and the curl of a cabdriver's hat-brim by Keene were perfect selective imitation, themselves almost inimitable; the crinoline and the hat are gone with those who knew how to wear them, but the picture in *Punch* remains.

Of the five-sided conversations (with parenthetical stage directions) printed under the drawings of the du Maurier period, the less said the better, except that the dialect was better than the dialogue, whether it was that of lisping young swells or the native notes of Somerset or the refined tones of footmen. The du Maurier drawing-room drawing, which certainly had an influence on Charles Dana Gibson, was (so to speak) poor in vocabulary and rich in syntax, as is usually the case with anything made for an initiated circle.

Photomechanical reproduction came in during du Maurier's day but hardly affected his generation of artists. Phil May's pen was better served by the camera and the zinc block than Leech's had been by end-grain boxwood and gravers, but the general language was the same. With the generation of George Belcher there was a great change. His own crumbly charcoal or crayon strokes were perfectly adapted to the new process—indeed it was mutual—as were the fat blacks of Forain and the mid-20th-century cobwebs of Emett. Fougasse's highly personal little curly stick men, drawn perhaps with a signwriter's pen, could be reproduced by almost any method, but the sharp lines and solid black areas of Bateman (deriving ultimately from Beardsley's decorative style) and the thick-thin pen strokes of Shepard (more in the Keene tradition) were well served by modern processes (see *Technique*). Shepard was more truly an illustrator than a cartoonist, but Bateman's towering humours and bulging-eyed apoplectic businessmen were in the direct line from Edward Lear to such frantic American cartoonists as Virgil Partch.

Busch and Lear.—Edward Lear is almost as hard to place as Goya. He practised as comic draftsman an economy and geniality that are hard to improve upon, but like Daumier he supposed that his own best gifts lay in another field. Humour had been brought into satire by Hogarth; a truly funny style of drawing was brought into cartooning by Lear and by Wilhelm Busch (1832–1908), the creator of *Max und Moritz* and a grandfather of the comic strip. Hitherto, standard drawing techniques had been applied to grotesque shapes and comic situations (Grandville's lithographic method was the same as Delacroix's). But Busch's lines seemed to parody in themselves the graceful contours of the serious artist, they gasped or hiccupped or stuttered, while Lear's went wandering off into a sort of joke on calligraphy (later to be described by Paul Klee). Furthermore, both these men traveled into areas of fantasy previously barely hinted at—Busch into wildly inventive naughtiness beyond the call of the bad boy's duty; Lear into solemn *non sequitur* of proto-Surrealist character ("There was an old woman of Leeds, Whose head was infested with beads. . ."). Neither can be called a direct critic of modes and manners, yet Busch's view of German middle-class life was sharper than Moritz von Schwind's, and Edward Lear was in a sense doing what the monkey pictures and *chinoiseries* had done. His people were outlandish whether they came from Cádiz or Dorking or Kamchatka, yet they represented *us,* and the satire was purely social and apolitical. Both the wild improbability and the spiky ungracious drawing of Busch and Lear had an ancestor in Heinrich Hoffmann's *Struwwelpeter,* whose adventures, with the original cuts, have been reprinted in many languages for many generations. *Struwwelpeter,* however, contained a sadistic element which, while ignored by the young, has at last begun to seem deplorable to their elders.

Beardsley.—Beardsley is also hard to place. He used caricaturist's methods but little of his work, except perhaps the illustrations to *The Rape of the Lock,* was actually caricature or cartoon. If some of Cranach's prints can be called illustrated libels, some of Beardsley's can be called illustrated yearnings by unfrocked lechers. They are important because their combination of large white spaces, clear lines and solid or slightly irritated blacks could be reproduced successfully in a choice of dimensions, and thus laid down a discipline for illustration, commercial art and the comic strip.

Illustration.—In the great period of illustration from the introduction of process and halftone to the perfection of colour film, there were numerous interactions between illustration and cartoon. If du Maurier's cartoons and Gibson's were often only illustrated wordy jokes, the illustrations of Randolph Caldecott, Arthur Rackham, Howard Pyle and A. B. Frost were often full of caricature. Frost in his illustrations to *Uncle Remus* was as much a cartoonist as E. W. Kemble in his Negro subjects in *Life*. Palmer Cox's "Brownies" in the American children's magazine *St. Nicholas* were among the forerunners of the comic strip; and there were still serially published independent cartoons in the tradition of Gillray, for instance the "Dark Town Fire Brigade," coloured lithographs by Thomas Worth which were among the last truly lively publications of Currier & Ives in the mid-1880s. Seventy years later the democratic conscience had grown tender enough so that jokes about minorities had to cut across colour lines or avoid them.

3. 20th Century.—The whole tenor of pictorial comedy was shifted by World War I and by the boom times thereafter. Some previously forbidden subjects became admissible. Political caricature during and after the war was excessively partisan, while the cartoons about the war itself were lenitive. Bruce Bairnsfather's Old Bill and his colleagues in Britain and the poilus of Poulbot in France got through it by joking. After it was over, the public for comic publications was greatly enlarged; while the newly rich were standard butts for cartoonists catering to all classes, they were themselves buying comic weeklies.

In the United States the usually monthly comic magazines of universities and colleges had a sudden flowering, to such an extent that an anthology of their cartoons called *College Humor* was published for several years in the 1920s. The syndication of comic strips, which had originally been for an urban audience, called for a broadening which was reflected in weeklies. The tendency of previously serious weeklies to use small cartoons here and there, or to insert a funny page somewhere, created not only new markets for cartoonists but also a temporary decline in the purely humorous magazines, and *Punch, Life* and *Judge* had difficulty surviving the depression of the 1930s. The title of *Puck* had already passed to a newspaper chain which used it for a Sunday supplement, and the title of *Life* eventually passed to a periodical of different character. *Simplicissimus* never quite rose between wars to its pre-1914 stature; the effort which went into Dadaist and Surrealist publications in Germany and France in the '20s, when art itself became an object of social satire, meant a loss to other comic publications. Meanwhile the public in general gradually became aware of modern art, and its presumed incomprehensibility became almost as routine a subject by 1940 as mothers-in-law or freshly painted park benches.

In the United States an older generation of humorists somewhat of the upper-class *Punch* style lingered briefly after World War I. Of such were Oliver Herford, whose *Alphabet of Celebrities* and other comic verses with pictures were published as small books; Peter Newell, whose highly original *Slant Book, Hole Book,* etc., had a sharp eye to late prewar costume; Gelett Burgess, whose *Goops* for children were spaghettilike little figures whose behaviour pointed a moral.

But to these was now added a new generation of sophisticated but slightly flashier performers, many of them with theatrical connections, many at first employed by the fashion magazine *Vanity Fair* and later by the *New Yorker* (beginning in 1925): Ralph Barton who did superb roués; Rea Irvin of the thin trembly line, poached eyes and almost oriental splendour; Gluyas Williams and Ellison Hoover who satirized business, industrial labour and other subjects not well known to the *Punch* tradition; and Alfred Frueh, whose caricatures of theatre people were Toulouse-Lautrec with a difference. The depression of the 1930s brought forward a few artists with a genius for social protest, few of whom had any real sense of comedy because tragedy was not to them, as it had been to Daumier, the other side of the same coin. Käthe Kollwitz in Germany was a fine artist and could have been a great cartoonist; in the United States the communist *Daily Worker* had the services of William Gropper, a distinguished lithographer and editorial cartoonist who was sometimes able to capture something of the humorous tone of the prewar *The Masses*. And it gradually became known that in communist Russia a comic magazine called *Krokodil* was allowed to gibe at the ways of its brothers and even occasionally of its masters.

The New Yorker.—The two most interesting features of cartoon and caricature in the first half of the 20th century were the rise of the one-line joke and the pictorial joke without words, and the enormous diversity of styles of drawing. The *New Yorker* was probably the inventor or reinventor of the one-line joke, certainly its chief fomenter. Five-decker dialogues with headings were swept away even from *Punch,* and there was a greater unity of words with picture, paralleling the tendency toward tabloid newspapers with large photographic halftones and very pithy text. The joke without words, often in two or more frames, was the extreme of economy of language. One result of this change was that the comedy-of-manners cartoon must convey its comment entirely through costume, setting and (to a lesser extent) situation, and the emphasis thus tended to fall more on comic situation than on plays on words, class differences or marked action. The *New Yorker* and magazines whose cartoons had been influenced by it aimed at a sophisticated audience. The *New Yorker* itself, while enjoying in its maturity a position equivalent to that of *Punch* in the 1880s, aimed its advertising and much of its writing at upper-income classes, but its cartoons were aimed at the classes described as highbrow and upper-middlebrow. Such appanages of the old-fashioned British-style upper class as servants were always treated by *New Yorker* cartoonists (notably Mary Petty) as necessarily comic fossils of an old order, and hence in rather than out of that old upper class. Whole new areas of social-comedy subject matter arose in this magazine: the life of the Jewish community, the fauna of bars, the managerial class and its flavour, the lighter side of the well-kept woman, commercialized sports and the imagined life of colonies or races of antisocial beings (Charles Addams' people).

Modern Art Influences.—The diversity of styles of drawing reflected the influence of Postimpressionist art quite as much as did the use of modern art as a subject for jokes. The great draftsmen who were on the edges of Impressionism (such as Toulouse-Lautrec) had much influence on caricature and cartoon; while the same photomechanical reproduction which forwarded the latter communicated modern painting to a vast public. Nonobjective art can parody only itself; therefore there has hardly been such a thing as a nonobjective or abstract cartoon; but every other phase of modern art has affected caricaturists, except perhaps on the editorial page where a conservatism like that of the literary editorial tends to reign. The loose, almost deliberately ugly method of the Expressionists got into some of the single-cartoon commentators to such an extent that their shorthand was sometimes difficult for those who did not read them daily. The meandering willful line of Paul Klee certainly influenced Saul Steinberg; the Cubists' studies in African sculpture were echoed in Covarrubias and Virgil Partch; the "classical" period of Picasso in R. Taylor and others; the curving economical line of Matisse (oddly enough) in Richard Decker. For some other influences see *Technique*. Occasionally cartoonists parodied one another: Oliver Herford once presented Gibson girls as paper dolls without expression; Al Capp in the comic strip "Li'l Abner" parodied "Dick Tracy" from time to time.

The Cartoon of Predicament or Situation.—The comic strip having taken over the comic presentation of events almost completely, especially since the rise of the one-line joke or picture caption, the modern cartoon became one largely of situation, or of predicament which was stated without a solution's being worked out or suggested. The mother of a side-show circus family, confronted with more than she can manage, simply says that after all she has only three hands; a young girl is in ecstasies over a sunset, while behind her a bearded artist-stereotype says, "Too much purple." Meanwhile the longer sort of comic anecdote retreated to a purely oral-aural life or to the bound volume of jokes, where it sometimes had a vignettelike illustration.

The cartoon of situation was certainly not new, but it predominated in the first half of the 20th century. Such a Daumier lithograph as the one showing a very fat woman in crinoline climbing into an omnibus bore no dialogue, but simply the caption, "A mere nothing, and the bus is full." This was a cartoon of predicament. There has tended to be a cluster of these situation subjects: the desert island no larger than a hearthrug, the man who meets a woman walking and imagines her naked (in a scalloped "balloon"), the flying carpet with novel chauffeur or passenger, the picture gallery with mutual reaction between work of art and viewer, the psychoanalyst's couch, the big-game hunter's trophy room. If the situation was clear, not even one line of joke was required. Such cartoons had a sort of family connection with the earliest caricatures, but they were not merely antiportraits of types, they were portraits with accessories which created the predicament. So were the tiny single woodcut figures which were inserted as pictorial puns into the text pages of *Punch* in the 1840s. But the latter-day predicament may be highly complicated; in the hands of such a cartoonist as George Price, whose split pen line built up tattered edifices of dowdiness, or Emett, whose fantastic locomotives and wispy codgers were half infernal and half heavenly, the comedy came from an accumulation of frustrating but ludicrous detail. Frustration, that renowned companion of modern life, was dissolved by laughter. Even the presumably invincible American businessman was often represented in cartoons in frustrating situations, often briskly indicated by the graphic lines on the charts in his office (Whitney Darrow was good at these). André François, who worked for both French and British papers, was a master of the rapidly sketched situation; so was the two-passenger cartoonist (a man and a woman jointly using the name "Anton") of *Punch* who kept up the tradition of satire through clothes, being particularly good at pseudo-Edwardian nattiness. In the drawings of the Rumanian-born Saul Steinberg there was almost a parody of the cartoon of situation, for his lines doubled back on themselves and bit their own tails, the hand was indicated as drawing the portrait of which it was a part, or the frustrating details positively engulfed the subject (a wicker chair taken over entirely by its curlicues; tattooing extended beyond the tattooed man; the woman with a lozenge-shaped face, on her lap a baby whose lozenge-shaped face is one-quarter of the larger lozenge).

Yet there were also extraordinarily simple performances: Jean Effel's unassuming little people with their blocky legs moved gently through the trials of Adam and Eve; Jacques Faizant's bad children produced hilarious effects by conveying their concentration in a few lines; Otto Soglow's stenographic vocabulary of forms for human bodies (perhaps slightly indebted to Burgess' *Goops*) was so graphic that it could be used in minuscule dimensions with perfect legibility. On the other hand, Peter Arno's large-scale and heavy outlines, despite simple straightforward design, made his beaky and bosomy figures almost jump off the page (for many years one of his near-bawdy cartoons almost invariably occupied a position in the *New Yorker* on the full page immediately after "The Talk of the Town," which suggested that the political cartoon of *Punch* was being ridiculed). Ronald Searle, after a long British career of making spiky and raffish pseudo-Edwardians and fiendish schoolgirls, had a success as an artist for American advertising. A pair of delightful opposite numbers were W. Heath Robinson and the slightly later Rube Goldberg, who on both sides of the Atlantic created wild half-anthropomorphic parodies of intricate machinery. During World War II Bill Mauldin's disenchanted soldiers were proper descendants of Bairnsfather's.

D. Comic Strips

1. The United States.—The U.S. innovation in cartooning went through a rapid youth and adolescence between 1896 and 1907, promptly ramified elsewhere though nowhere so luxuriantly as at home. Within 50 years it became so varied as to include booklets of vocational training, pictorial condensations of books of the Bible and well-known novels, almost naked propaganda devices and drawing styles no longer pretending to be comic, as well as story continuities containing practically nothing funny.

In February and March 1896 the colour-printed Sunday supplement of the *New York World,* which was already stocked with comic drawings, included a sort of aged baby on whose sacklike yellow garment were printed words which he presumably spoke or thought; his language was earthy. The yellow colour was at first a technical experiment; but the colour and the remarks so fascinated the public and were so plainly headed for success that William Randolph Hearst enticed the "Yellow Kid's" creator, Richard F. Outcault (1863–1928), over to his *New York Journal.* Joseph Pulitzer's *World* bought him back, and there were further bids, counterbids and competitive sensations from which the phrase "yellow journalism" arose.

James Swinnerton had, earlier in the '90s, drawn a weekly series, "The Little Bears and Tigers," for the *San Francisco Examiner;* they did not speak but they appeared regularly, and they were funny in the tradition of monkeys aping human ways and also in their own way. In themselves they were no more an absolute novelty than the "Yellow Kid," for there had been continuing casts of characters before, as in Wilhelm Busch's *Max und Moritz.* Rudolph Dirks based his "Katzenjammer Kids" (first appearance Dec. 12, 1897, in the "American Humorist" supplement to the *New York Sunday Journal*) on Busch. The kids' uproarious slapstick humour added to the features of continuing characters and words within the picture another element of the strip. Speeches in balloons (a device older than Gillray) had been used before the end of 1897 by Outcault for minor (usually animal) characters. Dirks soon borrowed them for all his characters, and he also used regular frames in succession.

Though the comic strip was complete in all essentials by the time Outcault's "Buster Brown" began in May 1902, his drawing and Dirks's were still rather fussy and in the contemporary manner of magazine illustration—echoes, so to speak, of Frost and Kemble. When Swinnerton, moving to New York, started "Little Jimmy" in the *Sunday Journal* early in 1905, he used a new style of simple outlines, barely indicated background and comparatively large forms, adapted to rapid scanning at arm's length.

Clare Briggs, in the *Chicago American* in 1904, had begun a daily strip in which tips on horse races were given through a comic character; the sports pages were tending to bring little repeating commentator figures into their daily caricatures of sporting personalities, but these were single-panel drawings, though there had been a few two- or three-panel vertical continuities; and most importantly, the strips were still restricted to Sunday appearance. In Nov. 1907 Bud Fisher's "Mr. Mutt" (later "Mutt and Jeff") in the *San Francisco Chronicle* put the horizontal strip on a daily basis, at first as a tip sheet but soon as a standard comic. The whole thing had thus arrived at maturity, except for syndication to several papers, which was brought about by Moses Koenigsberg, editor of the *Chicago American* and founder in 1913 of the syndicate later called King Features Syndicate.

The comic strip which emigrated from the United States eventually sent back countermissionaries: at least two British strips, "Pop" and "Colonel Potterby and the Duchess," made successes in the new "old country." (W. A.)

2. Great Britain.—Though British comic strips largely followed the pattern set in the United States, Britain claimed the first regular strip character, ne'er-do-well Ally Sloper (drawn by W. F. Thomas), whose adventures, told in captions beneath a sequence of drawings instead of balloons, appeared in a weekly paper bearing his name in 1884, and persisted fitfully until 1920. But it was a long time before newspaper publishers realized that adults might enjoy comic strips. Lord Northcliffe's weekly, *Comic Cuts,* first published in 1890 (it ran for 60 years), was a big success. It was followed by *Puck* in 1910 and by *Rainbow* in 1914. All three were theoretically children's papers, *Rainbow* appealing to younger readers than the other two.

The shrewd Northcliffe was the first to realize that a strip for children in a daily paper might capture those same children as adult readers. So, in April 1915, "Teddy Tail" first appeared in his *Daily Mail.* Though Teddy has been drawn by a number of artists, he is the longest-lived daily comic strip in Britain. Teddy was followed in 1919 by A. B. Payne's "Pip, Squeak and Wilfred" in the *Daily Mirror* (this strip was finally discontinued in March 1955) and in Nov. 1920 by "Rupert" in the *Daily Express.* But the first realization that adults, too, might enjoy comic strips seems to have come to the *Daily Sketch* in May 1921, when that paper introduced "Pop," drawn by Millar Watt. Eighteen months later came "Dot and Carrie" in the *Star.* It was drawn by J. K. Horrabin, and reflected that post-World War I phenomenon, the typist. A lull followed until the *Daily Mirror* began to build up its strip "stable," which began in 1929, with "The Pater," an imitation of "Pop," drawn by Harold Earnshaw, followed in 1931 by "Tich," another daily "gag" about an urchin, created by Frank and Steve Dowling. In Dec. 1932 that perky blond "Jane" arrived, as "The Diary of a Bright Young Thing," drawn by Norman Pett (Mike Hubbard took over in 1947). Six years later, when the *Mirror* was publishing "Ruggles" (a domestic strip which later broke new ground by featuring real people and real events), "Buck Ryan" the detective, and "Belinda" the blue-eyed waif, "Jane" became a serial and acquired a habit which made her the forces' "pin-up" of World War II: she regularly managed to lose her clothes. During the war the legend grew among fighting men that the more undressed Jane was the better Allied operations went. Jane continued to find it difficult to remain fully clothed, and remained by far the most widely read strip in the country until her retirement in Oct. 1959.

British comic strips gained quite a wide popularity all over the world. The *Daily Mirror*'s "Andy Capp," a North-country drunken layabout drawn by Reg Smythe, was the most successful cartoon strip since "Jane," following its first appearance in 1957. "Andy" appeared in over 500 newspapers, 250 of them in the U.S. The strip was translated into 13 different languages.

Model girl "Tiffany Jones," drawn by Pat Tourret for the *Daily Sketch*, appeared in over 100 papers outside Britain, about 60 of them in the U.S. "Fred Basset," the *Daily Mail's* pet dog, drawn by Graham, appeared in 30 U.S. papers and 23 others, and the *Daily Express* strip version of "James Bond" appeared in over 40 different countries. So did his female equivalent, "Modesty Blaise," drawn by Jim Holdaway and written by Peter O'Donnell. (E. F. HT.)

3. Types of Comic Strips.—Comic strips fell into a few categories: (1) the gag strip which depended on an anecdote which ended with a bang in the fourth panel, and whose continuity lay in the cast of characters only, as in "Moon Mullins"; (2) the strip with a single protagonist, a story line and changing scene and changing minor characters, such as "Orphan Annie"; (3) conversely, the strip with a fixed cast, a story line and guest characters who lived out a long or short episode, as in "Our Boarding House" (a one-panel comic), or who came to be vanquished and die, as the villains of "Dick Tracy"; (4) the strip which had no story line but was really a cartoon of situation, such as "Bringing Up Father" and "Blondie," each of which moved in an orbit of its own; (5) the passage-of-time strip, such as "Gasoline Alley," whose characters grew up and aged realistically; (6) the special-milieu strip, such as "Joe Palooka" (boxing), "Steve Canyon" (flying) or "Modest Maidens" (the "dumb" dressed-up city girl, a one-panel comic); (7) the adventure or heroic-adversity strip, such as "Superman" or "Buck Rogers"; (8) the fantasy, either quaint ("Krazy Kat" and "Barnaby") or frantic ("Smoky Stover") or based on mock-human animals ("Donald Duck" and family); (9) the chain-of-subjects strip, as practised by Fontaine Fox, T. A. Dorgan, Clare Briggs and H. T. Webster, each of whom moved (sometimes on set days of the week) from bridge to golf or from the joys of childhood to the exploits of a famous strong woman; (10) the serious strip, which could be a continuous story of the past like "Prince Valiant," or an "uplift" chronicle like that of the benevolently interfering "Mary Worth," or a limited-term serialization.

4. Comic Books.—The serious form was a favourite of the comic books. Both the newspaper syndicates and other publishers, often publishers of paper-backed books, began in the 1930s to issue pamphlets, usually in colour and printed on paper somewhat better than newsprint, which either assembled and reprinted newspaper strips or used new material aimed at special groups of possible buyers. "Mutt and Jeff" had been reprinted in book form as early as 1911. It was World War II which gave the comic book its tremendous circulation, particularly among people away from home who needed relaxation. The power of these concentrated picture books was soon observed by such differing groups as educators, the clergy and the peddlers of pornography, who promptly went to work. By 1954 the outcry against abuse of this power had led to a code of self-censorship in the industry. An interesting later case of special use of the technique was a comic-book format for a picture story of the nonviolent campaign in Montgomery, Ala., to abolish racial segregation.

III. TECHNIQUES

Obviously a caricature can be created in any medium. Our concern here is primarily with the technique of the published and widely distributed cartoon. There is an accidental kinship between the modern cartoon and the cartoon in the old sense, from which the name was borrowed. A cartoon is literally a *cartone* (in Italian, a "big sheet of paper"). The full-sized plan for a painting required a large sheet or, in the case of a fresco to cover a wall, many sheets. The process of transfer to panel or canvas sometimes involved piercing rows of dots along the drawn lines, through which powdered charcoal could be rubbed; this weakened the paper. Even when transfer by something like carbon paper was chosen, the cartoon was likely to be cast aside once it had served its purpose; cartoons for frescoes were usually transferred by slicing right into the wet plaster through the paper, which was thus cut to pieces. Hence very few old cartoons intended for execution in paint have come down to us, and the chief preserved ones are for tapestries. Ever since the application of photomechanical reproduction to modern cartoonists' drawings, the drawings themselves have been only a sort of fossil of the process rather than precious unique underlying autographs. And although they are not destroyed by the means of reproduction, yet the reproduction is so precise that in effect the drawing becomes the printed picture.

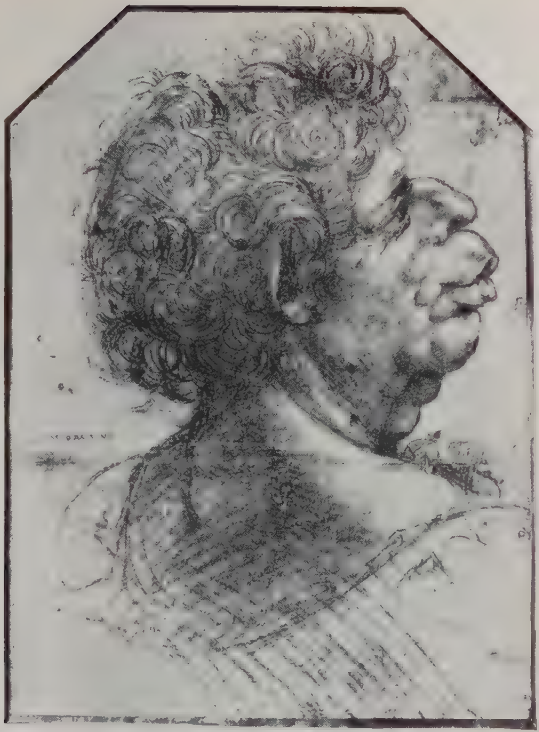
Further, the fact that mistakes in a drawing made for reproduction can be readily corrected with opaque white, which will deceive the camera but look rather unpleasant to the eye and feel lumpy to the finger, has often caused cartoonists' original drawings to be less immediately attractive than other sorts. So they tend not to be preserved.

1. Early Practices.—In the early days of cartooning, from Romeyn de Hooghe to Gillray and Townshend and Rowlandson, the usual technique was etching. A topical story depended upon speed for its success, and etching was quick. The artist could see what he was doing when he scratched his drawing on the grounded plate, and a technician could do the biting and printing if necessary, and even perhaps the captions and the speeches in balloons, which of course had to be lettered backward. When the comic magazine arrived, the desire to combine comic drawings with stories and verses required the use of woodcut which could be printed with letterpress, and here the artist was almost wholly in the hands of the technician who translated his drawing more or less. If the artist was particular about the right-handedness of action in his characters he had to either draw his picture with left-handed action or get the woodcut specialist to use a mirror as he worked; sometimes right and left were matters of no consequence. In the case of engravings, such as Hogarth's great series, this problem also arose, as it did in lithography. Lithography, however, was a boon to artists, and its appearance at the very beginning of the 19th century was promptly followed by independent prints (Géricault, Goya) and by lithographed papers such as the *Charivari*. Again, the lettering was normally done by an assistant specialist. (*See* DRAWING; PRINTMAKING.)

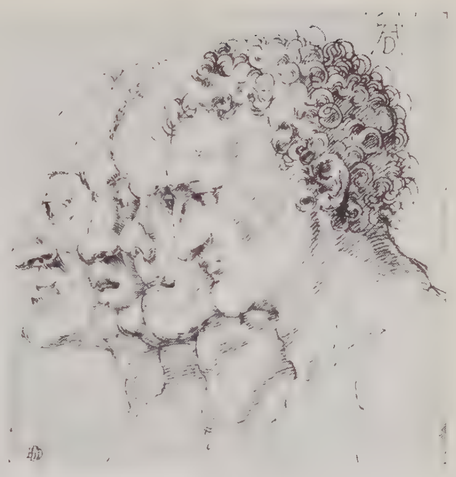
2. Photographic Reproduction.—Within a generation after the invention of daguerreotypy, means were sought for transferring photographic images to some other sort of multiplying device not requiring negatives. A combination of photography with surface printing from etched metal eventually provided this means. At first it was possible only to reproduce work done in lines, dots or masses of solid dark; gradations were impossible unless they were made by means of laborious pen dotting or spatters. This lack led to a search for papers with a grain which would break up lines and masses into dots or lines, from which photographic reproduction in gradations would result. Many of the drawings made after their own paintings by masters of the Impressionist movement or period were made on such papers for early photomechanical reproduction in periodicals and catalogues. Most were ribbed in imitation of the old mold-made papers with prominent laid lines which gave characteristic texture to the drawings of Hubert Robert and his contemporaries, and which may have given the inventor of these papers his idea. From such devices for physically breaking down areas into patterns of dots or lines, it was not far to the interposition of a screen between the camera film and the drawing to be photographed, which optically reduced lines and masses to dots of greater or lesser diameter but in a uniform pattern. This "halftone" made it possible to reproduce all sorts of tones, washes and gradations. It led of course to abuses, and there is no doubt that illustrations or cartoons in line and solid tone tend to look better with letterpress than grayed halftones; but the publishers of comic magazines, with some exceptions, are not as exacting about the look of the whole page as the designers of fine printing. There is more and more a tendency to omit framing lines from magazine cartoons and to let them break into text fairly freely. In newspapers, however, because of the needs of members of a syndicate, even one-panel daily cartoons use framing lines and are kept to uniform proportions.

(*See* PHOTOENGRAVING.)

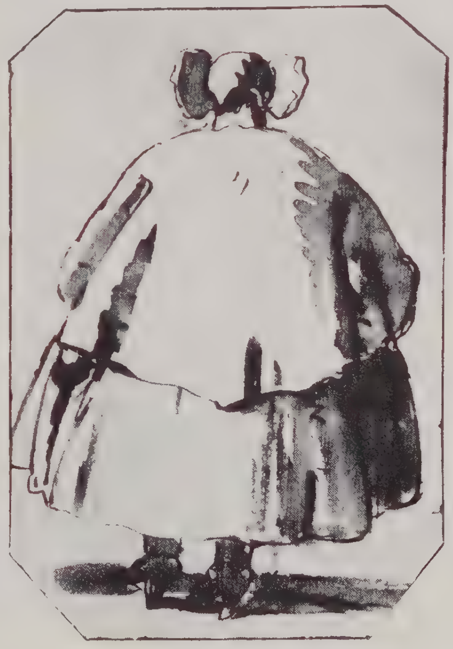
3. Comic-Strip Techniques.—The demands of the comic strip are rather different from those of the cartoon-using weekly; in particular, the whole feeling and colour of the strip is keyed to the regular pattern of balloons more or less across the top of the panels. Fairly large forms, a generous use of white space and comparatively few solid blacks are the bases of a general rule resulting from long experience. It is possible to introduce areas



"Grotesque Head in Profile to the Right" by Leonardo da Vinci (1452–1519), Italian. In the collection of Christ Church, Oxford

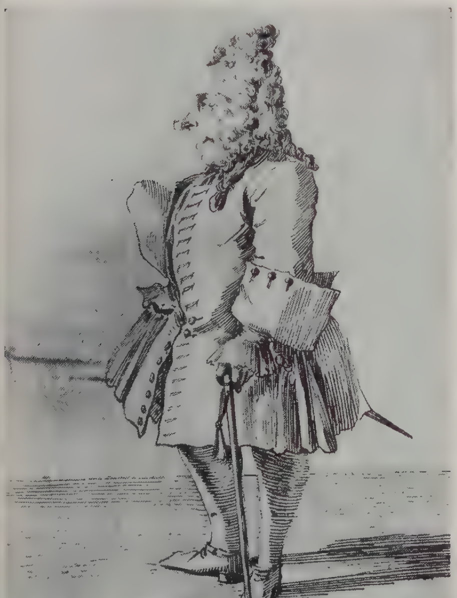


"Four Heads" by Albrecht Dürer (1471–1528), German. In the Nelson Gallery of Art, Kansas City, Mo.

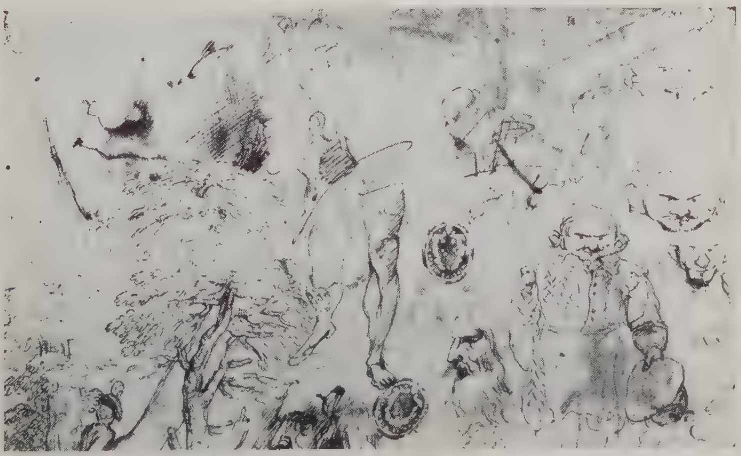


Wash drawing of a fat woman seen from the back by Giovanni Battista Tiepolo (1696–1770), Italian. Fondazione Cini, Venice

"Marquis of Spada" by Pier Leone Ghezzi (1674–1755), Italian

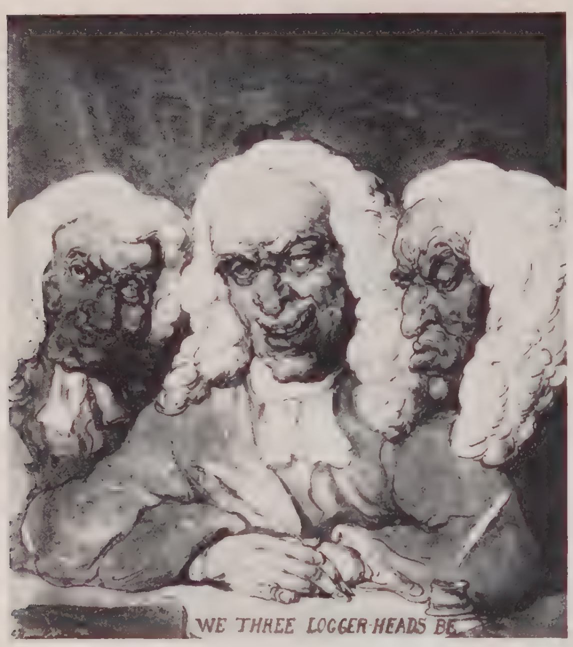


Part of a page of sketches by Agostino Caracci (1557–1602), Italian



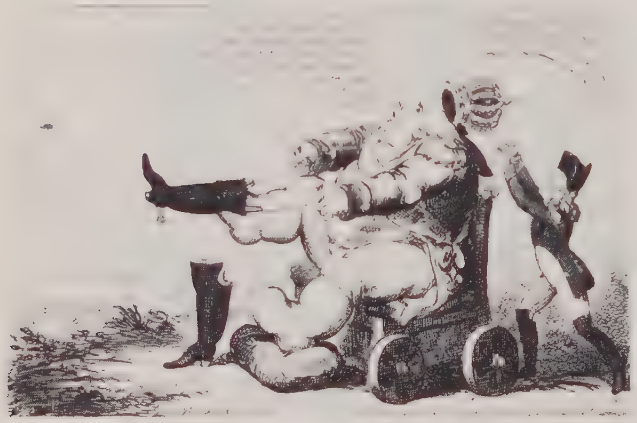
BY COURTESY OF (TOP LEFT) THE GOVERNING BODY OF CHRIST CHURCH, OXFORD, (TOP RIGHT) NELSON GALLERY-ATKINS MUSEUM, KANSAS CITY, MO.; NELSON FUND, (CENTRE RIGHT) FONDAZIONE GIORGIO CINI, ISOLA DI SAN G. MAGGIORE, VENICE, (BOTTOM LEFT) THE ALLEN R. HITE ART INSTITUTE, UNIVERSITY OF LOUISVILLE; GIFT OF MR. AND MRS. JANOS SCHOLZ, (BOTTOM RIGHT) THE ROYAL LIBRARY, WINDSOR CASTLE

CARICATURE AND CARTOON



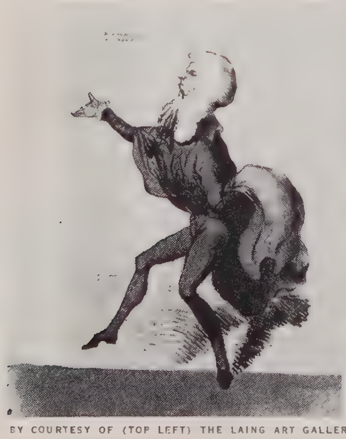
"We Three Logger-Heads Be" by Thomas Rowlandson (1756–1827), English. The drawing was a satire on the courts of appeals

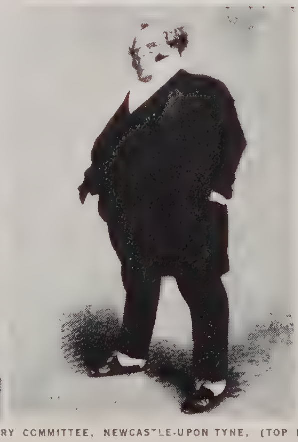
"Old Bumblehead the 18th Trying on the Napoleon Boots—Or, Preparing for the Spanish Campaign" by George Cruikshank (1792–1878), English. The figures in the cartoon are Louis XVIII of France and Napoleon II

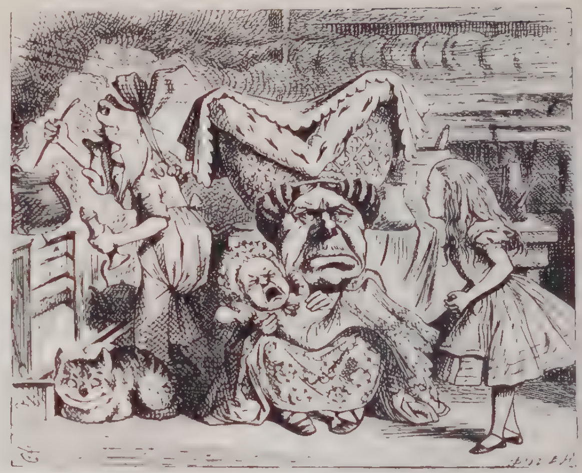


"The Baron of Oakland" by John Doyle (1797–1868), Irish

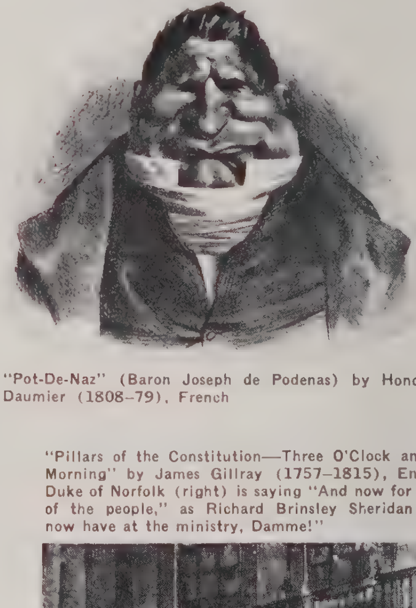
"M. Prudhomme" by Henri Monnier (1805–77), French





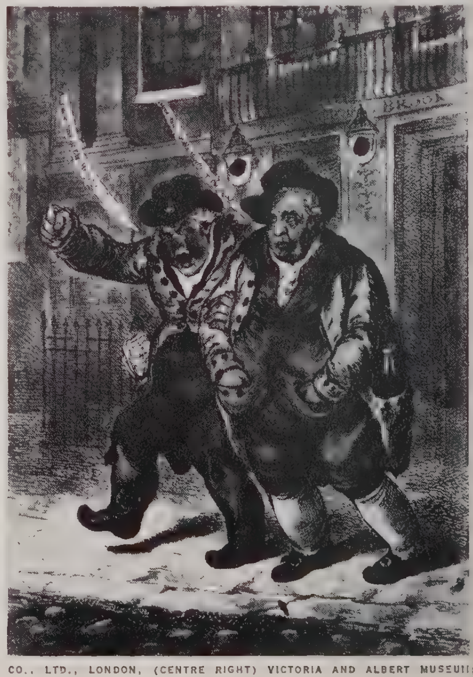


The Duchess from *Alice in Wonderland* by Sir John Tenniel (1820–1914), English

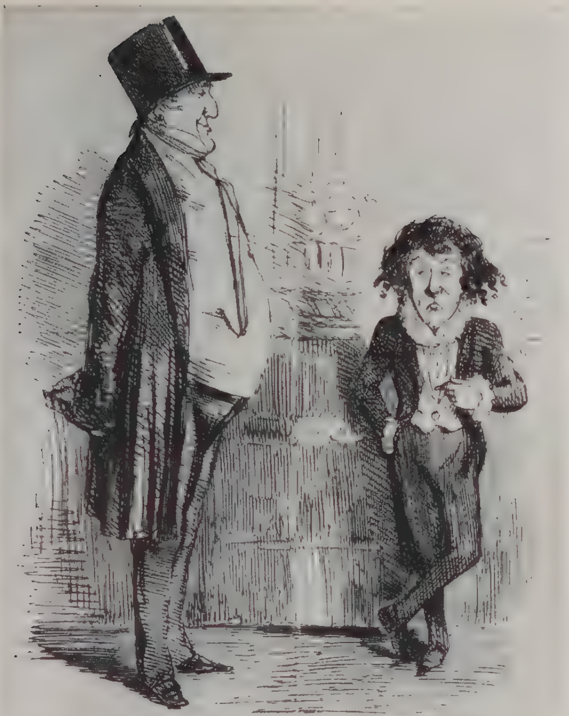


"Pot-De-Naz" (Baron Joseph de Podenas) by Honoré Daumier (1808–79), French

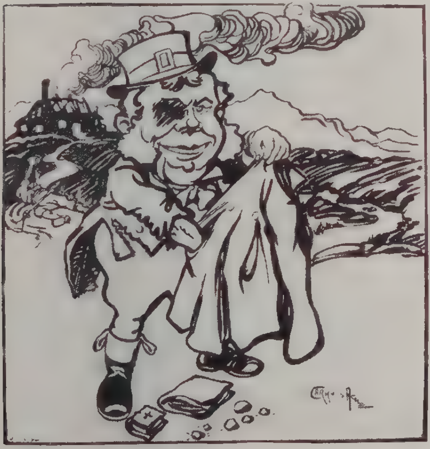
"Pillars of the Constitution—Three O'Clock and a Cloudy Morning" by James Gillray (1757–1815), English. The Duke of Norfolk (right) is saying "And now for the majesty of the people," as Richard Brinsley Sheridan says "And now have at the ministry, Damme!"



BY COURTESY OF (TOP LEFT) THE LAING ART GALLERY COMMITTEE, NEWCASTLE-UPON TYNE, (TOP RIGHT) MACMILLAN AND CO., LTD., LONDON, (CENTRE RIGHT) VICTORIA AND ALBERT MUSEUM; PHOTOGRAPH (BOTTOM CENTRE) H. BONNAIRE

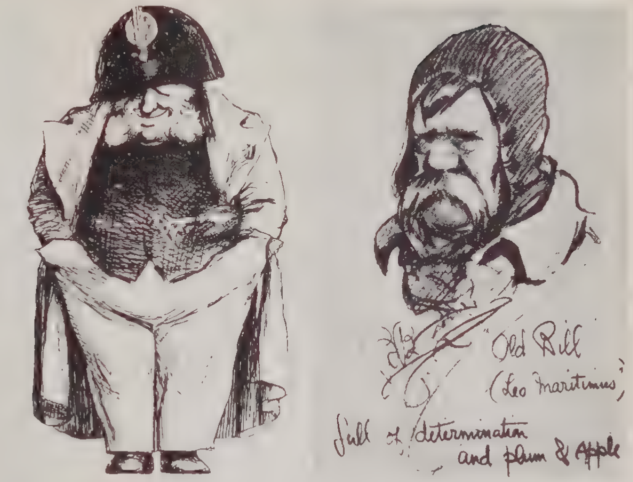


"The Rising Generation—In Parliament" by John Leech (1817–64), English. "Peel: 'Well, my little Man, what are you going to do this Session, eh?' D(israe)li (the Juvenile): 'Why—aw—aw—I've made arrangements—aw—to smash—aw—everybody.' "



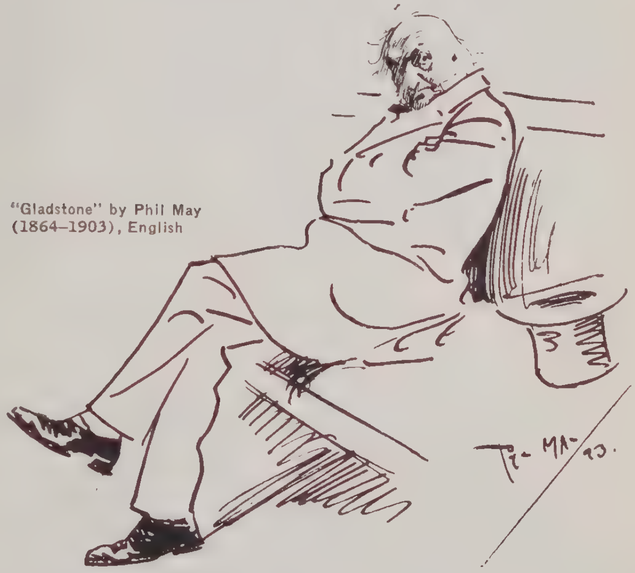
"Vanquished . . . At Last" by Caran d'Ache (Emmanuel Poiré, 1858–1909), Russian-born French caricaturist. The cartoon, showing John Bull rifling the pockets of South African president Kruger, was a satire on the Boer war

BY COURTESY OF (TOP LEFT) THE PROPRIETORS OF "PUNCH," (TOP RIGHT) G. P. PUTNAM'S SONS, N.Y. AND THE RICHARDS PRESS LTD., FROM B. BAIRNSFATHER, "BULLETS AND BILLETS," (BOTTOM RIGHT) MAX BEERBOHM AND WM. HEINEMANN, LTD.; PHOTOGRAPH, (CENTRE LEFT) H. BONNAIRE, FROM "LE CANARD SAUVAGE"

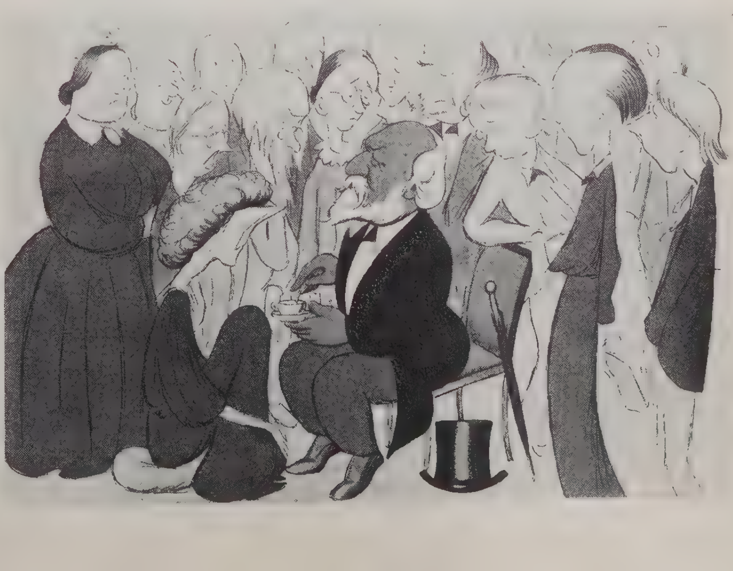

Old Bill
(Leo Maritimus)
Full of determination and plum & Apple

"Louis Philippe" by Richard Doyle (1824–83), English. *Right:* "Old Bill" by Bruce Bairnsfather (1888–1959), English

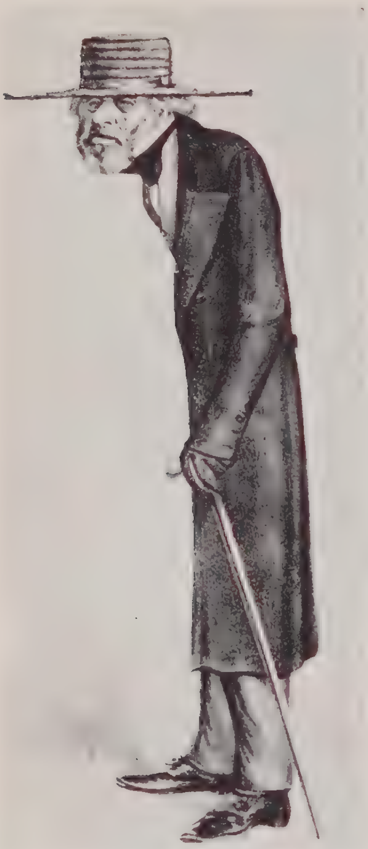
"Gladstone" by Phil May (1864–1903), English



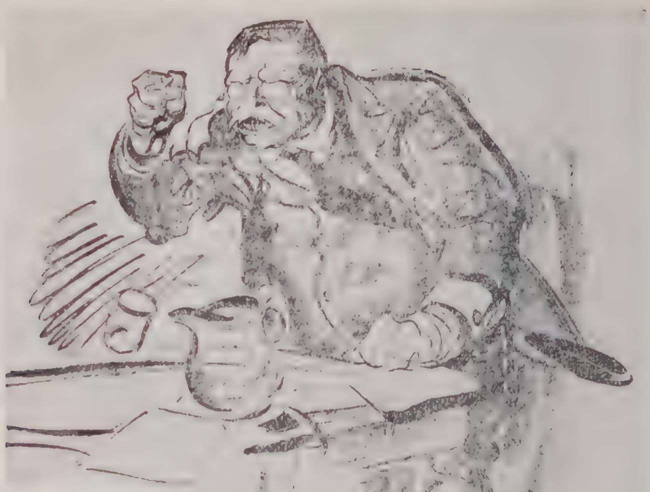
"Robert Browning Taking Tea with the Browning Society" by Max Beerbohm (1872–1956; knighted, 1939)



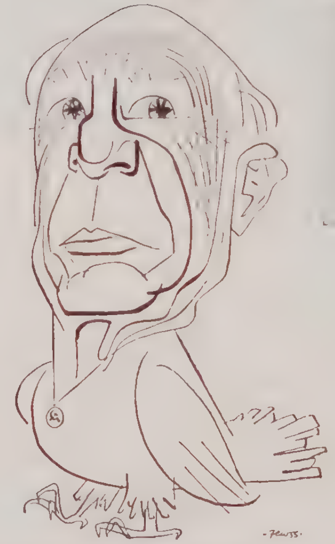
CARICATURE AND CARTOON



Thomas Carlyle by "Ape" (Carlo Pellegrini, 1839–89), Italian-born contributor to *Vanity Fair*

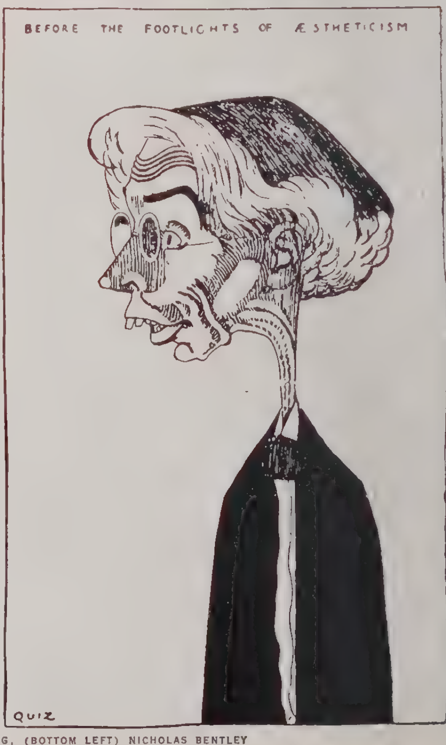


"The Boss" (Theodore Roosevelt) by Oscar Cesare, U.S.

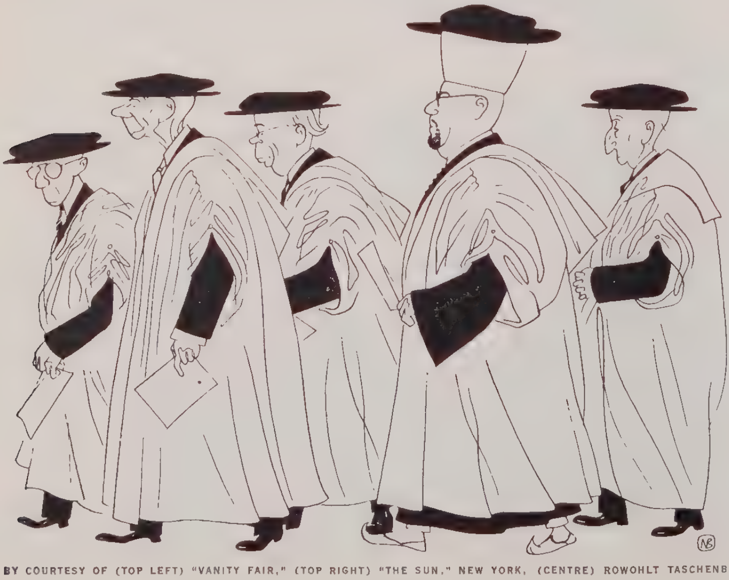


Pablo Picasso by Fewss (Mirko Szewczuk, 1920–57), German

Roger Fry by "Quiz" (Powys Evans), English

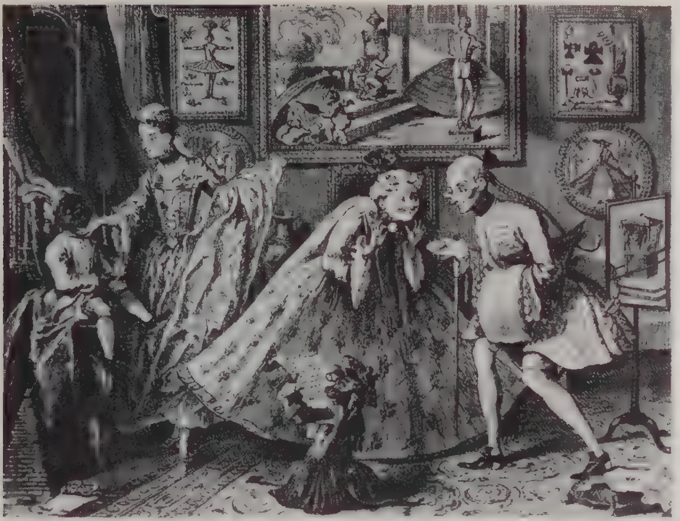

BEFORE THE FOOTLIGHTS OF ÆSTHETICISM
QUIZ

"University Dons" by Nicholas Bentley (1907–), English

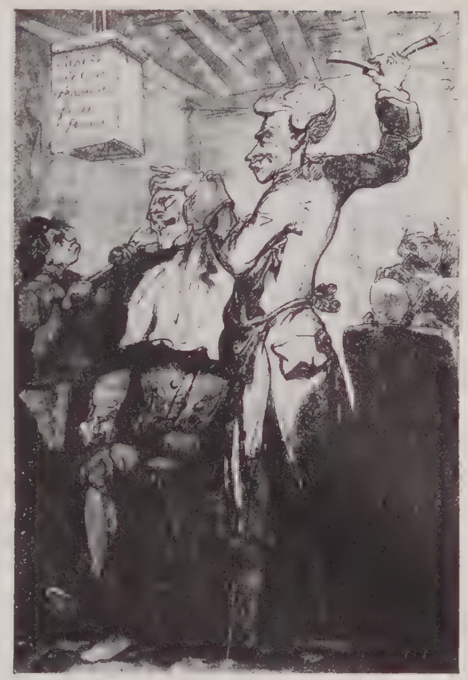


BY COURTESY OF (TOP LEFT) "VANITY FAIR," (TOP RIGHT) "THE SUN," NEW YORK, (CENTRE) ROWOHLT TASCHENBUCH, HAMBURG, (BOTTOM LEFT) NICHOLAS BENTLEY

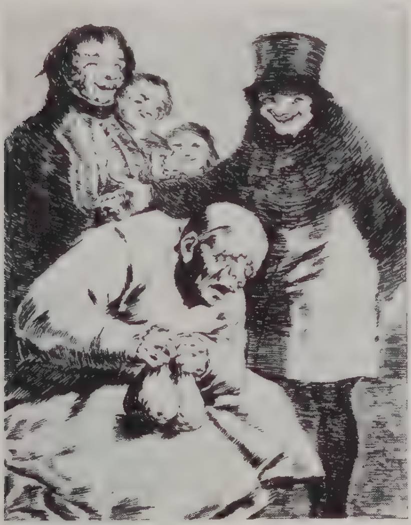
CARICATURE AND CARTOON



"Taste in High Life" by William Hogarth (1697–1764), English

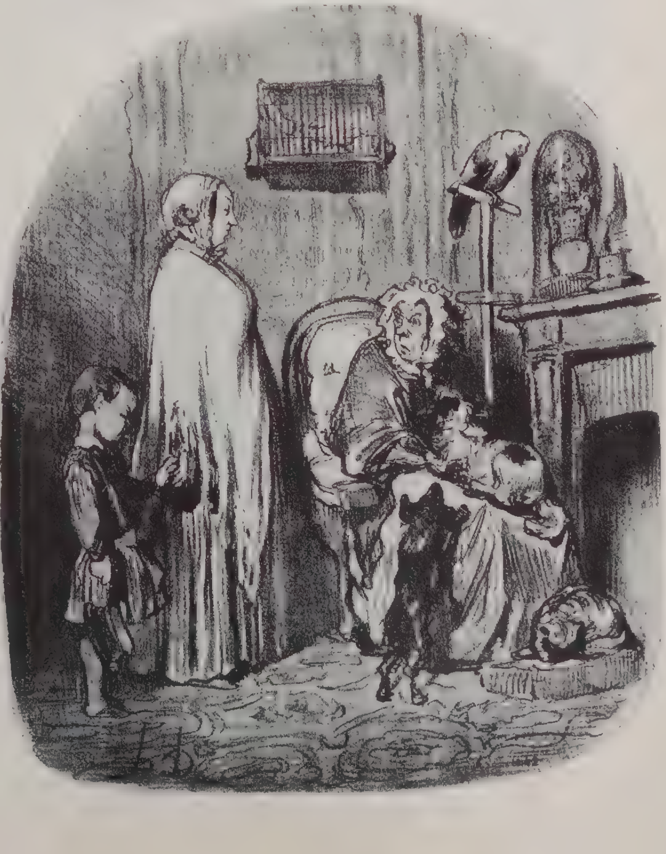


"A Sufferer for Decency" by Thomas Rowlandson (1756–1827), English

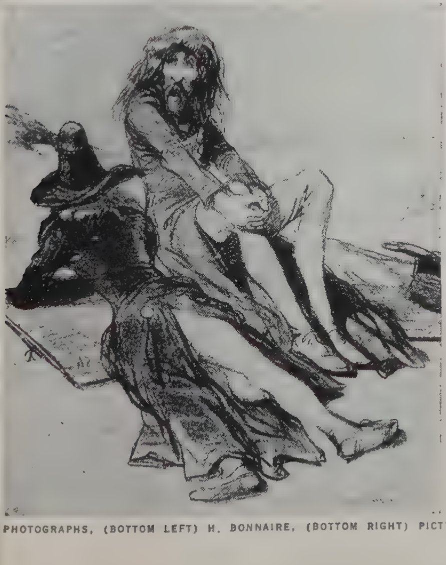


"Why Hide Them?" by Francisco de Goya (1746–1828), Spanish

"I Do Not Rent to People with Children" by Honoré Daumier (1808–79), French

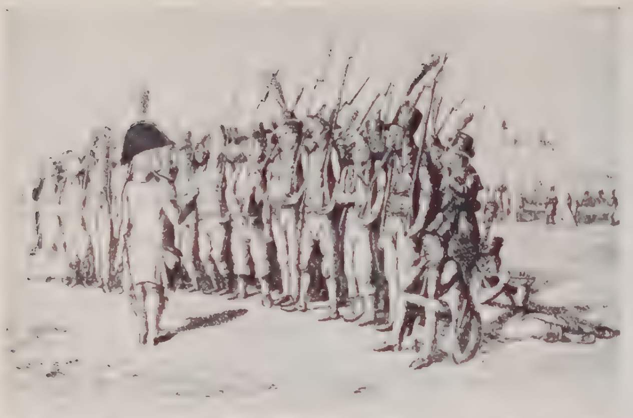


"It Is Truly Painful To See How These Wretched Shopkeepers Get Themselves Up" by Gavarni (Sulpice Chevalier, 1804–66), French

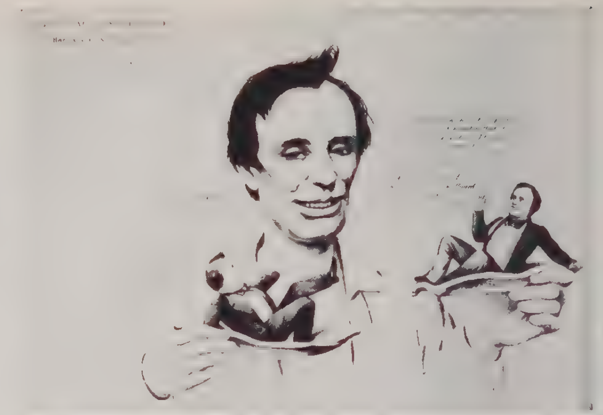


PHOTOGRAPHS, (BOTTOM LEFT) H. BONNAIRE, (BOTTOM RIGHT) PICTURE POST LIBRARY

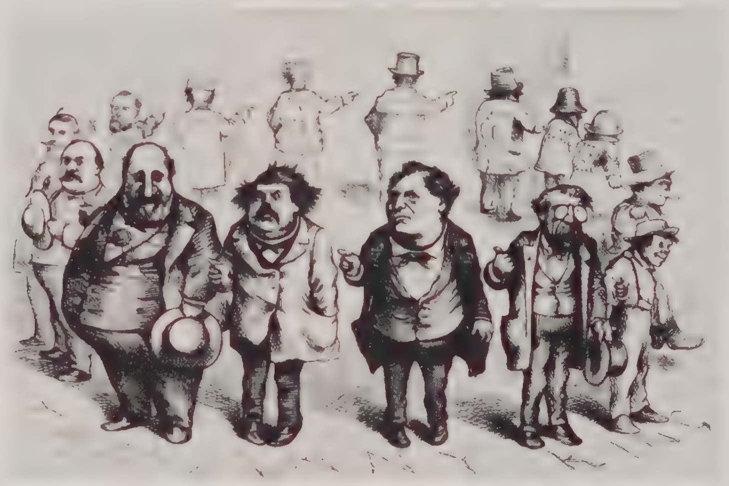
CARICATURE AND CARTOON



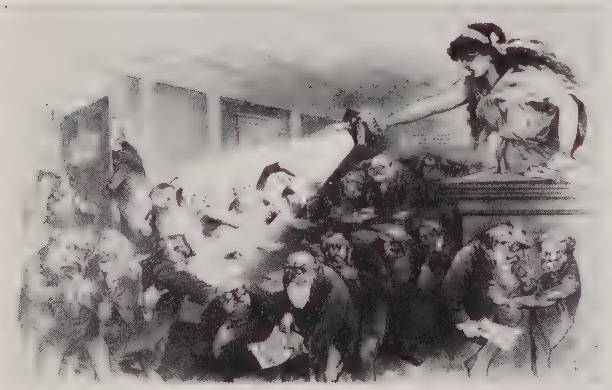
"The Nation's Bulwark—A Well Disciplined Militia," a U.S. cartoon of 1829 by R. H. Hobson, Philadelphia



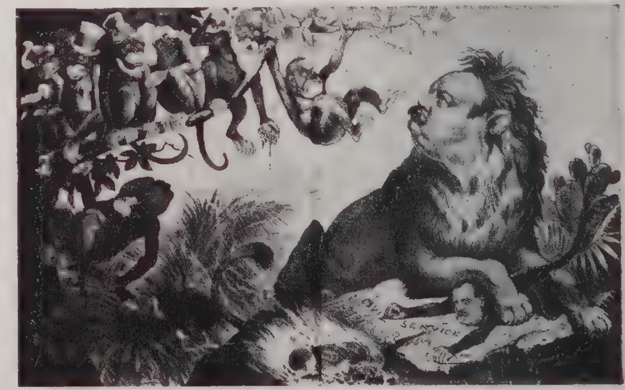
"Honest Abe Taking Them on the Half Shell" by Currier and Ives, U.S., 19th century. The two men on the shells are Lincoln's political opponents Douglas and Breckinridge



"Who Stole the People's Money? Do Tell. 'Twas Him" by Thomas Nast (1840–1902), U.S.

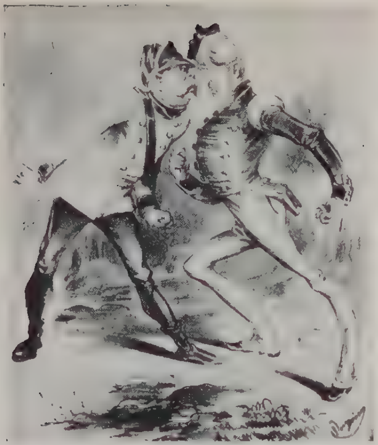


"They Hate The Light, But They Can't Escape It" by Joseph Keppler (1838–94), U.S. The cartoon dealt with the secret executive sessions of the U.S. senate at the turn of the century

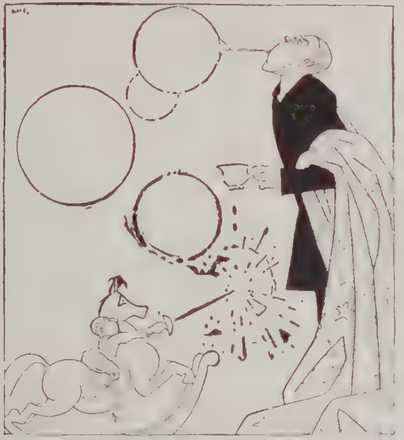


"Why They Dislike Him—He Will Not Prove Himself a Cat's-Paw in the Enterprise" by Bernhard Gillam (1859–96), U.S. The cartoon showing Cleveland in the lion's role was published during his campaign against James G. Blaine for the presidency

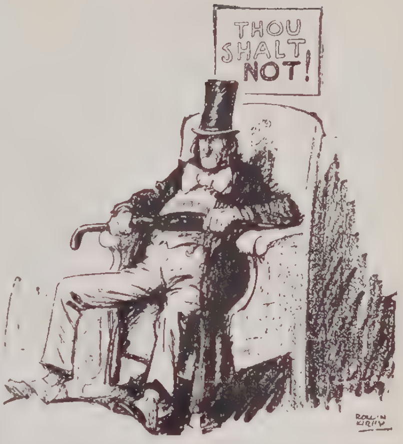
BY COURTESY OF (CENTRE) HARPER AND BROTHERS; PHOTOGRAPHS (TOP LEFT) CULVER SERVICE, (TOP RIGHT) AUTHENTICATED NEWS



"England v. Prussia" by Virginio, Italian, 19th century

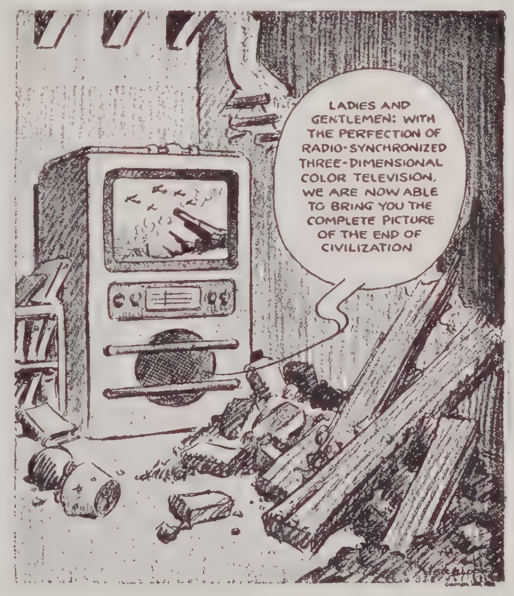


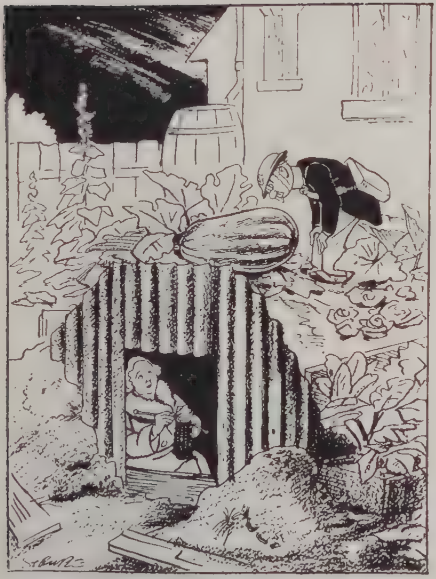
"Fiume" by Olaf Gulbransson (1873–1958), Norwegian. The cartoon shows D'Annunzio bursting the bubbles of U.S. president Wilson who claimed that Italy had no right to occupy Fiume in 1919


THOU SHALT NOT!
ROLLIN KIRBY

"A Spurious King" by Rollin Kirby (1875–1952), U.S.

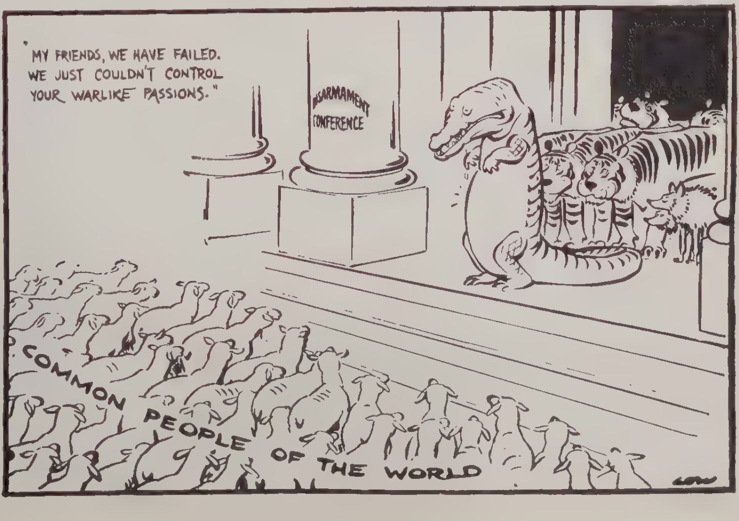
"The Ultimate Triumph of Human Ingenuity" by Herblock (Herbert Block, b. 1909), U.S.


LADIES AND GENTLEMEN: WITH THE PERFECTION OF RADIO-SYNCHRONIZED THREE-DIMENSIONAL COLOR TELEVISION, WE ARE NOW ABLE TO BRING YOU THE COMPLETE PICTURE OF THE END OF CIVILIZATION



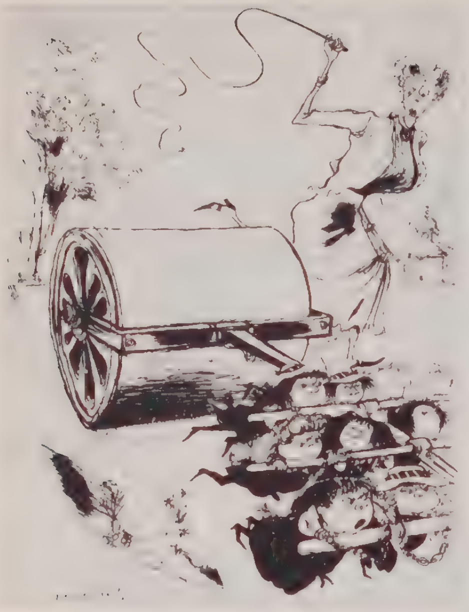
World War II cartoon by Sydney Strube, England: "Is it all right now, Henry?" "Yes, not even scratched."

"The Conference Excuses Itself" by David Low (1891–1963), British (b. New Zealand)

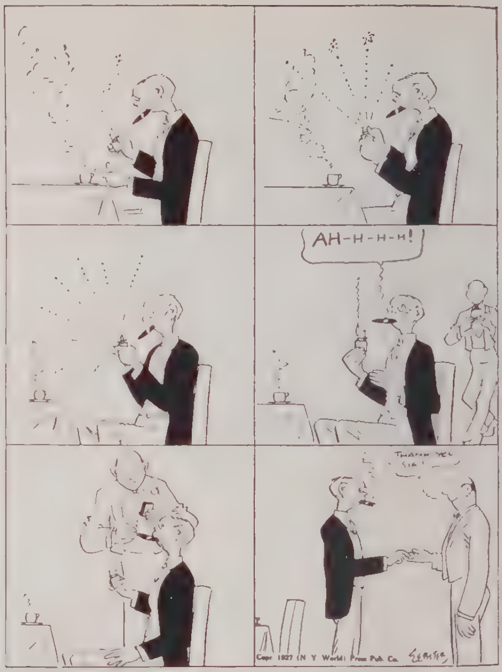

"MY FRIENDS, WE HAVE FAILED. WE JUST COULDN'T CONTROL YOUR WARLIKE PASSIONS."
DISARMAMENT CONFERENCE
COMMON PEOPLE OF THE WORLD
LOW

BY COURTESY OF (TOP CENTRE) "SIMPLICISSIMUS," (CENTRE LEFT) DAILY EXPRESS, LONDON; PHOTOGRAPHS (TOP RIGHT) CULVER SERVICE, (CENTRE RIGHT) NEA SERVICE, (BOTTOM RIGHT) LONDON EXPRESS NEWS AND FEATURE SERVICES

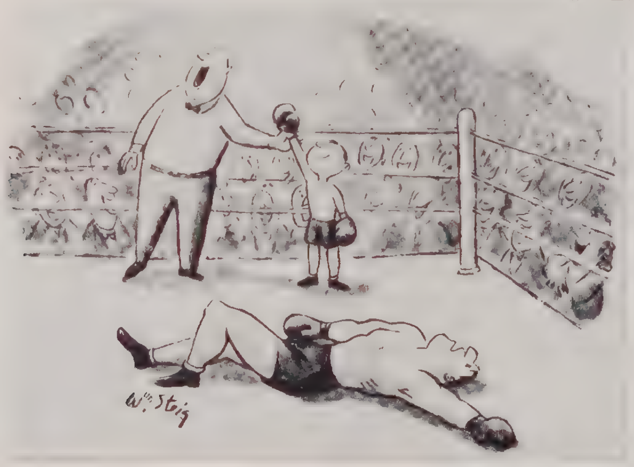
CARICATURE AND CARTOON



"Ruddy Sportsdays" by Ronald Searle (1920–), English

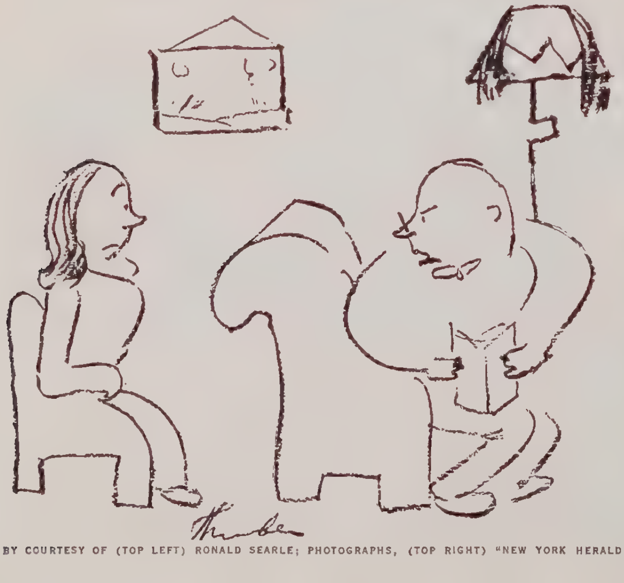

AH-H-H-H!
THANK YE SIR!
Copr. 1927 (N Y World) Press Pub. Co.
Webster

"Mr. Milquetoast, or The Timid Soul" by H. T. Webster (1885–1952), U.S.

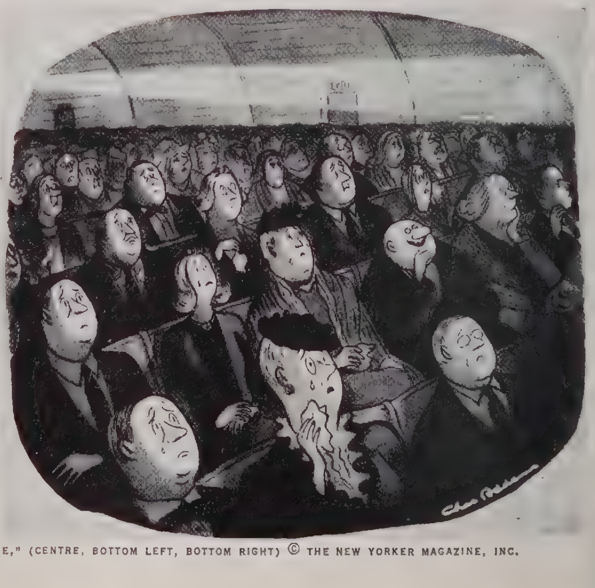


"New World Champion" from the "Dreams of Glory" series by William Steig (1907–), U.S.

"How is it possible, woman, in the awful and magnificent times we live in, to be preoccupied exclusively with the piddling?" by James Thurber (1894–1961), U.S.

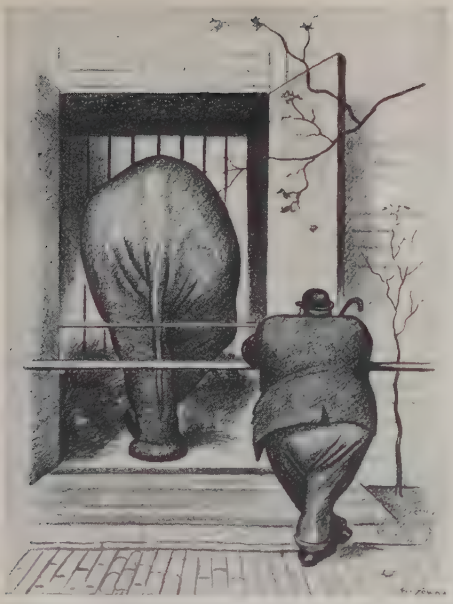


Untitled cartoon by Charles Addams (1912–), U.S.

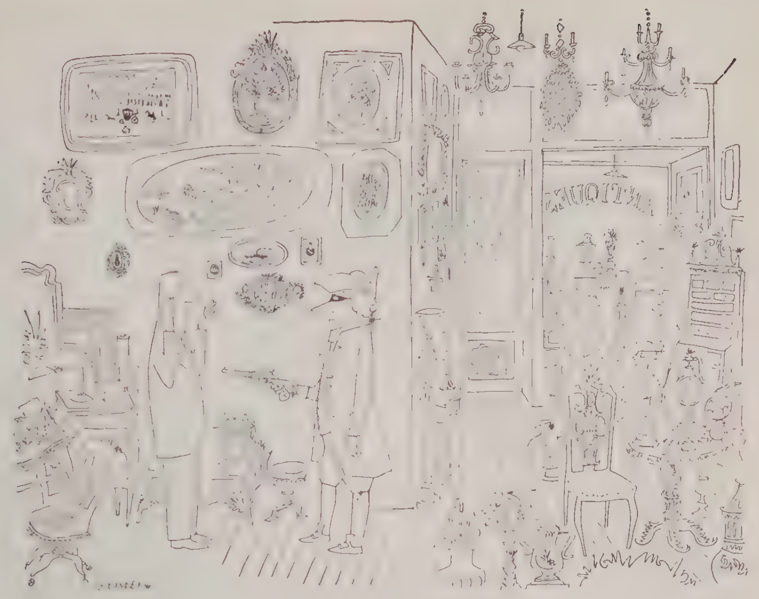

Chas Addams

BY COURTESY OF (TOP LEFT) RONALD SEARLE; PHOTOGRAPHS, (TOP RIGHT) "NEW YORK HERALD TRIBUNE," (CENTRE, BOTTOM LEFT, BOTTOM RIGHT) © THE NEW YORKER MAGAZINE, INC.

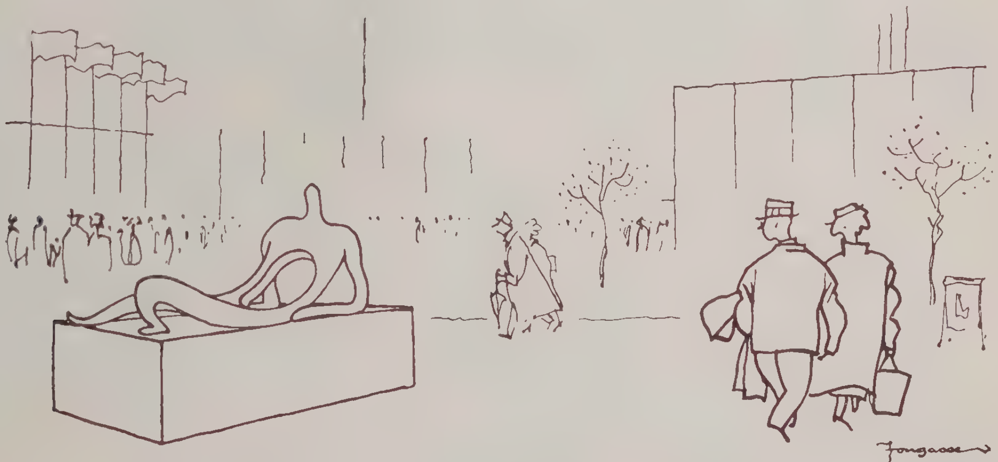
CARICATURE AND CARTOON



"Beast and Man" by Art Young (1866–1943), U.S.



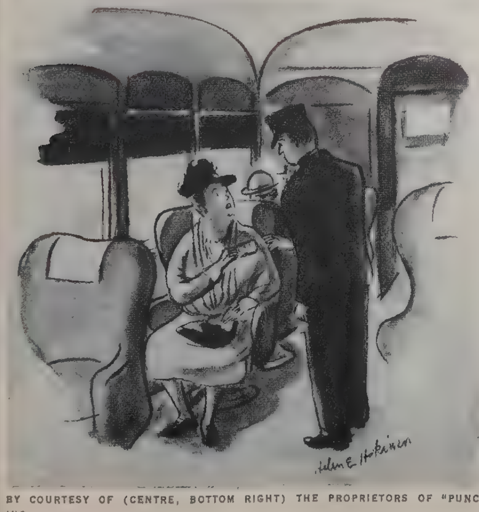
Captionless cartoon by Saul Steinberg (b. 1914 in Rumania), U.S.

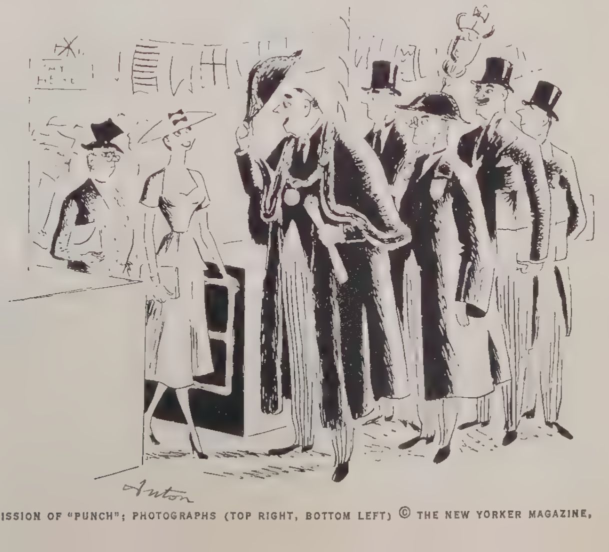


"That reminds me, dear—did you remember the sandwiches?" by Fougasse (Kenneth Bird, 1887–1965), English

"Does this ticket entitle me to a hangover in Philadelphia?" by Helen Hokinson (d. 1949)

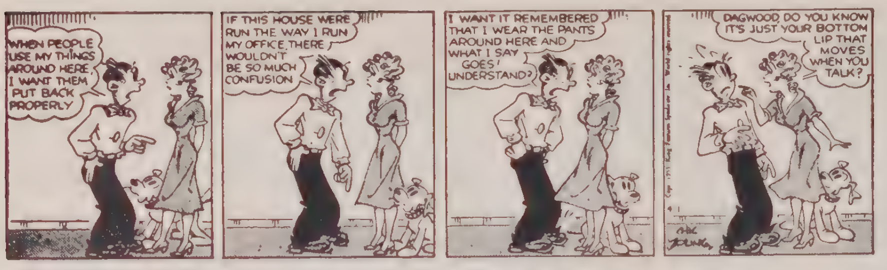
"... and since you are the 499,999th visitor to our Festival Year show, we should like you to accept ..." by Anton (Antonia Yeoman, 1914– and H. Underwood Thompson, 1910–), English



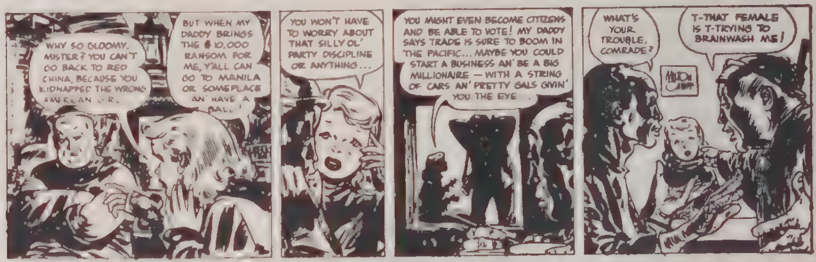


BY COURTESY OF (CENTRE, BOTTOM RIGHT) THE PROPRIETORS OF "PUNCH," REPRODUCED BY PERMISSION OF "PUNCH"; PHOTOGRAPHS (TOP RIGHT, BOTTOM LEFT) © THE NEW YORKER MAGAZINE, INC.

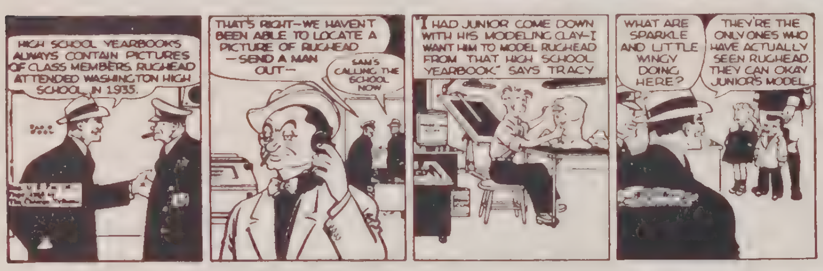
CARICATURE AND CARTOON


WHEN PEOPLE USE MY THINGS AROUND HERE, I WANT THEM PUT BACK PROPERLY
IF THIS HOUSE WERE RUN THE WAY I RUN MY OFFICE, THERE WOULDN'T BE SO MUCH CONFUSION
I WANT IT REMEMBERED THAT I WEAR THE PANTS AROUND HERE AND WHAT I SAY GOES! UNDERSTAND?
DAGWOOD, DO YOU KNOW IT'S JUST YOUR BOTTOM LIP THAT MOVES WHEN YOU TALK?
CHIC YOUNG

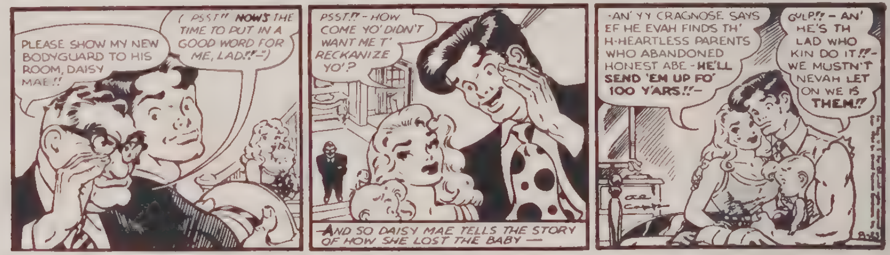
"Blondie," by Chic Young (1901–), U.S.


WHY SO GLOOMY, MISTER? YOU CAN'T GO BACK TO RED CHINA, BECAUSE YOU KIDNAPPED THE WRONG AMERICAN GIRL
BUT WHEN MY DADDY BRINGS THE $10,000 RANSOM FOR ME, Y'ALL CAN GO TO MANILA OR SOMEPLACE AN' HAVE A BALL!
YOU WON'T HAVE TO WORRY ABOUT THAT SILLY OL' PARTY DISCIPLINE OR ANYTHING...
YOU MIGHT EVEN BECOME CITIZENS AND BE ABLE TO VOTE! MY DADDY SAYS TRADE IS SURE TO BOOM IN THE PACIFIC... MAYBE YOU COULD START A BUSINESS AN' BE A BIG MILLIONAIRE — WITH A STRING OF CARS AN' PRETTY GALS GIVIN' YOU THE EYE
WHAT'S YOUR TROUBLE, COMRADE?
T-THAT FEMALE IS T-TRYING TO BRAINWASH ME!
MILTON CANIFF

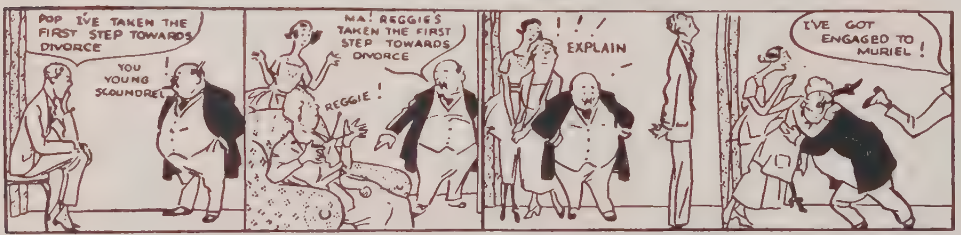
"Steve Canyon," by Milton Caniff (1907–), U.S.


HIGH SCHOOL YEARBOOKS ALWAYS CONTAIN PICTURES OF CLASS MEMBERS. RUGHEAD ATTENDED WASHINGTON HIGH SCHOOL IN 1935.
THAT'S RIGHT—WE HAVEN'T BEEN ABLE TO LOCATE A PICTURE OF RUGHEAD —SEND A MAN OUT—
SAM'S CALLING THE SCHOOL NOW
"I HAD JUNIOR COME DOWN WITH HIS MODELING CLAY—I WANT HIM TO MODEL RUGHEAD FROM THAT HIGH SCHOOL YEARBOOK" SAYS TRACY
WHAT ARE SPARKLE AND LITTLE WINGY DOING HERE?
THEY'RE THE ONLY ONES WHO HAVE ACTUALLY SEEN RUGHEAD. THEY CAN OKAY JUNIOR'S MODEL

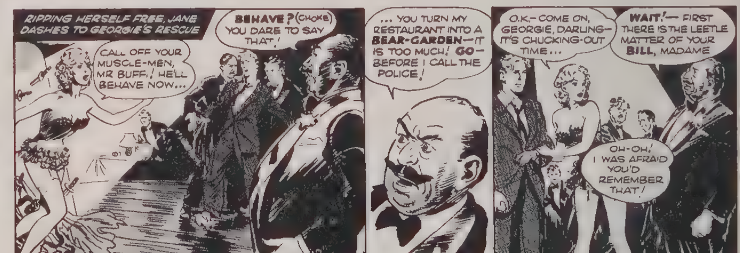
"Dick Tracy," by Chester Gould (1900–), U.S.


PLEASE SHOW MY NEW BODYGUARD TO HIS ROOM, DAISY MAE!!
(PSST!! NOW'S THE TIME TO PUT IN A GOOD WORD FOR ME, LAD!!—)
PSST!!—HOW COME YO' DIDN'T WANT ME T' RECKANIZE YO'?
—AND SO DAISY MAE TELLS THE STORY OF HOW SHE LOST THE BABY —
—AN' YY CRAGNOSE SAYS EF HE EVAH FINDS TH' H-HEARTLESS PARENTS WHO ABANDONED HONEST ABE—HE'LL SEND 'EM UP FO' 100 Y'ARS!!—
GULP!!—AN' HE'S TH LAD WHO KIN DO IT!!—WE MUSTN'T NEVAH LET ON WE IS THEM!!
AL CAPP

"Li'l Abner," by Al Capp (1909–), U.S.


POP I'VE TAKEN THE FIRST STEP TOWARDS DIVORCE
YOU YOUNG SCOUNDREL!
MA! REGGIE'S TAKEN THE FIRST STEP TOWARDS DIVORCE
REGGIE!
! ! !
EXPLAIN
I'VE GOT ENGAGED TO MURIEL!

"Pop," by Millar Watt (later by Gordon Hogg), English


RIPPING HERSELF FREE, JANE DASHES TO GEORGIE'S RESCUE
CALL OFF YOUR MUSCLE-MEN, MR BUFF! HE'LL BEHAVE NOW...
BEHAVE? (CHOKE) YOU DARE TO SAY THAT!
... YOU TURN MY RESTAURANT INTO A BEAR-GARDEN—IT IS TOO MUCH! GO—BEFORE I CALL THE POLICE!
O.K.—COME ON, GEORGIE, DARLING—IT'S CHUCKING-OUT TIME...
WAIT!—FIRST THERE IS THE LEETLE MATTER OF YOUR BILL, MADAME
OH-OH! I WAS AFRAID YOU'D REMEMBER THAT!
K100

"Jane," by Norman Pett (later by Mike Hubbard), English

POPULAR U.S. AND ENGLISH COMIC STRIPS

BY COURTESY OF (FROM TOP TO BOTTOM) KING FEATURES SYNDICATE, INC., © 1955; KING FEATURES SYNDICATE, INC., © 1955 FIELD ENTERPRISES, INC.; "THE CHICAGO TRIBUNE—NEW YORK NEWS" SYNDICATE, INC.; UNITED FEATURE SYNDICATE, INC.; "DAILY SKETCH," LONDON; "DAILY MIRROR," LONDON

of halftone or of a variety of ready-made checks, stripes or dots by the use of overlays of translucent material in the process of photographing; these are sometimes used to give texture to a costume or to darken a foreground, but many artists do not seem to want to use the great discretion they require and avoid them altogether. Those who do use them give marginal directions, and in the case of syndicated comics the editors have some choice.

A rather fine, almost traditional pen-drawing style came in with the serialization of "Tarzan" as a comic strip early in 1929; an illustrator's style rather than the broad comic style seemed suitable, and it had a strong effect. Those strips which depended less on a gag than on a continued story tended to adopt the style, and "Superman," "Flash Gordon," "Rip Kirby" and the strips of Milt Caniff, "Terry and the Pirates" and later "Steve Canyon," as well as "Male Call" during World War II, were drawn in a brush-and-pen style of considerable brilliance.

The artist working for reproduction on newsprint must, if he is going to use graded tone, remember that the halftone screen used will be much coarser than that for the glossy papers used in most weekly magazines. Regardless of the destination of his drawing, he usually works with black ink and various pens and brushes, using diluted washes if he expects to reproduce in halftone. Daily editorial cartoonists often use the lithographic crayon, which rapidly draws broad lines and can be slanted to lighten the weight of the line or rubbed to make a mass of dark (Rollin Kirby was a virtuoso). Comic-strip artists almost never use crayon or pencil except as preliminary aids before inking in. The makers of cartoons for magazines have much wider choice, though magazines tend to have their own stylebook for pictures as well as writing.

The syndicates which own the titles, general subject or story line and copyright of comic strips receive the drawn strips in batches from their artists several weeks in advance of the publication dates, which are usually indicated somewhere inconspicuously in the strip. Just as the artists often have assistants and "idea men," so the syndicate editors form an advisory staff which may affect the conduct of a strip. Once settled upon, a strip or a week's strips will be photographed and electrotyped, and from the master metal, after proof impressions taken from it are passed, papier-mâché molds or matrices ("mats" in the trade) will be made in quantity. These are shipped to the subscribing newspapers, and in due course will be used to cast plates for the rotary press. Even at this local level there will occasionally be editing; a sharp eye once in a long time will notice strange lettering in one or two balloons.

Both relief printing and lithography were being done in colour when the comic strip appeared, and the first strips, appearing only in Sunday papers, were coloured. The drawings for Sunday comic pages, normally two or three times as many frames as the daily strips, may be tried out with various colour combinations by their artists, but the final choice lies with syndicate editors and blockmakers, to whom marginal directions may be given by the artists. Certain strips have divorced their Sunday story altogether from the weekday continuity, and a few have Sunday and weekday versions by different artists; but most comic strips simply recapitulate on Sunday or provide a longer version of Saturday's climax. *See* PRINTING.

BIBLIOGRAPHY.—British Museum, Department of Prints and Drawings, *Catalogue of Political and Personal Satires,* from 1320 to date of compilation by F. G. Stephens and Mrs. M. D. George, 11 vol. (1870 ff.); "Champfleury" (G. H. Fleury), *Histoire de la Caricature,* 2 vol. (1865), and three expanded subdivisions of this work for the ancient world, the middle ages and the Renaissance; M. H. Spielmann, *The History of Punch* (1895); E. Fuchs, *Die Karikatur der europäischen Völker* (1901), a rather Marxian view; C. R. Ashbee, *Caricature* (1928); E. H. Gombrich and E. Kris, *Caricature* (1940), which goes to the psychological root of the matter, and "The Principles of Caricature," in E. Kris (ed.), *Psychoanalytic Explorations in Art,* pp. 189–203 (1952); W. Hofmann, *Caricature: From Leonardo to Picasso,* trans. from the German (1957), a purely European view; William Murrell, *A History of American Graphic Humor,* 2 vol. (1934, 1938); A. Nevins and F. Weitenkampf, *A Century of Political Cartoons* (1944); F. Wertham, *Seduction of the Innocent* (1954), the case against comic books; D. Low, *Cartoon History of Our Times* (1939), and many other reprints of Low; Coulton Waugh, *The Comics* (1947); Gilbert Seldes, *The Seven Lively Arts,* rev. ed. (1957). Ashbee, Hofmann, Murrell and Waugh have ample bibliographies. There have been numerous volumes of reprints of well-liked cartoons. (W. A.)

CARILLON, a musical instrument consisting basically of fixed cup-shaped bells, with a total chromatic range of at least two octaves.

Originally, four small bells in a row (hence the medieval Latin form *quadrilionem*) were struck by hand with a hammer. From the 13th century onward they were operated mechanically by means of a barrel set with pegs or studs and revolving in connection with the machinery of a clock. The introduction of a keyboard mechanism to the carillon, in Antwerp about 1480, led to a great increase in the instrument's range and expression, and both these methods of playing continued in use. In hand playing, a clavier of levers and pedals is connected mechanically to the bell clappers; this arrangement allows a great range of dynamics. Older automatic systems employ a drum similar to a Swiss music box, where pegs control hammers that strike the outside of the bell.

The oldest carillon is that of 24 bells in the Rijksmuseum, Amsterdam, Neth., cast in 1554 by Pieter van den Gheyn. The carillons of Utrecht, Delft and Amersfoort (cast *c.* 1660) were among the most musically expressive. In Flanders the outstanding instruments were those at Bruges (cast by Joris Dumery), Antwerp, Ghent and Mechelen (cast by Frans and Pieter Hemony). Mechelen's bells became, however, sadly inferior to those of other carillons, after centuries of mechanical playing and the practising of students. Louvain was the best endowed of the older carillon cities, possessing three large instruments.

The largest modern carillons are those at Riverside church, New York city, and at the Rockefeller chapel, The University of Chicago, each of 72 bells. In the U.S. the carillon was not confined to cast bells alone. Electronics permitted a new type of instrument to be produced, with a tone identical to that of a perfect bell, and electropneumatic or all-electric systems were used for playing the carillon. Several electronic carillons were produced, but the vacuum tube was used only as the magnifier of the bell tones through audio-amplification circuits. As in the conventional carillon, the basic bell tone in the electronic carillon is generated by metal struck by a hammer. The range varies from two to five octaves.

In England carillons have never been widely popular because of the old preference for change ringing (*see* BELL), but some instruments, notably those of the Bournville trust schools, Birmingham, and the Loughborough war memorial, have been built.

Music for the carillon, including a set of carillon preludes, was written by the Flemish composer Matthias van den Gheyn (1721–85).

Modern carillon music consists largely of arrangements of keyboard music, including fugues and sonatas for piano and organ, and arrangements of works by Handel, Bach, Mozart, Beethoven, Mendelssohn and Wagner.

BIBLIOGRAPHY.—W. G. Rice, *Carillons of Belgium and Holland* (1915); W. G. Rice, *Carillon Music and Singing Towers of the Old World and the New,* rev. ed. (1931); F. Percival Price, *The Carillon* (1933); P. D. Peery, *Chimes and Electronic Carillons* (1948). (J. BL.)

CARINA, one of the three constellations into which the large southern Ptolemaic constellation Argo was subdivided. It contains many variable stars and the supergiant star Canopus.

CARINTHIA (KÄRNTEN), a *Bundesland* (federal state) of the federal republic of Austria. Pop. (1961) 495,226. Area 3,681 sq.mi. (9,534 sq.km.).

Physical Geography.—Stretching from the crest of the Central Alps southward to the crests of the Carnic Alps and Karawanken, which form the boundary with Italy and Yugoslavia, Carinthia is entirely an alpine country but contains also a low-lying area, the Klagenfurt basin. This, with the eastern ranges of the Central Alps, forms lower Carinthia. Upper Carinthia consists of the more mountainous western parts.

The Drau (Drava) river, from the "Tirol Gate" to its confluence with the Gail river, divides upper Carinthia into a northern part of crystalline rocks dissected by the Drau tributaries and a southern part consisting of the low and well-rounded Gailtal Alps of Triassic limestones and dolomites, the straight, wide and swampy Gail valley and the Austrian section of the rugged Carnic Alps. In the Grossglockner group Austria reaches its highest point

(12,457 ft.) and contains its longest glacier, the Pasterze, 6 mi. in length. There are two large lakes, Weissensee and Millstätter See.

The Klagenfurt basin, structurally formed, is characterized by low altitude and a gently undulating surface. Parts of the structural troughs within it are now occupied by the other two of the main Carinthian lakes, the Ossiacher See and the Wörther See. A southern trough between the Sattnitz hills and the Karawanken is followed by the Drau river and is called Rosental. There are numerous small lakes of glacial origin. During the Ice Age blockage of drainage turned the Lavanttal, also a structural basin, into a lake whose sediments gave rise to the best soils of Carinthia. The mountain groups of lower Carinthia are the Gurktal Alps in the north and the Lavanttal Alps in the east, both part of the Central Alps. Another mountainous part is the northern flank of the Karawanken.

Carinthia is the southernmost part of Austria and in the south has a Mediterranean rainfall maximum in October. Its sheltered position within a mountain frame gives few strong winds, a warm, sunny summer and, because of air drainage, a very cold winter. January means vary between 25° to 19° F. and extremes of −4° F. occur frequently. Rainfall ranges between 32–40 in. in the basins and 98 in. on the surrounding mountains.

The vegetation of Carinthia is greatly varied. On the mountains coniferous trees prevail, but on lower ground deciduous stands are frequent.

History.—This area was the core of the Celtic kingdom of Noricum, which in 16 B.C. became a Roman province. After the breakdown of Roman rule Carinthia became prey of Teutonic tribes, followed by Avars, Slavs and Bavarians. The country was then attached to Bavaria, with the result that peaceful penetration by Bavarian settlers was intensified, and they gradually assimilated the Slav population except for some parts in the southeast. In 976 Carantania, or Carinthia, became a duchy in its own right and included Styria and the present East Tirol. When the line of the Carinthian dukes died out, Carinthia became part of the great but short-lived state of Otakar II of Bohemia. In 1276 it came into the hands of Rudolf I of Habsburg, who in 1286 gave it to the count of Tirol. In 1335, however, it returned to the Habsburgs, where it remained until 1918.

After World War I Yugoslavia claimed southern Carinthia, and in 1919, 128 sq.mi. of territory was ceded to Yugoslavia and 172 sq.mi. to Italy. During the *Anschluss* the *Reichsgau Kärnten* of greater Germany, in addition to present Carinthia, consisted also of East Tirol as well as upper Carniola. It again became a *Bundesland* with its former boundaries in 1945.

Population.—The population at the 1961 census was 495,226. The density was 52 to the square kilometre (about 135 to the square mile). Ethnically, more than 90% of the population of Carinthia is German, the dialect spoken belonging to the Bavarian group. There is, however, a sizable minority of Slovenes. According to their religious denomination, 86.6% were Roman Catholics and 9.8% were Protestants. The principal towns of Carinthia are the provincial capital, Klagenfurt (*q.v.;* 69,218), Villach (*q.v.;* 32,971) and St. Veit an der Glan, its capital until 1518 (10,950).

Government and Social Conditions.—The *Land* government, elected by and responsible to the provincial diet (*Landtag*), is elected for four-year periods by popular vote. The *Landtag* is a legislative body, but the acts it passes must be approved by the federal government. Carinthia is divided into nine administrative districts, and local government is controlled by elected burgomasters and town and commune councils.

There is a fairly high proportion of larger holdings (28% are more than 50 ac.), and there are considerable possibilities of employment in industry and trade. However, difficulties are evident in the areas of dispersed settlement: distances from schools and the pronounced conservatism of the people. The custom of undivided inheritance is prevalent.

The Economy.—Farming uses about 46% of the surface and forestry 44%, the highest after Styria. Wheat, rye and oats are grown in the Klagenfurt basin and in Lavanttal, maize (corn) in the Gail valley and fruit along the lake shores. More important and widespread is livestock farming. Most of the forests are privately controlled, mainly by owners of large farms and estates. Timber production is considerably in excess of natural growth.

Iron ore (about 200,000 metric tons produced annually) is mined at Hüttenberg, and lead-zinc-molybdenum ore west of Villach. Austria's chief resources of magnesite (400,000 tons annually) are near Spittal an der Drau. Brown coal is produced in the Lavant valley, and associated with it is the thermoelectric power station at St. Andrä. There are hydroelectric power plants at Schwabegg and Lavamünd, and the Reiszeck-Kreuzeck reservoir plant, with a head of 1,800 m. (5,905 ft.), is in the Möll valley. Industry is not so well developed. Timber is the most important raw material, with paper and cellulose plants at Villach, the leading industrial centre, and at Wolfsberg, in the Lavant valley.

Carinthia is crossed by a west-east railway line, Maribor-Fortezza (Franzenfeste), and by the north-south Vienna-Tarvisio (Tarvis) line. Villach is Carinthia's main railway junction. The main road to Salzburg is via the Katschberg pass (5,384 ft.), for the Grossglockner-Hochalpenstrasse, an important route into Italy, which climbs to more than 8,000 ft., is open only during the summer months. The Vienna road leads via Neumarkt pass into the Mur valley. There is an airport at Klagenfurt, but air traffic is relatively unimportant.

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CARINUS (MARCUS AURELIUS CARINUS) (d. A.D. 285), Roman emperor, 283–285. Probably named Numerius like his brother, he was sent by his father, the emperor Carus, with the title of Caesar to the army of the Rhine in 282 and became emperor in the west on his father's death in the summer of 283, his brother Numerian becoming emperor in the east. After a campaign on the Rhine, he returned to Rome, where he celebrated games in honour of Carus' eastern victories, in Sept. 284. A few weeks before, his brother had been replaced in the east by Diocletian (*q.v.*), who spent the winter consolidating his rule in the Balkans. In the spring of 285, near Verona, Carinus defeated Aurelius Julianus, the governor of Venetia, who had proclaimed himself emperor, but a few weeks later, while in Moesia, he was killed by his own troops in the course of a battle against Diocletian on the banks of the Margus river (Morava in Yugoslavia). (JN. R. M.)

CARISBROOKE, a village in the Isle of Wight, Eng., lies 1 mi. S.W. of Newport, in which municipal borough it was incorporated in 1933. Pop. (1961) 2,767. Lukely brook separates the village from the steep hill on which stands the castle. This shows three main periods of building—Roman, Norman and Elizabethan. The Roman fort, the entrance of which is still visible on the eastern side, probably dates to the end of the 3rd century A.D. After the Norman Conquest William Fitz Osbern built a motte and double bailey of earthwork and timber. This castle is mentioned in the Domesday survey, and it was there that William I arrested Bishop Odo of Bayeux in 1082. Early in the 12th century the stone keep and the present stone curtain wall round the western bailey were built by the De Redvers family, who held the castle until Isabella de Fortibus sold it to Edward I in 1293. Late in the 16th century, under the threat of Spanish invasion, the castle was enclosed by an elaborate outer fortification designed by Federigo Gianibelli. Charles I was imprisoned there from Nov. 1647 to Sept. 1648 and twice tried unsuccessfully to escape. Particularly interesting is the medieval well, 161 ft. deep, the only one in Great Britain where the bucket is still drawn up by a donkey. Formerly the residence of the governors of the island, the castle contains the Isle of Wight museum. The castle is administered as an ancient monument by the ministry of works and is open to the public.

The parish church of St. Mary has a fine Perpendicular tower (15th century) and an early Norman nave. The church registers include a note of the Spanish Armada's passing the Isle of Wight in July 1588. A Roman villa of basilican type was discovered in the vicarage garden in 1859. (J. D. Jo.)

CARISSIMI, GIACOMO (1605–1674), one of the greatest Italian composers of the 17th century, chiefly notable for his oratorios and secular cantatas, was born at Marino, near Rome, and baptized there on April 18, 1605. Following brief appointments at Tivoli and Assisi, he settled in Rome in the late 1620s as director of music at the church of S. Apollinare and retained this post until he died (in Rome, Jan. 12, 1674).

Although not an operatic composer, Carissimi helped to satisfy the Italians' inordinate enthusiasm for opera, which was performed in few centres and only at certain times of the year. He made its pastoral or dramatic content and idiom available in the home and in the church through his numerous cantatas, consisting of sequences of recitatives, ariosos and arias or duets, and his 16 oratorios, which are short "substitute operas" on Old Testament subjects, performed during Lent, when operas were forbidden. In his cantatas he consolidated the pioneer work of Luigi Rossi, but in oratorio he was himself a pioneer.

Carissimi's works are marked by emotional balance and an ideal fusion of the lyrical and the dramatic; and when working on a large scale his pronounced feeling for tonality prevents any tendency to diffuseness. His genius is well displayed in his finest oratorio, *Jephtha,* lasting about 20 minutes, where both solo narrator and chorus act as commentators and the latter also take the roles of opposing groups in the story. The final chorus is particularly fine. Balance is obtained by contrasting solo arias, such as the beautiful one of Jephtha's daughter. Handel expanded this basic scheme in his oratorios, and Carissimi also exercised great influence on later music not only through his music but also through his numerous pupils.

See also Cantata; Oratorio.

See E. Vogel, *Die Oratorientechnik G. Carissimis* (1928). (N. Fo.)

CARLETON, WILLIAM (1794–1869), Irish novelist, outstanding as an observer of peasant life, was born at Prillisk (near Clogher), County Tyrone, Feb. 20, 1794. He was educated at peasant "hedge schools" and was originally intended for the priesthood. In 1818, however, he made his way to Dublin, where, after enduring poverty, he was commissioned to write stories illustrating the superstitions allegedly encouraged among the peasantry by the Roman Catholic Church. He soon discovered his true powers, however: the tracts became *Traits and Stories of the Irish Peasantry* (1830), his finest work. From this until his death in Dublin on Jan. 30, 1869, Carleton wrote voluminously. His best-known novels are *Fardorougha the Miser* (serialized 1837–38; in book form, 1839), *Valentine McClutchy, the Irish Agent* (1845), a vehicle for his views on the Irish land question, and *The Black Prophet* (serialized, 1846; in book form, 1847), a novel about the Great Famine, though his best work is undoubtedly contained in the *Traits and Stories . . . ,* of which a second series appeared in 1833. These wonderful genre pictures of Irish peasant life before the famine are full of vitality and humour, an unforced tenderness toward his subject and an occasional dark intensity of foreboding. Carleton began an autobiography, which was completed by D. J. O'Donoghue and published as *The Life of William Carleton* (1896). (A. Cr.)

CARLILE, RICHARD (1790–1843), English radical and freethinker, was a notable and successful champion of the freedom of the press. A shoemaker's son, he was born at Ashburton in Devon on Dec. 8, 1790, was educated at the village school and by 1813 was a journeyman tinman in London. Influenced by Thomas Paine's *Rights of Man,* he was converted to radicalism and from 1817 was a vigorous salesman of *The Black Dwarf* and other extreme radical weeklies. In 1817 William Sherwin made Carlile his agent for the production and sale of *Sherwin's Weekly Political Register,* with control of his shop. Carlile immediately published several radical and deist works, wrote *The Political Litany* and was consequently imprisoned for 18 weeks for blasphemy. In 1818 he published the works of Thomas Paine and his followers, for which he was fined £1,500 and sentenced to three years imprisonment (1819); the sentence was later extended. Carlile became sole proprietor of *Sherwin's Weekly Political Register* in 1819, and, changing its name to *The Republican,* he edited it from prison. When the police were not in possession, his shop was kept open by his wife, his sister and several supporters, who were, in turn, imprisoned, the prosecutions being encouraged by a public subscription headed by the duke of Wellington. But Carlile was victorious in 1825, when the government decided to discontinue the prosecutions. After his release he edited various new weeklies and between 1829 and 1831 conducted discussions in the London Rotunda, which became the centre of radical and free thought activities. Carlile was a pioneer of almost every extreme radical cause, including abolition of monarchy, completely secular education and the emancipation of women. He considered that freedom of speech and the propagation of knowledge were far more important than specific political and social reforms. He served further terms of imprisonment after 1825, and when he died, in London on Feb. 10, 1843, he had spent a total of nine years and four months in prison.

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CARLILE, WILSON (1847–1942), founder of the Church Army (*q.v.*), was born in Brixton, London, on Jan. 14, 1847. His ambition to make a fortune in business was changed to that of "serving Christ and the men he loves" as a result of a startling experience of conversion, and he was ordained in the Church of England. In 1882 he started training lay people as evangelists in the belief that their ministry might be successful in reaching the many nonchurchgoing members of the working classes. Profoundly disturbed at the appalling conditions under which many slum dwellers lived, he launched the social work of the Church Army (1888). He was called the "archbishop of the gutter." He became a prebendary of St. Paul's cathedral (1906) and was honorary chief secretary of the Church Army until his death on Sept. 26, 1942, at Woking, Surrey.

See A. E. Reffold, *Wilson Carlile* (1947). (E. W. Ca.)

CARLINGFORD, CHICHESTER SAMUEL FORTESCUE, Baron (1823–1898), British statesman, who helped frame Gladstone's conciliatory Irish legislation, was born at Glyde, County Louth, Ire., on Jan. 18, 1823. Elected member of parliament for Louth in 1847, he married the charming and talented former Countess Waldegrave in 1863. He was appointed chief secretary for Ireland in 1865, at a time when the Fenian agitation was very active. Fortescue had always opposed religious discrimination and helped Gladstone in carrying the disestablishment of the Anglican Church in Ireland. He also did the groundwork for the Land act of 1870, which recognized the tenant's right to compensation for improvements. But he was not considered forceful enough as Irish secretary and in 1871 was transferred to the board of trade. There he remained until 1874 when, rejected by his constituency, he was raised to the peerage as Baron Carlingford. He was appointed lord privy seal in 1881. Gladstone used his experience of Ireland in framing the second Land act (1881), which established fair rent tribunals. But Carlingford declined to follow Gladstone in adopting the policy of Home Rule for Ireland and withdrew from active politics in 1886. He died at Marseilles, France, on Jan. 30, 1898, and the title became extinct. (D. G.)

CARLINGFORD (Cáirlinn), a market town and port in County Louth, Republic of Ireland, on the north side of Carlingford peninsula and at the foot of Slieve Foy. Pop. (1956) 565. The peninsula is separated from the Mourne mountains by Carlingford lough, an inlet of the Irish sea, sometimes claimed as the spot where St. Patrick landed in 432. Carlingford is built round the ruins of a castle, dating from the reign of King John, and the abbey, a 14th-century Dominican house. There are remains of 16th-century and earlier fortified houses, some of them occupied. The oyster and seaweed beds are valuable.

CARLISLE, EARLS OF. In 1322 Sir Andrew de Hartcla (Westmorland) was created earl of Carlisle after the battle of Boroughbridge (*see* English History). Next year he was executed for treason, having been detected in intriguing with the Scots, and his title was forfeited.

In 1622 the title was conferred upon James Hay (*c.* 1580–1636), son of Sir James Hay of Kingask. He had been a gentleman of the bedchamber and a "prime favourite" of James I, who had already created him Baron Hay of Sawley (1615) and Viscount Doncaster (1618). He was employed on diplomatic missions to France (1616–24), to Germany (1619–20) and to Lorraine and Savoy (1628); he was interested in the plantation of New England and received a grant from James I (confirmed in 1627 by Charles I) of all the Caribbean islands, including Barbados. According to the earl of Clarendon, "he left behind him a reputation of a very fine gentleman and a most accomplished courtier, and after having spent in a very jovial life above £400,000 which upon a strict computation he received from the crown, he left not a house nor an acre of land to be remembered by."

In 1617 Carlisle had married, as his second wife, Lucy (1599–1660), second daughter of Henry Percy, 9th earl of Northumberland. Her beauty and wit, which were celebrated by the leading poets of the day, and her influence with the queen made her a conspicuous figure at the court of Charles I. She formed a close friendship with the earl of Strafford, but after his execution became an equally close friend of John Pym. Both men highly valued her friendship, which probably sprang from a taste for political intrigue, for there seems to be no justification for the charge that she was their mistress. She appears, however, at least in 1641–42, to have betrayed the confidences of both sides. Her greatest service to the parliamentary opposition was to forewarn them of the king's intention to arrest the five members (Jan. 1642). In 1647 she was accused of intriguing with the Presbyterians against the army, and during the Civil War she showed great zeal and activity in the royalist cause. She was imprisoned in the Tower from March 1649 until Sept. 1650 and, according to a royalist newsletter, was even threatened with the rack. She died on Nov. 5, 1660.

On the death of the 2nd earl, JAMES HAY, without issue in 1660, the peerage became extinct in the Hay family.

CHARLES HOWARD (1629–85), 1st earl of Carlisle in the Howard line, was the second son of Sir William Howard of Naworth, Cumberland. He became a Protestant in 1645. He bore arms on the royalist side in the Civil War but became a supporter of the Commonwealth. He bought Carlisle castle and became governor of the town; was appointed high sheriff of Cumberland (1649–50); and fought with distinction under Oliver Cromwell at the battle of Worcester, later becoming captain of the protector's bodyguard. He sat in the parliaments of 1653, 1654 and 1656; became a member of the council of state (1653); and was appointed deputy major general of Cumberland, Westmorland and Northumberland (1655). In 1657 he was included in Oliver Cromwell's house of lords. In 1659 he urged Richard Cromwell to defend himself by force against the army leaders, and after Richard's fall he was imprisoned twice. Again elected to parliament in April 1660, he was after the Restoration created Baron Dacre of Gillesland, Viscount Howard of Morpeth and earl of Carlisle (April 30, 1661). He became lord lieutenant of Cumberland and Westmorland and in 1672 of Durham, and held various other military appointments in the north. He went on embassies to Russia, Sweden and Denmark in 1663–64 and took the garter to Charles XI of Sweden in 1668. In 1673 he became deputy earl marshal, and in 1677 he was appointed governor of Jamaica and reappointed governor of Carlisle. He died on Feb. 24, 1685.

FREDERICK HOWARD (1748–1825), 5th earl, was one of the commissioners sent out by Lord North to attempt a reconciliation with the American colonies in 1778. He was lord lieutenant of Ireland, 1780–82. He opposed William Pitt's policy on the regency question in 1788–89 and on the eastern question in 1791, but abandoned the opposition on the outbreak of war with revolutionary France. He opposed the enactment of the 1815 Corn law. He was the author of some political tracts, a number of poems and two tragedies, *The Father's Revenge* and *The Stepmother,* highly praised by his contemporaries. In 1798 he became guardian of Lord Byron, the poet, who lampooned him in *English Bards and Scotch Reviewers.* He died at Castle Howard, Sept. 4, 1825.

GEORGE HOWARD (1773–1848), 6th earl, who served under the "ministry of all the talents" (1806–07) and was lord privy seal in 1827–28 and 1834, also made some minor contributions to literature.

His eldest son, GEORGE WILLIAM FREDERICK HOWARD (1802–64), 7th earl, after a distinguished academic career at Eton and Christ Church, Oxford, supported the parliamentary reform movement and became chief secretary for Ireland, 1835–41, lord lieutenant of Ireland, 1855–58 and again 1859–64. He, too, was the author of poems, a tragedy, a travel diary and other works. He took a warm interest in the reformation of juvenile criminals and established a model reformatory on his own estates. He died unmarried at Castle Howard, Dec. 5, 1864, and the title passed to his brother and then to a nephew, GEORGE JAMES HOWARD (1843–1911), 9th earl. He took a minor part in politics and was a strong supporter of the temperance movement but achieved greater distinction as a connoisseur of art and a painter. He died at Hindhead, April 16, 1911. His wife, Rosalind Frances (1845–1921), youngest daughter of the 2nd Lord Stanley of Alderley, was an even more enthusiastic temperance advocate, was a staunch friend of W. E. Gladstone, was keenly interested in women's education and became an advocate of woman suffrage. (R. B. WM.)

CARLISLE, a city, municipal and parliamentary borough and the county town of Cumberland, Eng., 298 mi. NNW of London and 9 mi. S of the Scottish border by road. Pop. (1961) 71,101. Area 9.5 sq.mi. (24.6 sq.km.). It lies on the River Eden about 8 mi. above its mouth in the Solway Firth and at the junction of two tributaries from the south, the Caldew and the Petteril. Silloth, on the Irish Sea, is the nearest port (23 mi..W). Carlisle is one of the principal railway centres in Great Britain.

The area was first reached by the Romans in the late 70s of the 1st century A.D., under Julius Agricola, and very early Roman pottery has been found in Carlisle. Within the next 100 years it was transformed from a settlement of crude British huts into the Romano-British Luguvalium, a town of considerable civic comfort. The large Roman fortified camp of Petriana (now in the suburb of Stanwix) housed a squadron of cavalry 1,000 strong and lay just north of the Eden on the line of Hadrian's Wall (*q.v.*), which was commenced in A.D. 122 across the Tyne-Solway Isthmus. The Romans held the wall and city until 383, and almost every excavation in the city centre yields some relic of Roman occupation. Much of the original structure of Carlisle Castle and the cathedral nave is of stones from Petriana.

Carlisle (Caer Luel of the Britons, also Karliol, hence its name) is mentioned in 685 when it was bestowed by Egfrith on St. Cuthbert to form part of his see of Lindisfarne, and when St. Cuthbert visited the city he was shown the ancient walls and a Roman fountain. In the 9th century it was completely destroyed by the Danes, and in the 10th century Edmund I, the grandson of Alfred the Great, gave it (together with the whole of Cumberland) to Malcolm I, king of the Scots. Because of this the city does not appear in Domesday Book, and in *Macbeth* Shakespeare refers to the "prince of Cumberland" as successor to the Scottish throne. William II, called Rufus, claimed the city as English in 1092 and set up the walls and castle. For the next 650 years Carlisle knew little peace. In 1136 David I of Scotland again captured it; he strengthened the castle and died there in 1153. In 1157 Henry II reclaimed Carlisle from the Scottish king, and, with the granting of its first charter in 1158, the city became permanently English. This charter and a later one of Henry III in 1251 were both destroyed by fire but were confirmed by the charter of Edward I in 1293. Edward I held three parliaments in the castle, and in 1307 the bull of excommunication was read against Robert I the Bruce in the cathedral before Edward set out on his last Scottish campaign. He died just outside the city. In 1541 Henry VIII strengthened and modified the castle in view of the growing use of artillery, and had the citadel constructed as a subsidiary fortification. Elizabeth I carried out further extensive repairs, although her general policy toward the Scots was more conciliatory. In 1568 Mary (Mary Stuart) fled from Scotland and came to the castle as a guest. She remained as a captive and from Carlisle began her slow journey southward toward the execution block.

The charter of Edward III in 1353 established the city's right to "a free guild and a free election of their mayor and bailiffs," but it was with the accession of Elizabeth I that the first serious attempt was made to establish law and order. In 1561 the Dormont Book was drawn up, setting out the oaths of the mayor (still sworn to by each succeeding mayor) and various council officials and enumerating certain bylaws. The principal, or governing, charter is the one of 1637 granted by Charles I which renews former charters and grants in addition that the royal sword, accompanied by mace-bearers, be borne before the governing body.

The Cathedral.—Like the castle, Carlisle Cathedral, originally the church of an Augustinian priory (founded 1093), was started by William II, and the bishopric was created in 1133 by Henry I. Much of the building was gutted by the fire of 1292 and again in 1392. Only two bays of the Norman nave remain, and its arches exhibit a remarkable distortion caused by the sinking of the foundations; it is now a memorial chapel to the fallen of the Border Regiment. The central tower on the cruciform building was added in 1401. The choir is ornate and beautiful and retains the original 15th-century woodwork with some particularly fine misericords. The huge Decorated east window, with its elaborate tracery, is one of the finest of its kind in Europe and contains some of the original glass dating from the mid-14th century. Sir Walter Scott was married in the nave in 1797. The nearby fratry has a splendid dining hall and a beautiful reader's pulpit.

The City.—Other notable buildings are the town hall (1717), the courthouses (which replaced the old citadel), the 14th-century guildhall (the home of the eight guilds which formerly governed the city, Tullie House (built in 1689 and now the city museum and art gallery), and the modern 11-storied civic centre, opened in 1964, with its freestanding octagonal council chamber. Fragments of the city wall remain, and there is a market cross dated 1682. The corporation plate includes two 16th-century racing bells, the country's oldest horse-racing prizes. The regimental museum of the Border Regiment, in the castle keep, is open to visitors. Thomas Woodrow, grandfather of Pres. Woodrow Wilson, was pastor of Lowther Street Congregational Church, 1820–35.

The constant wars and border raids impeded commerce until the second half of the 18th century, and the city's true commercial prosperity began with the railway development. The Newcastle–Carlisle Railway (1835) was the first east-to-west line in England. Carlisle became a county borough in 1914 and is the shopping and marketing centre for a wide area. A belt of public park land is preserved on either side of the river. The area of the borough was extended in 1951 to provide additional land for housing. There are colleges of art and technology and a municipal airport with pilot-training facilities. The principal industries are the manufacture of biscuits (cookies), textiles, metal boxes, sweets (candies), cranes, and coal-mining machinery. There are several industrial estates. The sale of intoxicating liquor became a state undertaking in 1916 ("Carlisle Experiment"), conducted first by the Liquor Control Board and later, under the Licensing Act of 1921, by the Carlisle and District State Management Scheme.

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(K. SH.)

CARLISLE, a borough of Pennsylvania, U.S., and the seat of Cumberland county, lies in the Cumberland valley, 18 mi. S.W. of Harrisburg, the state capital. The county and town derive their names from their English counterparts. The site was first settled in 1720 by James le Tort, a French-Swiss Indian trader. Cumberland county was created in 1750, and Carlisle was designated the county town in 1751. It was incorporated as a borough in 1782.

A provincial fort was built at Carlisle in 1756 during the French and Indian War, and the town became a munitions centre during the American Revolution. It was also the home of James Wilson, signer of the Declaration of Independence, and of Molly Pitcher, Revolutionary War heroine.

Carlisle has a distinctive atmosphere resulting from its surviving colonial structures and from the presence of Dickinson college (chartered 1783) and the unaffiliated Dickinson school of law (founded 1834). It is the site of Carlisle barracks, after 1951 the seat of the Army War college. The barracks from 1879 to 1918 housed the Carlisle Indian school, where Jim Thorpe began his athletic career.

Carlisle manufactures rugs and carpets, tires, steel castings, radio parts, paper, textiles and clothing. It adopted the commission-manager form of government in 1921.

For comparative population figures *see* table in PENNSYLVANIA: *Population.* (S. W. HM.)

CARLISM (Spanish CARLISMO), a Spanish political movement of traditionalist character, originating in the 1820s as the *apostólico* or extreme clerical party, and mobilized in 1827 in the form of paramilitary Royalist Volunteers. This opposition to liberalism crystallized in the 1830s around the person of Don Carlos (*q.v.*), younger brother of King Ferdinand VII (d. 1833), and afterward conde de Molina. In claiming the right to succeed his brother, Don Carlos denied the validity of Charles IV's pragmatic sanction of 1789, then being used by Ferdinand to ensure the succession of his infant daughter Isabella (born on Oct. 10, 1830). Instead, the Carlists invoked the Salic Law, introduced into Spain by Philip V in 1713.

The disputed succession and its ideological overtones provoked the Carlist War of 1833–39. The Carlists, though defeated, thereafter upheld their cause despite the conservatism of the Isabelline monarchy and unsuccessful attempts to effect a dynastic reconciliation through a marriage between Isabella II (*q.v.*) and Don Carlos' heir, Don Carlos, conde de Montemolín. The Carlist claim passed to the latter upon the "abdication" of "King Charles V" in 1845. On the death of "King Charles VI" (Montemolín) in 1861, the leadership of the cause was assumed by his brother Don Juan; his alleged liberalism brought about his "abdication" in 1868 in favour of his son, Don Carlos, duque de Madrid, "King Charles VII," who then led the movement until his death in 1909. During the 19th century the Carlists frequently resorted to armed rebellion: a second Carlist War was unsuccessfully waged in the late 1840s, an abortive attempt made at a military *coup d'état* in 1860, and full-scale war resumed between 1872 and 1876 during the political upheavals following the deposition (1868) of Isabella II. Yet another defeat, and the restoration (1874) of Isabella's son Alfonso XII brought decline to Carlism, until Spain's humiliation in the Spanish-American War stimulated new growth and a brief return to insurgency during the years 1900–02.

The Carlist ideology and program was initially a spontaneous and somewhat crude amalgam of religious obscurantism and the rural localism enshrined in the *fueros* (laws) of Navarre, the Basque provinces, inland Catalonia, and lower Aragon. In the 1840s it received more sophisticated infusions from the sympathetic, non-Carlist traditionalist theorists Juan Donoso Cortés (1809–53) and Jaime Luciano Balmes (1810–48), and later was more eloquently expounded by Aparisi y Guijarro and more particularly by Juan Vázquez de Mella (1861–1928), who from the 1890s onward laboured to give Carlism greater relevance to contemporary problems. The core of the ideological system thus developed was the "traditional" or "representative" monarchy. Though branded by their opponents as absolutists, the Carlists claimed to deny both absolute monarchy and the concept of divine right, envisaging their king as a personification of national sovereignty, ruling with the assistance of a nominated council of notables and "authentic" *Cortes* (courts, parliaments). The latter would represent the interests, hierarchies, and regions of which society and polity were organically constituted, would exercise effective restraint upon royal power, and would actively participate in the legislative process. It was argued that this foretaste of the corporate state would restore social harmony and national cohesion, as well as permit considerable devolution of power, by ending the exploitation and centralization regarded as inseparable from liberalism and as the causes of class conflict and regional separatism. Unity and peace would be sustained by means of religious uniformity and the church's monopoly of education.

Carlism's appeal, based upon religious fervour and a degree of decentralization, has always been greatest in the peasant societies of the rural north and east. Even at times of general weakness, the movement has held firm in its stronghold of Navarre. Expansion elsewhere in northern and eastern Spain has normally occurred at times of crisis: 1827–39, 1868–76, 1898–1902, and 1931–36. It is from these areas that the levies of the 19th century and the *requetés* (Carlist troops of the Civil War) were drawn. Difficulty has always been encountered in expanding the appeal of Carlism beyond these regions and into the cities and even in maintaining support in less troubled periods. Carlism's religious appeal has been frequently undercut by a largely hostile ecclesiastical hierarchy and a liberalizing papacy, its monarchism by a conservative and pro-Catholic monarchy, its qualified regionalism by the greater stridency of Basque and Catalan nationalism, and its stand on national unity by more "contemporary" fascist and authoritarian organizations. The attractions of parliamentarism and of dealings with other Catholic and monarchist parties have caused recurrent internal disputes and, in 1888, a serious schism. Relations between Carlists and their pretenders have often been delicate; in 1919 a dispute between the heir of "King Charles VII," Don Jaime (1870–1931), and Mella, provoked the defection of the latter and many of his supporters. The deaths of Mella in 1928 and Don Jaime in 1931, together with the political climate of the Second Republic, made possible the reunification of these three factions in 1932 in the Traditionalist Communion. Headed by the new pretender, the octogenarian brother of "Carlos VII," Don Alfonso Carlos (1849–1936), duque de San Jaime, ideologically stimulated by Mella's protégé Victor Pradera, and under the political leadership of an Andalusian, Manuel Fal Conde, the Carlists prepared for and participated in the rising of July 1936 and the ensuing Civil War. In April 1937 the movement was forcibly merged by Gen. Francisco Franco with the fascist Falange.

Carlists have held high office throughout the course of the Franco regime, though in diminishing numbers as they and the regime have become less mutually sympathetic. The movement again split over the disputed succession following the death of Alfonso Carlos in 1936. Instead of adhering to the strict law of succession and appointing as his heirs the family of the exiled Alfonso XIII, Alfonso Carlos named as regent and, implicitly, heir, his nephew Francis Xavier of Bourbon-Parma, thereafter Javier I to most of his Spanish supporters. Many Carlists refused to accept this solution, several of the most eminent eventually, in 1958, acknowledging as rightful king the son of Alfonso XIII, Don Juan.

During the 1960s the cause of the Carlist supporters of Don Javier received a boost with the assumption of the *de facto* leadership by the son of Don Javier, Hugues, now styling himself Carlos Hugo. In the mid-1960s the movement, still strongest in Navarre, was making a new appeal to discontented youth and frustrated regionalists. Advocating "People's Monarchy," it was moving toward outright opposition to the regime. Its prospects were damaged, however, by General Franco's announcement in 1969 that the son of Don Juan, Juan Carlos, would be the future king of Spain.

For genealogical table, *see* Bourbon.

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CARLOMAN, the name of several Frankish princes of the Carolingian family (*see* Carolingians). Four of them are particularly noteworthy.

Carloman (d. 754), the elder son of Charles Martel (*q.v.*). On his father's death (741) he divided with his brother Pepin the mayoralties and authority over all the Merovingian territories, taking for himself all the northeast of the kingdom round Austrasia. He was often at war against the rebellious Alamanni and the independent tribes of Saxons and Bavarians. He helped St. Boniface to establish his archbishopric and supported his missionary work. The council convened by Carloman at Estinnes in Hainaut in 743 laid the foundations of later Carolingian administration. He retired to a monastery in 747 and died at Vienne on Aug. 17, 754, having spent his last few years at Monte Cassino in Italy.

Carloman (751–771), the younger brother of Charlemagne, with whom, at the instance of their father, Pepin the Short, he was anointed king of the Franks in 754 by Pope Stephen III (II) in the abbey of St. Denis. Carloman inherited the eastern part of Pepin's lands (768). He favoured alliance with the Lombards and married Gerberga, a daughter of their king, Desiderius. Carloman died at Samoussy (Aisne), on Dec. 4, 771, and Charlemagne then annexed his territory.

Carloman (828–880), the eldest son of Louis the German. Carloman rebelled against his father in 861 (together with his father-in-law Ernest, count of the Bohemian march) and in 863, but in 865 was entrusted by Louis with a share in his authority, being granted jurisdiction over Bavaria and Carinthia. After this he remained loyal to his father, even helping to suppress the rebellion of his two younger brothers (866) and taking part in a campaign against the Moravians (869). The latter by 874 were forced to admit Frankish supremacy. After the death of the emperor Louis II (875), a faction in northern Italy, led by the emperor's widow, Engelberga, favoured Carloman as candidate for the imperial crown; but Pope John VIII preferred Charles the Bald. When Louis the German died (876), Carloman succeeded him as king of some of the German territories. In undisputed control of Bavaria, he promptly crossed the Alps on the death of Charles the Bald (877) and was recognized as king in northern Italy. The pope, however, still refused him the imperial crown. Falling ill, Carloman had to renounce his lands and titles to his brother Louis the Younger. He died at Öttingen in March or Sept. 880. His illegitimate son Arnulf became emperor in 896.

Carloman (d. 884), the second son of Louis II le Bègue or the Stammerer. On Louis II's death (879) Carloman was associated with his brother Louis III as king of the West Franks, but both, as the children of a first marriage which had been unacceptable to their grandfather Charles the Bald, had difficulty in obtaining recognition. On Louis' death (882) Carloman became sole ruler. He died while hunting on Dec. 12, 884.

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CARLOS I (1863–1908), king of Portugal from 1889 to 1908, was born in Lisbon on Sept. 28, 1863, the son of Luís I and of Maria Pia of Savoy, daughter of Victor Emmanuel II of Italy. He married Marie Amélie of Orléans, a granddaughter of the French king Louis Philippe, in 1886 and succeeded his father on Oct. 19, 1889. Forces generated by mistakes made before his time proved to be the undoing of this talented and intelligent man, who was also known for his competent paintings and oceanographical studies. At home, republicans, disaffected monarchists and freemasons kept up a running opposition. Popular indignation over the British ultimatum of 1890 (*see* Portugal: *History*) was directed against the throne and resulted in the republican revolt at Oporto (Jan. 1891). There were also rebellions in Portugal's overseas territories. Although visits of foreign rulers temporarily bolstered the prestige of the monarchy, discreditable public discussions about the king's civil list and private life ultimately jeopardized the throne. After the revolt of 1906, Carlos allowed João Franco to establish a dictatorship; Franco's repressive measures increased the activities of the antimonarchical secret societies, and they soon bore fruit. Another revolt broke out on Jan. 28, 1908. The king, then at Vila Viçosa, hurried to Lisbon. On Feb. 1, the day of his arrival there, Carlos and the crown prince, Luís Filipe, were assassinated.

See Luís Vieira de Castro *D. Carlos I,* 3rd ed. (1943). (M. Ca.)

CARLOS, Don (1545–1568), príncipe de Asturias, was the son of Philip II of Spain. His tragic death and his supposed love for his stepmother Elizabeth of Valois have often been used as a romantic plot, notably by Schiller and by Verdi. Carlos was born at Valladolid on July 8, 1545, the only child of Philip's consanguineous marriage with Maria, daughter of John III of Portugal. All the most sinister hereditary characteristics of the houses of Trastámara, Avis and Habsburg seem to have combined in Don Carlos to produce a sickly, gluttonous, sadistic megalomaniac. Carlos repaid his father's indulgence with mortal hatred. All attempts to introduce him to political responsibility through membership of the king's councils served only to show that he was completely unfit for any authority, while inflaming his ambition. Eventually, Philip had to admit that his heir was a danger to the state, and on Jan. 18, 1568, he arrested him, writing to his sister that he must do so to fulfill his duties as a Christian prince. Carlos died in prison in Madrid on July 24, 1568. His habit of sleeping on ice in his stifling prison and his gluttony probably caused his death. There is no evidence that he was murdered, by Philip's orders or otherwise, though, within a few days, rumours of murder were whispered even in the court itself.

Bibliography.—L. Cabrera de Córdoba, *Felipe Segundo,* vol. i (1876); F. Rachfahl, *Don Carlos, Kritische Untersuchungen* (1921); R. B. Merriman, *The Rise of the Spanish Empire in the Old World and in the New,* vol. iv (1934); G. de Boom, *Don Carlos, l'héritier de Jeanne la Folle* (1955).

CARLOS, Don (1788–1855), conde de Molina, the first Carlist pretender to the Spanish throne and the second surviving son of King Charles IV, was born in Madrid on March 29, 1788. He was imprisoned in France from 1808 to 1814 and led an uneventful life until he incurred the hostility of the Spanish radicals during the constitutional period (1820–23). Although pious and rigidly orthodox, he was unwilling to pay attention to the overtures of the *apostólicos* (extreme clericals) until his brother Ferdinand VII tried to make him recognize his daughter Isabella as heir to the throne. Don Carlos refused, maintaining that by the form of Salic law established by Philip V in 1713 (subsequent revocations of which he considered invalid) he was Ferdinand's rightful successor. Since the Spanish liberals supported Isabella's claim, Don Carlos became the candidate of the clericals, asserting that he represented the true traditions of the monarchy, the church and regional liberties against the foreign innovations of liberal constitutionalism and centralization. He went to Portugal in March 1833 to meet his brother-in-law Dom Miguel, the Portuguese pretender, and, in consequence of the civil war there, was cut off from Spain when Ferdinand VII died in Sept. 1833. Don Carlos could return to Spain, where his supporters proclaimed him king as Charles V, only via England, and it was not until July 1834 that he put himself at the head of his partisans in the Basque provinces. Tomás de Zumalacárregui, his commander in chief, was a general of genius, but Don Carlos' lack of judgment prevented any early solution to the first Carlist War. After Zumalacárregui's death (1835) and the Carlists' failure to take Bilbao, the initiative passed increasingly to the liberals. When, in Aug. 1839, the Carlist general Rafael Maroto signed the convention of Vergara, by which the liberals recognized the Basque *fueros,* most of the fighting ceased and Don Carlos went into exile. He abdicated his pretensions in 1845, taking the title conde de Molina, in the vain hope that his son Don Carlos (*q.v.;* 1818–61) might heal the breach within the Bourbon family by marrying Isabella II. He died at Trieste on March 10, 1855. *See* also Carlism. (C. A. H.)

CARLOS, Don (1818–1861), conde de Montemolín and the eldest son of Don Carlos (*q.v.;* 1788–1855), the first Carlist pretender, whom he succeeded as head of the Carlist line, with the title Charles VI, in 1845, was born in Madrid on Jan. 31, 1818. On his behalf Gen. Ramón Cabrera raised the Carlist bands in 1845 and for two years waged war (*guerra de los matiners*) in the Catalan interior. Efforts to heal the breach within the Bourbon family during the 1840s and again after 1854 broke down because of Montemolín's intransigence. An attempted *pronunciamiento* by Montemolín, his brother Fernando and the liberal general Jaime Ortega at San Carlos de la Rápita, near Tortosa, in April 1860 was a complete fiasco. The brothers were captured but were allowed to leave Spain after an abject renunciation (repudiated once safely in exile) of their claims. Montemolín died at Trieste on Jan. 13, 1861. Since his brother Fernando had died on Jan. 1, and the Condesa de Montemolín died at midnight on Jan. 13 also, foul play was suspected but never proved. *See* also Carlism. (C. A. H.)

CARLOS, Don (1848–1909), duque de Madrid, styled Charles VII by the Carlists, was the eldest son of Don Juan de Borbón (1822–87) and a grandson of the first Carlist pretender, Don Carlos (1788–1855). Born at Ljubljana, in Carniola (now part of Yugoslavia), on March 30, 1848, he became the Carlist claimant when his father abdicated on Oct. 3, 1868. Don Carlos was unable to dominate the counsels of his party in the critical years after the deposition of Isabella II (1868), when Carlism experienced a revival, and his misjudgments and vacillation were responsible for many of the failures of his cause. After the election of Amadeo of Savoy as king in Nov. 1870, the Carlists became more militant, whipping up national feeling against the foreign king. Many favoured armed revolt, arguing that parliamentary corruption would prevent them from ever coming to power by constitutional means, and a rising took place in the spring of 1872, which began the second Carlist War. The Carlist defeat at Oroquieta in May 1872 showed the rising to be premature. It was the establishment (Feb. 1873) of the fiercely anticlerical first republic which enabled Don Carlos to rally support in the traditionally Carlist areas and to put large forces into the field. He returned from exile on July 16, 1873, and established his court at Estella, in Navarre, but his physical presence was a mixed blessing because he was neither a competent soldier nor an inspiring leader. Although his cause prospered during 1873–74, when the republic was distracted by the cantonalist revolts in the south, the successful coup in Dec. 1874 in favour of Isabella II's son Alfonso XII doomed the Carlists. The army and large sections of the church rallied to the restored dynasty, and by March 1876 Don Carlos was driven into exile. A wanderer and an embarrassment to foreign governments for the rest of his life, he refused to surrender his claims or to provide any real leadership for his followers, who were divided by the development of rival regionalist parties and liberal Catholicism. He died at Varese, Italy, on July 18, 1909. *See* also Carlism.

See Conde de Rodezno, *Carlos VII, duque de Madrid,* 3rd ed. (1944).

(C. A. H.)

CARLOTA (Marie Charlotte Amélie Augustine Victoire Clémentine Léopoldine) (1840–1927), empress of Mexico, only daughter of King Leopold I of Belgium and Princess Louise of Orléans, was born at Laeken, near Brussels, June 7, 1840. At the age of 17 she married the archduke Maximilian (*q.v.*), brother of the emperor Francis Joseph I of Austria, and accompanied him to Mexico (1864) on his mission to accept the Mexican crown under the auspices of Napoleon III. When the French ruler decided to withdraw his troops, Maximilian's position became untenable in the face of Mexican resistance (led by Benito Juárez) and United States opposition. Carlota returned to Europe and sought aid successively and fruitlessly in Paris, Vienna and finally from the pope in Rome. Her inability to aid her husband, who was executed in 1867, precipitated a mental collapse. Carlota was cared for in a Belgian château until her death, Jan. 19, 1927. (S. R. R.)

CARLOW (Ceatharlach), a county in the province of Leinster, Republic of Ireland, is bounded on the north by County Kildare, east by counties Wicklow and Wexford and west by counties Kilkenny and Laoighis (Leix). With an area of 346 sq.mi., it is the smallest Irish county except Louth.

Physical Features.—In the southeast is a range of barren granitic mountains (Mt. Leinster, 2,610 ft.; Knockroe, 1,777 ft.). This range is flanked on the west by Carboniferous limestone, the level expanse of which covers most of the county. In the west is the ridge of Old Leighlin bog (Gallows hill, 978 ft.), forming the beginning of the Leinster coal measures, which are worked mostly in County Kilkenny. Glacial deposits cover much of the lower land. Stretches of the river Barrow, flowing north-south through the county, are incorporated in the Dublin-Waterford canal system.

The soil of County Carlow is mainly friable loam, particularly suitable for the growing of barley of malting standard. The climate is temperate; the average annual rainfall is 35.8 in. In the past Carlow was extensively planted with hardwood trees; and after World War II, plantations of quick-growing softwoods were developed by the forestry commission. Pheasant, partridge, wood-cock and snipe are abundant, and the Barrow and its tributaries are fished for salmon and trout.

History.—Ceatharlach (the four lakes) lay within the extensive lordship of Leinster, which fell to Richard de Clare, 2nd earl of Pembroke, in the second half of the 12th century. It later figures as the liberty of Carlow and is believed to have been confirmed as such by King John to William Marshal, 1st earl of Pembroke, and to have had the privileges of a palatinate on descending to one of the earl's heiresses. In later centuries it was a buffer area in the conflicts between the Butlers, earls of Ormonde, and the Fitzgeralds, earls of Kildare. Antiquarian relics include large dolmens and the ruins of several Norman castles, such as those at Carlow and Leighlinbridge. The remains of monastic settlements are to be found, and the 12th-century cathedral of St. Laserian, Old Leighlin, is still in use. In the south the ancient settlement of St. Mullin's (or St. Moling), with its churches and round tower, dates from the 7th century.

Population, Administration and Economy.—The population of the county was 33,345 in 1961. The chief centres of population are Carlow (*q.v.*), the county town, Bagenalstown and Tullow. The county is administered with County Kildare by a county manager, who is advised by the elected county council. The counties Carlow and Kilkenny together return five members to *dail eireann* (house of representatives).

Carlow is sometimes referred to as "the English county of Ireland," probably because it is more intensively cultivated than most Irish counties. Wheat and barley are the chief grain crops, and sugar beets are grown and processed. Agricultural limestone is processed and transported throughout the southeast of the county. Flour milling and malting are carried on extensively, and there are small engineering industries ancillary to agriculture. Sheep and dairy and beef cattle are raised; but since intensive wheat growing began during World War II, livestock has become secondary to tillage.

The railway from Dublin to Kilkenny and Waterford runs through the county, serving Carlow and Bagenalstown. Branch lines have been closed since World War II except for the transport of agricultural produce at certain seasons. The Barrow navigation connecting Waterford with the Grand canal system was closed for commercial traffic in 1959 but is maintained for pleasure cruising.

See John Ryan, *The History and Antiquities of the County of Carlow* (1833). (F. A. G. W.)

CARLOW (CEATHARLACH), the county town of County Carlow, Republic of Ireland, on the river Barrow, 52 mi. S.S.W. of Dublin by road. Pop. of urban district (1961) 7,707. The town, originally an Anglo-Norman stronghold, was granted a charter of incorporation in the 13th century and was reincorporated by James I, returning two members to the Irish parliament. The castle, a turreted keep of which two towers and a wall remain, was probably raised by William Marshal, 1st earl of Pembroke, between 1207 and 1213 and is the earliest of its kind in Ireland. An important dolmen is at Haroldstown, Browne's Hill, 2 mi. N.E. of the town, and at Killeshin, 3 mi. W., is a church of Norman and pre-Norman date. Here may be seen a rare example of a Hiberno-Romanesque doorway. The town is the seat of the Roman Catholic bishop of Kildare and Leighlin, whose cathedral, built in 1883, is in the revived Gothic style. St. Patrick's college (1793) is the oldest in the English-speaking world for the training of Roman Catholic priests.

The town benefited considerably by the establishment of a large beet-sugar factory and refinery. Flour, leather footwear and machinery are also manufactured. (F. A. G. W.)

CARLSBAD: *see* KARLOVY VARY.

CARLSBAD, a city of southeastern New Mexico, U.S., and seat of Eddy county, is best known as the gateway to Carlsbad caverns with their beautiful limestone formations (*see* CARLSBAD CAVERNS NATIONAL PARK). It is also a recreational centre. The city is bisected by the Pecos river; a dam in the city provides the best body of water within a 200-mi. radius, and beach facilities along the river are comparable with oceanside resorts. Mean temperature is 63° F., with an average of 336 days of sunshine annually; swimming, boating, water skiing and golfing are enjoyed throughout the year.

Potash, discovered in 1925, is mined in significant quantities in the area. In addition, Carlsbad is a shipping point for cotton, alfalfa, wool, oil and livestock and is the centre of a rich irrigation district.

Founded in 1887, it was originally known as Eddy for its founder, Charles B. Eddy. Because of its mineral springs it acquired its present name in 1899, from the famed European spa, Carlsbad (Karlovy Vary). It was chartered as a city in 1918.

For comparative population figures *see* table in NEW MEXICO: *Population.* (JE. W. B.)

CARLSBAD CAVERNS NATIONAL PARK, a tract of approximately 50,000 ac. in southeastern New Mexico, U.S., was established as a national monument in 1923 and designated a national park in 1930. Beneath the park winds a labyrinth of the largest subterranean chambers yet discovered. The total length of the rooms and passages is still unknown, but the explored part of the main cavern is 23 mi. long, of which 3 mi. are open to visitors. Of the three major levels, the deepest is 1,100 ft. below the ground. Elevators take visitors to the 750-ft. level. The second level is at 900 ft.

The caverns have been formed by the dissolvent action of water on limestone. In many of the rooms thus created, notably the Queen's chamber, the Green Lake room, the King's palace and the Papoose room, there are stalactites and stalagmites of calcite. The roof of the Papoose room supports gleaming draperylike formations. The Big room is about 1,300 ft. long and 650 ft. wide. Its ceiling arches 285 ft. above the floor. Here are the Giant dome, a stalagmite 62 ft. tall, and the Twin domes, only slightly smaller, superbly proportioned and delicately fluted.

A colony of several million bats inhabits a part of the caverns known as Bat cave during the summer months. These bats led to the exploration of the caverns in 1901, when a local cowboy, Jim White, saw them pouring from the cave's mouth at sundown to forage for insects.

As with all national parks, Carlsbad Caverns' surface area is a sanctuary for its native plants and wildlife. (Dx. B.)

CARLSBAD DECREES, a series of resolutions (*Beschlüsse*) passed by the conference of ministers of the more important German states held at the Bohemian spa of Carlsbad (now Karlovy Vary) from Aug. 6 to Aug. 31, 1819. The states represented were Austria, Prussia, Bavaria, Mecklenburg, Saxony, Hanover, Württemberg, Nassau, Baden, Saxe-Weimar-Eisenach and electoral Hesse. The occasion of the meeting was the desire of the Austrian foreign minister, Prince von Metternich (*q.v.*), to take advantage of the consternation caused by recent revolutionary outrages—especially the murder of the dramatist August Kotzebue (*q.v.*)—to persuade the German governments to combine for the suppression of the liberal and nationalistic agitation. (*See* GERMANY: *History.*)

The business to be discussed, as announced in Metternich's opening address, was twofold: first, matters of urgent importance necessitating immediate action; secondly, questions affecting the fundamental constitution of the German confederation. These questions were debated in 23 formal conferences. On the urgent matters there was practical unanimity. All were agreed that disciplinary measures were necessary. It was decided to lay before the federal diet definite proposals for: (1) a uniform press censorship of all periodical publications; (2) a system of "curators" to supervise universities and schools, coupled with the suppression of the recently created *Burschenschaften* (*q.v.*); and (3) the establishment of a central commission of investigation at Mainz, armed with inquisitorial powers, for the purpose of unmasking the widespread conspiracy assumed to exist. In fact, the statesmen probably overestimated the unity and strength of the opposition. Metternich's secretary, the ultraconservative Friedrich Gentz, hailed the repressive Carlsbad decrees as the "greatest retrograde step in Europe for the last 30 years."

As to the fundamental constitution of the German confederation, there was, among the statesmen at Carlsbad, a marked divergence of opinion, especially on the question of the correct interpretation of article xiii of the federal act. The controversy raged round the distinction between "assemblies of estates," as laid down in the article, and "representative assemblies," as had already been established in several German states. Gentz, in an elaborate memorandum, laid down that representation by estates was the only system compatible with the conservative principle, as representative assemblies were based on the preposterous egalitarian idea of the sovereignty of the people, which in his view was bound to lead to the decomposition of society. In answer, Graf Heinrich Wintzingerode, on behalf of the king of Württemberg, placed on record a protest in which he urged that insistence on the system of estates would stereotype caste distinctions foreign to the whole spirit of the age, would alienate public opinion from the governments and, if enforced by the central power, would violate the sovereign independence of those states which, like Württemberg, already had representative institutions. Since agreement could not be reached, the debate on the constitutional issue was adjourned until the general conference of German ministers to be summoned to Vienna later in the year.

The acts, protocols and resolutions of the conference of Carlsbad are ed. by M. de Martens, *Nouveau recueil général de traités,* vol. 4 (1846).

See V. Karell, *Der Karlsbader Kongress* (1937). (H. G. Sc.)

CARLSON, EVANS FORDYCE (1896–1947), U.S. marine officer, commander of Carlson's raiders of World War II, was born at Sidney, N.Y., on Feb. 26, 1896. He ran away from home to enlist in the U.S. army at 16 and served in the Philippines, in Hawaii and on the Mexican border before World War I. He was made a captain and served as assistant adjutant general on the staff of Gen. John Pershing in France and Germany and in the army of occupation (1917–19).

Carlson returned to civilian life in 1920 but enlisted as a private in the marine corps in 1922, being commissioned a second lieutenant the following year. He served in the West Indies with the battle fleet and in Nicaragua.

Carlson first served in China from 1927 to 1929 and returned in 1937 to spend two years as an observer of the Chinese armies, including nearly a year with guerrillas behind Japanese lines. He resigned from the marine corps in 1939 and wrote *The Chinese Army* (1940) and *Twin Stars of China* (1940).

In April 1941 he re-entered the marine corps as commander of the 2nd marine raider battalion (Carlson's raiders), used his experience in China to train the group and led it in a surprise attack on Makin Island (Aug. 1942) and in a month-long raid behind Japanese lines on Guadalcanal (Nov. 1942). He advanced through grades to the rank of brigadier general and retired in 1946 because of wounds. He died May 27, 1947.

CARLTON, an urban district in the Carlton parliamentary division of Nottinghamshire, Eng., lying immediately east of Nottingham. Pop. (1961) 38,815. The district included after 1934 the parish of Gedling and part of that of Colwick. Industries comprise mining, furniture making, hosiery and printing. Colwick has one of the largest railway marshalling yards in the country.

CARLYLE, THOMAS (1795–1881), Scots essayist and historian, who became one of a select group of sages whom the serious-minded Victorian public read avidly, discussed endlessly and reverenced deeply. Whether his subject was historical, political or economic, religious or biographical, his aim was always to be a prophet. He was born at Ecclefechan, Annandale, on Dec. 4, 1795, the second son of James Carlyle and the eldest child of his second marriage. James Carlyle was by trade a mason and, later, a small farmer, a man of profound Calvinist convictions, whose character and way of life had a profound and lasting influence on his son. Carlyle was devoted, too, to his mother and to his eight brothers and sisters, and his strong affection for his family never diminished.

After attending the village school at Ecclefechan, Thomas was sent to Annan academy in 1805, where he apparently suffered from bullying, and later to Edinburgh university (1809). There he read widely but followed no precise line of study. His father had intended him to enter the ministry, but Thomas became increasingly doubtful of his vocation. He had an aptitude for mathematics, and in 1814 he obtained a mathematical teaching post at Annan. In 1816 he went to another school, at Kirkcaldy, where Edward Irving (*q.v.*) was teaching and became one of the few men to whom Carlyle gave complete admiration and affection. "But for Irving," Carlyle said later, "I had never known what communion of man with man means." Their friendship continued after Irving moved to London in 1822 and became famous as a preacher.

The next years were hard for Carlyle. Teaching did not suit him and he abandoned it. In Dec. 1819 he returned to Edinburgh university to study law, and there he spent three miserable years, lonely, unable to feel certain of any meaning in life and eventually abandoning the idea of entering the ministry. He did a little coaching and journalism; he was poor and isolated, and he was conscious of intense spiritual struggles. About 1821 he experienced a kind of conversion, which he described some years later in fictionalized account in *Sartor Resartus,* whose salient feature was that it was negative—hatred of the Devil, not love of God, being the dominating idea. Though it may be doubted whether everything was really experienced as he described it, this violence is certainly characteristic of Carlyle's tortured and defiant spirit. In those lean years he began his serious study of German, which always remained the literature he most admired and enjoyed. For Goethe, especially, he had the greatest reverence, and he published a translation of *Wilhelm Meister's Apprenticeship* in 1824. Meanwhile, he led a nomadic life, holding several brief tutorships at Edinburgh, Dunkeld and elsewhere.

On Oct. 17, 1826, he married Jane Welsh, the intelligent, attractive and somewhat temperamental daughter of a well-to-do doctor in Haddington. Miss Welsh had been one of Irving's pupils, and she and Carlyle had known one another for five years. The hesitations and financial worries which beset them are recorded in their letters. It is interesting that Carlyle, usually so imperious, often adopted a weak, pleading tone to his future wife during the time of courtship, though this did not prevent him from being a masterful, difficult and irritable husband, and, in spite of their strong mutual affection, their marriage was full of quarrels and misunderstandings.

In the early years of their marriage the Carlyles lived mostly at Craigenputtock, Dumfriesshire, and Carlyle contributed to the *Edinburgh Review* and worked on *Sartor Resartus.* Though this book eventually achieved great popular success, he had at first much difficulty in finding a publisher. It is a fantastic hotchpotch of autobiography and German philosophy, written with mingled bitterness and humour. Its main theme is that the intellectual forms in which men's deepest convictions have been cast are dead and that new ones must be found to fit the time, yet the intellectual content of this new religious system is elusive. Its author speaks of "embodying the Divine Spirit of religion in a new Mythus, in a new vehicle and vesture," but he never says very clearly what the new vesture is to be.

In 1834, after failing to obtain several posts he had desired, Carlyle moved to London with his wife and settled in Cheyne row. Though he had not earned anything by his writings for more than a year and was fearful of the day when his savings would be exhausted, he refused to compromise but began an ambitious historical work, *The French Revolution.* The story of how the partially completed manuscript was lent to J. S. Mill and accidentally burned is well known. After the accident Carlyle wrote to Mill in a generous, almost gay, tone, which is truly remarkable when Carlyle's ambition, his complete dependence upon a successful literary career, his poverty, the months of wasted work and his habitual melancholy and irritability are considered. The truth seems to be that he could bear grand and terrible trials more easily than petty annoyances. His habitual, frustrated melancholy arose, in part, from the fact that his misfortunes were not serious enough to match his tragic view of life, and he sought relief in intensive historical research, choosing subjects where divine drama, which his own life lacked, seemed most evident. His book on the French Revolution is perhaps his greatest achievement. After the loss of the manuscript he worked furiously at rewriting it. It was finished early in 1837 and soon won both serious acclaim and popular success, besides bringing him many invitations to lecture and solving his financial difficulties.

True to his idea of history as a "Divine Scripture," Carlyle saw the French Revolution as an inevitable judgment upon the folly and selfishness of the monarchy and nobility. This simple idea was backed with an immense mass of well-documented detail and, at times, a memorable skill in sketching character. The following extract is characteristic of the contorted, fiery and doom-laden prose, alternately colloquial, humorous and grim: "An august Assembly spreads its pavilion; curtained by the dark infinite of discords; founded on the wavering bottomless of the Abyss; and keeps continual hubbub. Time is around it, and Eternity, and the Inane; and it does what it can, what is given it to do." (Part 2, book 3, ch. 3.) Though many readers were thrilled by the drama of the narrative, it is not surprising that they were puzzled by Carlyle's prophetic harangues and their relevance to the contemporary situation.

In *Chartism* (1840) he appeared as a bitter opponent of *laissez faire*, but the radical-progressive and the reactionary elements were curiously blurred and mingled. With the publication of *On Heroes, Hero-Worship, and the Heroic in History* in 1841 his reverence for strength, particularly when combined with the conviction of a God-given mission, began to emerge. He discussed the hero as divinity (pagan myths), as prophet (Mohammed), as poet (Dante and Shakespeare), as priest (Luther and Knox), as man of letters (Johnson and Burns) and as king (Cromwell and Napoleon). It is perhaps in his treatment of poets that Carlyle shows to the best advantage. Perverse though he could be, he was never at the mercy of fashion, and he saw much more, particularly in Dante, than others did. Two years later this idea of the hero was elaborated in *Past and Present*, which strove "to penetrate . . . into a somewhat remote century . . . in hope of perhaps illustrating our own poor century thereby." He contrasts the wise and strong rule of a medieval abbot with the muddled softness and chaos of the 19th century, pronouncing in favour of the former, in spite of the fact that he had rejected dogmatic Christianity and had a special aversion to the Roman Catholic Church.

It was natural that Carlyle should turn to Cromwell as the greatest English example of his ideal man, and he produced the bulky *Oliver Cromwell's Letters and Speeches: With Elucidations* in 1845. His next important work was *Latter-Day Pamphlets* (1850), in which the savage side of his nature was particularly prominent. In the essay on model prisons, for instance, he tried to persuade the public that the most brutal and useless sections of the population were being coddled in the new prisons of the 19th century. Though incapable of lying, Carlyle was completely unreliable as an observer, since he invariably saw what he had decided in advance that he ought to see.

In 1857 he embarked on a massive study of another of his heroes, Frederick the Great, and *The History of Friedrich II of Prussia, Called Frederick the Great* appeared between 1858–65. Something of his political attitude at this time can be gathered from a letter written in April 1855 to the exiled Russian revolutionary A. I. Herzen, in which he says "I never had, and have now (if it were possible) less than ever the least hope in 'Universal Suffrage' under any of its modifications" and refers to "the sheer Anarchy (as I reckon it sadly to be) which is got by Parliamentary eloquence, Free Press, and counting of heads" (quoted from E. H. Carr, *The Romantic Exiles*).

Unfortunately, he was never able to respect ordinary men. Here, perhaps, rather than in any historical doubts about the veracity of the Gospels, was the core of his quarrel with Christianity—it set too much value on the weak and sinful. His fierceness of spirit was composed of two elements, a serious Calvinistic desire to denounce evil and a habitual nervous ill temper, for which he often reproached himself but never managed to defeat.

In 1865 he was offered the rectorship of Edinburgh university. The speech which he delivered at his installation in April 1866 was not very remarkable in itself but its tone of high moral exhortation made it an immediate success. It was published in 1866 under the title *On the Choice of Books*. Soon after his triumph in Edinburgh, Mrs. Carlyle died suddenly in London. She was buried in Haddington and an epitaph by her husband was placed in the church. Carlyle never recovered completely from her death. He lived another 15 years, weary, bored and a partial recluse. A few public causes gained his support: he was active in the defense of Governor Eyre, dismissed and deprived of £6,000 a year for what Carlyle called "saving the West Indies and hanging one incendiary mulatto, well worth gallows, if I can judge." He was excited by the Franco-German War, saying "Germany ought to be President of Europe," but such enthusiastic moments soon faded. In these last years he wrote little. His history *The Early Kings of Norway: Also an Essay on the Portraits of John Knox* came out in 1875, and *Reminiscences* was published in 1881. Later he edited his wife's letters, which appeared in 1883 under the title *Letters and Memorials of Jane Welsh Carlyle, Prepared for Publication by Thomas Carlyle*. Carlyle died in London on Feb. 5, 1881, and although Westminster abbey was offered for burial, he was buried, according to his wish, beside his parents at Ecclefechan.

It is perhaps difficult to be fair to Carlyle. Those who do not accept him as an inspired prophet find he makes intolerable claims on his readers' patience and on their emotional energy. A sentence, a paragraph can be pithy, but a whole book is always repetitive and diffuse, and he could never be fair.

Though he was a man of many words and wide learning, his religious sense, intense in its way, played always round two grand and simple ideas which many religions have in common—the terror of God's glory and the immortality of the soul. The whole of his life and writings can be seen as an attempt to secularize, to reclothe, the Calvinist insights, without mitigating them. In the effort to preserve religion while discarding its doctrines, he has affinities with several famous Victorians, particularly Matthew Arnold. But whereas Arnold, working from a moderate Anglican basis, attempted to turn Christianity into sweetness and light, Carlyle preserved to the full, and even increased the fierceness, the momentous drama, the seriousness of Calvinism. The idea of the elect and the reprobate, even though transferred into moral and secular terms, was an ever-present reality to him. For an infallible Bible he substituted an infallible History, what he called "the true epic poem and universal Divine Scripture, whose plenary inspiration no man out of Bedlam or in it shall bring in question." Though it is possible to challenge his merits as a writer, there is no doubt of his historical importance. He stirred the conscience of his century; he helped thousands to see their experiences in a historical and spiritual context and thus to find new meaning in a monotonous and drab existence; and in an age of prolonged and burdensome physical toil, he inspired thousands with belief in the dignity of their work.

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(A. O. C.)

CARMAGNOLA (properly Francesco Bussone, sometimes called Conte di Carmagnola) (d. 1432), Italian *condottiere*, whose fame rests largely on the tragic circumstances of his downfall, commemorated in verse by Alessandro Manzoni, was born at Carmagnola, near Turin, probably between 1380 and 1385. Of humble origin, he won titles and fiefs (though not that of Carmagnola) by helping Filippo Maria Visconti to restore the duchy of Milan to its full territorial dominion (*see* Visconti). The duke's favour evidently cooled more quickly than his captain's ambition, and in 1425 Carmagnola took service against Milan with the Venetians. His generalship proved so ambiguous and inept as to create suspicion of treason, for which he was tried, tortured and put to death by Venice on May 5, 1432.

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(P. J. J.)

CARMAGNOLE, a word first applied to a Piedmontese peasant costume (from Carmagnola, the town in Italy) well known in the south of France and brought to Paris by the revolutionaries of Marseilles in 1792. It consisted of a short-skirted coat with rows of metal buttons, a tricoloured waistcoat and red cap and became the popular dress of the Jacobins. The name was then given to the famous revolutionary song, composed in 1792. Each verse of this ends with the refrain:

Vive le son, vive le son,
Dansons la carmagnole,
Vive le son du canon!

CARMAN, (WILLIAM) BLISS (1861–1929), Canadian poet remembered chiefly for certain poignant love poems and one or two transcendental rhapsodies in celebration of nature, was born at Fredericton, N.B., on April 15, 1861, of early New England stock turned United Empire Loyalist; on his mother's side he was a distant relative of Ralph Waldo Emerson. He was educated under the famous schoolmaster George R. Parkin at Fredericton collegiate and at the University of New Brunswick. He attended lectures at the universities of Oxford and Edinburgh and at Harvard, where he was deeply impressed by the philosophy classes of Josiah Royce.

In 1890 he went to New York city and for two decades earned a living in editorial capacities on various journals, including the *Independent, Current Literature*, the *Chap-book* and, for a short time, the *Atlantic Monthly*. Between 1893 and 1905 he published nearly 20 volumes of verse, including almost everything of his that deserves to endure. Among these are *Low Tide on Grand Pré* (1893); three series of *Songs from Vagabondia* (1894, 1896, 1901), written in collaboration with Richard Hovey, the U.S. poet, whom he had met at Harvard; *Behind the Arras* (1895); *Ballads of Lost Haven* (1897); *Pipes of Pan* (published in five volumes under various titles, 1902–05); and *Sappho* (1904), improvisations based on the Greek fragments of Sappho. From 1904 to 1908 he was engaged in writing a series of semi-inspirational works in prose, *The Kinship of Nature, The Friendship of Art, The Poetry of Life* and (in collaboration with Mary Perry King) *The Making of Personality*. These added little to his reputation. His later poetry is an echo of his earlier, fainter and less compelling. Two volumes, *Sanctuary* and *Wild Garden*, were published in the year of his death, which occurred on June 8, 1929, in New Canaan, Conn.

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CARMARTHEN (Caerfyrddin), a municipal borough and the county town of Carmarthenshire, lies on the right bank of the river Towy, 8 mi. above its mouth on Carmarthen bay, 22 mi. N.W. of Swansea. Pop. (1961) 13,249. Of great antiquity, its site on the historic south Wales coast commands the Towy route into central Wales. The main part of the town is on a hillock surmounted by the remains of a Norman castle and the modern county hall. Eastward are the parish church of St. Peter, largely of 14th-century construction, and the site of the Roman station of Maridunum.

The history of Carmarthen during the post-Roman centuries is largely uncertain, but it was of ecclesiastical rather than military importance; Merlin appears in the legends of this era. When the Normans established themselves early in the 12th century, Carmarthen began to assume its historic role as the administrative and economic centre of western Wales. Though there were earlier charters, what may be regarded as the first town charter was granted by Henry III in 1227. Llewelyn the Great, King John, Edward I, Richard II, Owen Glendower, Jasper Tudor, Sir Rhys ap Thomas and Walter Devereux, 1st earl of Essex, figure in the town's history, largely one of attacks, sieges and burnings.

On the eastern side of the town was the Augustinian priory, established by the Normans, which housed the Black Book of Carmarthen, the oldest Welsh manuscript extant, now in the National Library of Wales, Aberystwyth; while on the western side was the Franciscan friary. In the middle ages Carmarthen was important for its wool trade, being declared by Edward III in 1353 the sole staple (mart) for Wales. As a result of the social changes in Tudor times, a guildhall was built in 1583 (replaced by the present guildhall *c.* 1770). Carmarthen has a place in the story of the early Protestant martyrs, among whom was Bishop Robert Ferrar of St. David's (burned in the market place in 1555). During the Civil War the castle was at first held for the king but changed hands on the appearance of Cromwell; earth defenses of the period (the "Bulwarks") have been preserved. For centuries Carmarthen was a busy river port, and on the Towy coracles may still be seen. The mayor also retains his title as "Admiral of the River Towy," bestowed by Henry VIII, who granted the borough the right (still exercised) to possess a ceremonial sword. In the 18th and 19th centuries Carmarthen was a social centre and was associated with Sir Richard Steele (buried in St. Peter's church), Bishop Connop Thirlwall, John Nash (traces of whose work still survive in the town), Sir Thomas Picton, Brinley Richards and Sir Lewis Morris. It also became a printing, literary and academic centre, and an important meeting of the renascent Eisteddfod was held there in 1451. In 1747 an iron-smelting works was built in the town, which later manufactured tin plate until 1900. Carmarthen became a railway junction after 1856 and is now the hub of road communications in southwest Wales. The town expanded, particularly after World War II, and its population increased by almost 20%. It is the flourishing agricultural, commercial and administrative centre for a wide area. Important cattle marts are held each week, and there is a large modern milk-processing plant. Trinity college trains many teachers, and there is the extensive new West Wales General hospital.

Carmarthen, together with Lichfield, Poole and Haverfordwest, is one of the old boroughs that remain counties in themselves, a privilege granted to Carmarthen by James I in 1604. It was created a parliamentary borough in 1536 and after 1832 returned a member jointly with Llanelly, but in 1918 it was merged in the Carmarthen parliamentary division. Its commission of the peace and quarter sessions were abolished in 1951, but there is still a borough sheriff for assize purposes. (E. V. J.)

CARMARTHENSHIRE (Sir Gaerfyrddin), a county of south Wales, bounded north by Cardiganshire, east by Brecknockshire and Glamorgan, west by Pembrokeshire and south by Carmarthen bay and the Bristol channel. With an area of 919.8 sq.mi., it is the largest Welsh county.

Physical Features.—The physical core of Carmarthenshire consists of the plain of the Towy, with its continuation into the Tâf valley. This lowland, curving from a southwesterly to a westerly direction, is aligned along a denuded anticline or arch mainly floored by black shales of Tremadoc (Cambrian) Age and covered at the sides by conglomerates, sandstones and shales, with beds of volcanic ash and lava of Arenig (Ordovician) Age. Above these are shales, flags and limestones named from Llandilo, where they are remarkably developed. North of the Towy lowland, the hills are formed of Ordovician and Silurian shales and mudstones, deeply dissected and divided into two zones, one south of Brechfa, with a maximum height of 900 ft., and one north of Brechfa and the Cothi river, reaching above 1,300 ft. South and southeast of the Towy the Silurian sandstones and mudstones form the first hills; then, in order of geological succession, comes Old Red Sandstone followed by Carboniferous limestone and coal measures. The Old Red Sandstone forms to the southeast the Black mountains of Carmarthenshire, rising to 2,632 ft., and to the south of this the scarps and moorlands of the Carboniferous limestone and Millstone Grit ("Farewell rock") form the northwestern rim of the south Wales coal field, the rich coal measures of the Gwendraeth, Amman and Llanelly district being within the county. The Old Red Sandstone rocks on the southern side of the main Towy lowland form only very subordinate hill lines westward from the Black mountains, and the Towy makes its way through the Old Red Sandstone zone to an estuary formed by coastal sinking. The main drainage follows the line of the denuded anticline occupied by the Towy, whose tributaries include the Sawdde, from the southeast, and the Cothi and Gwili, which drain the northern dissected uplands. The streams Gwendraeth Fach and Gwendraeth Fawr and the Loughor follow northeast-southwest lines which are characteristic of the region, and the Loughor divides the county from Glamorganshire on the east. The east-west alignment of the middle Towy is duplicated by the Tâf lowland toward the southwestern margin of the county; south of St. Clears, however, the Tâf turns southeastward to the sea near Laugharne. The land forms have been substantially modified by glacial action during the various phases of the advance and retreat of the icecaps which occurred in the Welsh highlands during the Pleistocene. Many of the hills were smoothed by the passage of ice, although erosion by ice and glacial melt water has also etched a more complicated pattern of land forms and drainage network. Deposits of boulder clay are frequent on the lower valley sides, especially west of Carmarthen town on the lowland area which shows evidences of having been a lake, probably in late glacial times. With the exception of Llyn-y-Fan, in the Black mountains, and those at Talley, which appear to have no outlet, the natural lakes are inconsiderable. The largest sheet of water is the Usk reservoir on the county's eastern boundary.

History.—The region above the 600-ft. contour is dotted with tumuli and cairns and, especially in the northwest, with menhirs and other stone monuments. Bronze objects are found especially along the southern coast and at Conwil in the Gwili valley. The hilltop camps of Romano-British age cap spurs of the high ground and seem to be situated at defensible points that guarded ways up from the sea and communications along the valleys. Carn Goch (5 mi. N.E. of Llandilo) covers about 15 ac. and is enclosed by a stone rampart. The Roman focus of ways across the country lay at Maridunum, later Carmarthen, the present capital of the county. The post-Roman centuries saw the civilizing and Christianizing influence of the Celtic saints on the one hand, leaving its mark in the dedications of rural churches, and on the other hand the numerous raids from the sea and by land of the Irish and the Scandinavians. The strong reign of Rhodri Mawr (*c.* 870) is said to have brought a measure of peace, and his grandson Howel the Good (Hywel Dda) was the first to codify the ancient laws of Wales at his palace of Ty-Gwyn-ar-Dâf (white house on the Tâf), near modern Whitland. The period subsequent to 1080 saw the beginning of the Norman intrusion. The Normans first built castles along the coast at Kidwelly, Llanstephan and Laugharne and then penetrated up the valley ways to Carmarthen and Llandilo. Many of these castles occupy sites previously chosen for defense by earlier rulers of the country; *e.g.,* the castle at Dinefwr, or Dynevor. This was the seat of the princes of south Wales, the central point of Ystrad Tywi (vale of Towy), the nucleus of the future county. The campaigns of Edward I gave the Normans a more unified control of the principality, and by the Statutes of Rhuddlan (1284) the counties of Cardigan and Carmarthen were formed out of the districts of Ceredigion and Ystrad Tywi. Nearly one-third of the present county, however, still remained under the jurisdiction of the lords marcher, and it was not until the act passed in 1536 under Henry VIII that these districts were added to Edward I's original shire. The surrounding hill country, ideal for sheep raising, made Carmarthenshire famous for its wool in the later middle ages.

There are few remains of the medieval monastic houses: Talley abbey (late 12th century), the only Premonstratensian house in Wales, founded by Rhys ap Gruffydd, prince of south Wales; Whitland abbey, or Albalanda, a Cistercian house, probably founded by Bishop Bernard of St. David's (mid-12th century), on a site long associated with Welsh monastic life; and the celebrated Augustinian priory of St. John at Carmarthen (12th century). Connections with the house of Tudor through Sir Rhys ap Thomas, who fought for Henry Tudor at the battle of Bosworth Field, were important in the 16th century. At Abergwili, site of the modern palace of the bishops of St. David's, Bishop Richard Davies (*c.* 1501–81) and William Salesbury of Llanrwst translated the New Testament and the Prayer Book into Welsh, and in the early part of the 17th century Rhys Prichard (d. 1644), the Puritan vicar of Llandovery, published his famous *Canwyll y Cymry* (*The Welshmen's Candle*). William Laud, as bishop, and Jeremy Taylor were also associated with the county. The castles, especially the southern ones, made half-hearted resistance to the parliamentarian forces. Griffith Jones (1683–1761), vicar of Llanddowror, founded Welsh circulating schools, the effective beginning of the modern educational movement in Wales. William Williams Pantycelyn (1717–91) was the chief hymnologist of the Welsh Methodist movement. The county was deeply implicated in the Rebecca riots (*q.v.;* 1843). The poet Dylan Thomas (*q.v.*) lived at Laugharne and is buried there.

Population and Administration.—The population, which was 167,736 in 1961, remains fairly static. The municipal boroughs are Carmarthen, Kidwelly, Llandovery and Llanelly (*qq.v.*). There are 5 urban districts, 4 rural districts and 63 civil parishes. The county is in the south Wales circuit, and assizes are held at Carmarthen. There is one court of quarter sessions, and there are ten petty sessional divisions. The county has two parliamentary divisions, Llanelly (industrial) and Carmarthen (rural), each returning one member to parliament. It is wholly in the diocese of St. David's. The northeastern part of Carmarthenshire is included in the Beacons National park, which was designated in 1955. The National trust owns about 2,400 ac. in the county.

The Economy.—Apart from the relatively small industrial southeast, the county is rural and supports extensive dairy farming, besides mixed farming and sheep rearing in the northern hills. There are several creameries based on the large milk production, though much of the prime product is exported, notably to London. In the north there are state forests and small woolen mills, which make tweeds, flannels and hosiery. Carmarthen has important weekly marts, while those at Llandovery, Llandilo, St. Clears and Whitland still flourish. Anthracite coal is mined in the southeast, where there are many mining villages, the chief towns being Llanelly and Ammanford. Reorganization has closed some old collieries and modernized others; a new £13,000,000 colliery at Cynheidre started production after 1960. Other minerals worked are limestone, silica, sandstone, fire clay and a little barytes. Lead and gold, the latter extracted by the Romans, are not now worked. Llanelly, the largest town, produces steel and has a modern tinplate plant. Nearby, at Burry Port, is the Carmarthen bay power station. There are several brickworks, and other manufactures are optical lenses at Kidwelly, chemicals at Burry Port, hosiery and upholstery springs at Ammanford and automobile components and piano actions at Llanelly.

After World War II the industrial region in the southeast of the county was included in the south Wales and Monmouthshire development area, and the growth of new industries was encouraged to absorb the labour made redundant by changes in the coal, steel and tin-plate industries.

The London-Fishguard railway runs via Llanelly, Carmarthen and Whitland, and the line from Shrewsbury travels through Llandovery and Llandilo, with branches thence to Carmarthen, Llanelly and Swansea. Road transport has made Carmarthen a considerable centre.

See J. E. Lloyd (ed.), *History of Carmarthenshire,* 2 vol. (1935); B. L. Davies and H. Miller, *Carmarthenshire, the Land of Britain Survey,* part xxix (1944). (E. V. J.; ED. BR.)

CARMEL, MOUNT, a well-defined mountain spur projecting into the sea south of Haifa, Israel, is about 14 mi. long and 8½ mi. broad. Although it does not exceed 1,800 ft., its bold outline can be seen for many miles. Its name means "garden" or "orchard"; the Arabic name *Jabal Mar Elyas* means "the mount of the prophet Elias (Elijah)."

The mountain is limestone in which numerous caves served as homes for early man. Excavations by the British School of Archaeology in 1929–31 revealed a series of caverns with deposits extending from the Lower Paleolithic (Old Stone Age) to the Mesolithic (locally called the Natufian) and linked the latter deposits with the lowest levels excavated at Jericho (Tell es Sultan). The most interesting discovery in the caves was of the so-called Mount Carmel man; consisting of a group of skeletons in a Mousterian level, with some Neanderthal and some Homo sapiens characteristics, it forms an important link in the study of human skeletal development.

Known to Egyptians of the Old Kingdom as the "gazelle nose" from its distinctive shape, the mountain was bypassed by the Egyptians in their campaigns against the Syrian and Palestinian city states in the time of the Middle and New Kingdoms. Thutmose III (18th dynasty) in his eighth campaign led his troops through the defiles of the mountain to defeat the Syro-Palestinian confederacy at the battle of Megiddo and to capture the city after encircling it with a wall. Mt. Carmel is mentioned in the Amarna tablets of 18th-dynasty date and in the records of the 19th dynasty; but it had no strategic importance and invading armies usually detoured it. In the first millennium Mt. Carmel marked the joint boundaries of Asher, Zebulon, Issachar and Manasseh, but the frontiers were ill-defined.

Always a sacred place and a refuge, Mt. Carmel had several deities called Baal (lord). It was the scene of the struggle and overthrow of the priests of Baal, publicly challenged by Elijah, as recounted in the Bible (I Kings xviii, 19 ff.). The exact site of this incident is uncertain but is thought to have been on the southern half of the ridge. Mt. Carmel was noted for its oracle, which was consulted by the emperor Vespasian before he attained power.

Mt. Carmel naturally became a refuge for early Christian anchorites. In A.D. 570 a monastery dedicated to the prophet Elijah was in existence, but the date of its foundation is uncertain. About 1156 the order of Carmelites (*q.v.*) was founded and a monastery built; it was rebuilt in 1767 and used by Napoleon as a hospital after his Egyptian campaign. It was burned in 1788 on his retreat and not rebuilt again until 1827. The memorial to Napoleon's soldiers was re-erected by the French in 1919. Gen. Sir Edmund (later Viscount) Allenby, following the route of Thutmose III, attacked and defeated the Turks at Megiddo in Sept. 1918. Between World Wars I and II Mount Carmel was partly reforested. (M. V. S.-W.)

CARMELITES, in England called WHITE FRIARS, one of the mendicant Roman Catholic religious orders. The origin of the order can be traced to Mt. Carmel in Palestine, where a number of devout men, apparently former pilgrims and crusaders, established themselves near the traditional fountain of Elijah. Their rule, written between 1206 and 1214 by St. Albert, Latin patriarch of Jerusalem, and approved in 1226 by Pope Honorius III, shows them already organized under a leader called Brocard. The monks had the ideal of continuing on Mt. Carmel the way of life of the prophet Elijah, whom early Christian writers picture as a monk—in fact, as the founder of monasticism. In the course of time, the Carmelites attempted to show a historical continuity of the order going back to the times of the prophet. In 1675 the Bollandist Daniel van Papenbroeck in the April volumes of the *Acta Sanctorum* rejected these claims as fables. The controversy became so hot that in 1698 a papal decree imposed silence on both parties.

The life of the early Carmelites was strictly eremitical: the monks lived in separate cells or huts, devoted to prayer and work; they met only in the oratory for liturgical services and lived a life of silence, seclusion, abstinence and austerity. Soon, however, the losses of the crusading armies in Palestine made Mt. Carmel unsafe for the western hermits, who set out, about 1240, for Cyprus, Sicily, France and England. In England early establishments were made at Alnwick (Northumberland) and Aylesford (Kent), where the first general chapter of the order was held in 1247. The institute was adapted to the conditions of the western lands to which it had been transplanted: the life was turned from eremitical into cenobitical but on the mendicant, rather than the monastic, model. The polity and government were organized on the same lines, and the Carmelites were turned into a mendicant order. Under this form (approved in 1247) the Carmelites spread all over western Europe, becoming exceedingly popular as an order closely analogous to the Dominicans and Franciscans. In the late scholastic period, the order produced such theologians as Gerard of Bologna, John Baconthorpe, Guido Terrena and Michael Aiguani, as well as the noted opponent of Lollardy, Thomas Netter of Walden, provincial of the English order. In 1432 a second mitigation of the rule by Pope Eugenius IV permitted the friars to eat meat on certain days of the week and to walk in the cloisters at suitable times. In 1452 the prior general, John Soreth, obtained permission to affiliate devout women with the order, thus giving rise to the Carmelite nuns.

In the course of time, the religious fervour of the order declined, and this resulted in the introduction of reforms, including those of John Soreth, the Congregation of Mantua (established 1442) and Nicolas Audet. Of all the movements in the Carmelite order, by far the most important and far-reaching in its results was the reform initiated by St. Teresa of Ávila. After nearly 30 years in a Carmelite convent, she founded (1562) in Ávila a small convent wherein a stricter way of life was to be observed. In spite of opposition and difficulties of all kinds, she succeeded in establishing not only nunneries but also, with the co-operation of St. John of the Cross, a number of friaries of this stricter observance. (*See* further TERESA, SAINT.) The aim of the reform was to restore and emphasize the austerity and contemplative character of primitive Carmelite life. From the fact that those of the reform wore sandals in place of shoes and stockings, they have come to be called the Discalced, or Barefooted, Carmelites, to distinguish them from the older branch of the order. In 1580 the reformed monasteries were made a separate province under the general of the order, and in 1593 this province became by papal act an independent order with its own general and government (Ord. Fratrum discalceatorum B. Mariae V. de Monte Carmelo; O.C.D.), so that there are now two distinct orders of Carmelites. After the division, the reform of the original order (Ordo Fratrum B. Mariae V. de Monte Carmelo; O. Carm.) was effected by the movement known as the Strict Observance, established in 1645, which reemphasized the primitive contemplative ideals of the order, without, however, relinquishing the mitigation of 1432.

Both orders suffered severely from the French Revolution and suppression by Napoleon and the liberal governments of the 19th century but have since been restored in most countries of western Europe, in the middle east, Latin America and the United States. The Carmelites combine the contemplative and active way of life. While they maintain strictly contemplative monasteries, devoted exclusively to silence and prayer, they also engage in preaching, teaching, parochial work, publication of religious literature and other forms of apostolate. The order has produced a number of noted mystics in addition to St. Teresa of Ávila and St. John of the Cross; among them are St. Mary Magdalen of Pazzi and St. Thérèse de Lisieux. They conduct foreign missions in Iraq, India, Indonesia, the Philippines, Africa and the remote parts of South America.

The Carmelite cloistered nuns constitute the largest group of contemplative religious women in the Roman Catholic Church. Besides, in recent times, numerous congregations of Carmelite Sisters have been formed, devoted to teaching, care of the sick and other charitable works.

The Discalced Carmelites occupy the mother house on Mt. Carmel. Friars of both branches wear substantially the same habit: brown tunic, scapular and hood, with a white mantle. The nuns' habit is the same as that of the friars, with a linen wimple and black veil.

See also ORDERS AND CONGREGATIONS, RELIGIOUS.

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CARMEN SYLVA: *see* ELIZABETH, QUEEN OF RUMANIA.

CARMINE, a red or purplish-red pigment obtained from cochineal, a red dye extracted from dried bodies of female scale insects (*Coccus cacti*) that live in tropical and subtropical America (mainly Mexico and Central America) and feed on a species of cactus (*Nopalea coccinellifera*).

Carmine is used only occasionally—for pastries, confections, cosmetics, water-soluble drug preparations and microscope stains—when a natural pigment colourant is desired. Before the advent of synthetic colouring materials, it was used more extensively, particularly for water colours and fine coach body colours.

It takes 70.000 insects to make 1 lb. of cochineal and a 100-sq.mi. plantation to yield 600 lb. Of this, only 10% forms carminic acid ($C_{22}H_{20}O_{13}$), the principal constituent of carmine.

To prepare carmine, the powdered insect mass is boiled in ammonia or sodium carbonate solution; the insoluble matter is removed by filtration, and alum is added to the clear salt solution of carminic acid to precipitate the red aluminum salt of carminic acid. Absence of iron insures color purity. Stannous chloride, citric acid, borax or gelatin may be added to regulate the formation of the precipitate. For purple shades, lime is used with the alum. Chemically, carminic acid is a complex anthraquinone derivative. *See* Coloration, Biological: *Pigments* (*Biochromes*): *Anthraquinones.* (P. He.)

CARMONA, ANTÓNIO ÓSCAR DE FRAGOSO (1869–1951), Portuguese general and statesman, whose long tenure of office as president of the republic brought much-needed internal stability to Portugal, was born in Lisbon on Nov. 24, 1869. Embarking on a military career, he graduated from the Real Colégio Militar in 1888 and from the Escola do Exército in 1892 and had risen by 1922 to the rank of general. Carmona was among the officers who took part in the army *coup d'état,* headed by Gen. Gomes da Costa, on May 28, 1926, and was subsequently appointed foreign minister. With Costa's removal from power, Carmona assumed the post of premier in July 1926 and the functions of chief executive in November. A bloody insurrection against the dictatorial regime was put down in Feb. 1927. Carmona then made an appeal for public support, in the form of a national plebiscite, and he was elected to the presidency. Inaugurated in April 1928 for a seven-year term, Carmona, always standing as the candidate of the government party, was re-elected in 1935, 1942 and 1949. During these administrations he was overshadowed by António de Oliveira Salazar (*q.v.*), whom he had first brought into the government as minister of finance in 1928. Carmona died in Lisbon on April 18, 1951. A handsome man of dignified bearing, he consolidated, through the work of Salazar, the revolution that brought him to power. (M. Ca.)

CARMONA, a town of southern Spain, Seville province, lies 33 km. (21 mi.) E.N.E. of Seville by road, on a ridge of the Sierra de los Alcores overlooking the plain of Andalusia. Pop. (1960) 28,216 (mun.). The town is divided into old and modern districts; the old city has Roman walls and ancient towers, gateways and forts. A large Roman necropolis nearby, discovered in the 19th century, has been excavated; Gothic, Moorish, and late Baroque styles are predominant in churches, convents and palaces. Cereals and olives are grown, and olive oil is produced. Carmona (Roman Carmo) was the strongest city of Hispania Ulterior under Julius Caesar. It was later strengthened by the Moors, who built the Seville gate. The lofty citadel of Peter the Cruel (1350–69) is now in ruins. (M. B. F.)

CARNA, an obscure Roman deity with an ancient shrine on the Caelian hill. At her festival on June 1 (popularly called *Kalendae fabariae,* "the bean Calends") offerings of beans and bacon were made. Originally, perhaps, an Etruscan goddess of the dead, she brought health to the vital bodily organs, repelled vampire birds from children and was associated with Janus (*q.v.*) as divine doorkeeper. (D. E. W. W.)

CARNAC, a village of northwest France, in the *département* of Morbihan (*q.v.*) and *arrondissement* of Lorient, 14 km. (9 mi.) S.W. of Auray. Pop. (1962) 1,606. It has a church, St. Cornély, in the Renaissance style of Brittany, but owes its celebrity to the stone monuments in its vicinity. The most remarkable consists of long avenues of menhirs or standing stones which date from the late Neolithic Age. The difficulty of dating them more exactly is increased by the possibility that they were not all erected at the same time. Throughout the whole district there are also passage graves of Middle Neolithic times (from 3000 B.C. onward) which were often used again at various later periods, and different types of barrows, also Middle and Late Neolithic. About one-half mile to the northwest of the village is the Ménec system, which consists of 11 lines and extends a distance of 3,376 ft. The terminal circle is broken by the houses and gardens of a little hamlet. To the east-northeast there is another system at Kermario, which consists of 10 lines about 4,000 ft. in length. Still further in the same direction is a third system at Kerlescan, composed of 13 lines, about ½ mi. in length, terminated by an irregular circle. These three systems seem once to have formed a continuous series; the menhirs, many of which have been broken up for road mending and other purposes, have diminished in number by several thousands in modern times. The alignment of Kermario points to the passage grave of Kercado, covered by a barrow, explored in 1863; and to the southeast of Ménec stands the great tumulus of Mont St. Michel, which measures 377 ft. in length, and has a height of 65 ft. The tumulus, which is crowned with a chapel, was excavated by René Galles in 1862; and the contents of the sepulchral chambers, which include several jadeite and fibrolite axes and callais beads, are preserved in the museum at Vannes. About 1 mi. E. of the village is a small piece of moorland called the Bossenno, from the *bocenieu* or mounds with which it is covered; and there, in 1874, the explorations of James Miln, a Scottish antiquary, brought to light the remains of a Gallo-Roman villa. The tradition of Carnac is that there was once a convent of the Templars or Red Cross Knights on the spot, but this, it seems, is not supported by history. Similar traces were also discovered at Mané Bras, a height about three miles to the east. The stones of which these various monuments are composed is the ordinary granite of the district, and most of them present a strange appearance from their coating of white lichens. Carnac has an important museum of antiquities (Musée Miln-Le Rouzic).

Carnac-Plage about 1 mi. S.W. is a well-known beach resort.

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CARNAP, RUDOLF (1891–1970), one of the chief representatives of logical positivism (*q.v.; see* also Logic, History of), was born at Wuppertal, Ger., on May 18, 1891. From 1926 to 1931 he taught philosophy at the University of Vienna, where he belonged to the famous Vienna circle which first proclaimed the logical positivist doctrine. He was an editor of the movement's journal *Erkenntnis,* which appeared until 1940. In 1931 he joined the German University in Prague. The threat of German expansion under Hitler scattered the members of the group farther afield. Carnap, in 1935, emigrated to the United States, where he was professor of philosophy at the University of Chicago from 1936 to 1952, and at the University of California in Los Angeles from 1954. He also became associate editor of the *International Encyclopedia of Unified Science* which began in 1938 under the general editorship of Otto Neurath. This enterprise remained fragmentary; in a series of special studies it sought to show the universal scope of scientific method. Carnap died at Santa Monica, Calif., on Sept. 14, 1970.

Like other logical positivists, Carnap rejected metaphysical statements as not just false but strictly meaningless. The extreme form of this theory uses the "strong" verification principle as a criterion: the meaning of a statement is the method of its verification and is grounded directly in observed data. This eliminates not only metaphysics but much else besides: theoretical science, too, becomes suspect. Carnap therefore came to adopt a milder form of the principle, in which the link with observation need only be indirect. Likewise he abandoned the attempt at translating all ordinary (or "material mode") statements into sense data (or "formal mode") statements.

The task of philosophy, as Carnap saw it at first, was to study the logical syntax of language; that is, the way in which language, taken as a system of formulae for calculation, hangs together. Later he came to admit as legitimate the study of how signs are linked with what they stand for (semantics).

His works include *Der logische Aufbau der Welt* (1928); *The Unity of Science* (1934); *Logische Syntax der Sprache* (1934; Eng. trans. *The Logical Syntax of Language*, 1937); *Introduction to Semantics* (1942); *Meaning and Necessity* (1947). (P. Fo.)

CARNARVON, GEORGE EDWARD STANHOPE MOLYNEUX HERBERT, 5TH EARL OF (1866–1923), English Egyptologist chiefly remembered for his part in the discovery of the tomb of Tutankhamen (*q.v.*), was born at Highclere, Berkshire, on June 26, 1866, and educated at Eton and at Trinity college, Cambridge. He began excavations near Thebes with Howard Carter (*q.v.*) in 1907 and discovered tombs of the 12th and 18th Egyptian dynasties near the Valley of the Kings. A further concession having been obtained in 1914, operations in the valley itself were conducted after World War I, resulting in the discovery by Carter in Nov. 1922 of the antechamber of the tomb of Tutankhamen of the 18th dynasty. On Feb. 16–17, 1923, the sepulchral chamber was opened, the actual sarcophagus being discovered on Jan. 3, 1924. Meanwhile Lord Carnarvon had died in Egypt on April 6, 1923, from the results of a mosquito bite and pneumonia.

See the memoir by Lady Burghclere in *The Tomb of Tut-ankh-Amen* by Howard Carter and A. C. Mace, vol. 1 (1923). An account of Lord Carnarvon's earlier excavations with Carter is given in their book *Five Years' Explorations at Thebes* (1912). (W. R. D.)

CARNARVON, HENRY HOWARD MOLYNEUX HERBERT, 4TH EARL OF (1831–1890), British Conservative statesman, whose liberal attitude brought him into conflict with the cabinets in which he served, was born in London on June 24, 1831. He was educated at Eton and Christ Church, Oxford, inheriting his father's earldom in 1849. He read and traveled widely, and combined charm, accuracy and literary power with a chivalrous sense of duty. He was undersecretary for the colonies in 1858–59 and was twice appointed colonial secretary (1866–67 and 1874–78). He introduced the British North America bill, from which Canadian independence derived, in 1867, but resigned in March of that year because he disapproved of Disraeli's proposals for parliamentary reform. He voted for Gladstone's conciliatory Irish measures of 1869–70. In his second term of office he authorized the annexation of the Transvaal (1877), but his schemes to make a South African federation on the Canadian pattern failed. He resigned in 1878, disapproving of the government's war policy in eastern Europe. He presided over an important commission on imperial defense from 1879 to 1882. In 1885 he joined Lord Salisbury's cabinet as viceroy of Ireland. The appointment was unfortunate, because Carnarvon had far more sympathy with Irish national aspirations than had the rest of the Conservative party; and because he and C. S. Parnell carried away opposite impressions from a secret discussion they had on Home Rule on Aug. 1, 1885. Carnarvon finally resigned, a few days before his colleagues, in Jan. 1886. He died in London on June 28, 1890.

See Sir A. Hardinge, *Life of . . . Carnarvon, 1831–1890,* 3 vol. (1925). (M. R. D. F.)

CARNATIC, a name commonly given to a region of southern India between the Eastern Ghats and the Coromandel coast, extending about 600 mi. from the Guntur district of Andhra Pradesh in the north to Cape Comorin in Madras state in the south and varying in breadth from 50 to 100 mi. Sometimes the name is used to include the Malabar coast (*q.v.*). Properly, however, it applies to the country of the Kanarese-speaking people, Kanara, extending between the Eastern and Western Ghats, over an irregular area narrowing northward, from Palghat in the south to Bidar in the north, generally coincident with the modern state of Mysore (*q.v.*). The extension of the term in political usage to the eastern coastal plain began with the conquest of the whole peninsula south of the Tungabhadra river by the Vijayanagar kings (1336–1565). The Muslim states which overthrew them in the 16th century and the Mogul emperors who followed them in the 17th century continued and confirmed the practice. At the same time the true Carnatic country has been identified since the early 18th century with the area surrounding the city of Mysore.

History.—The Carnatic defined as the eastern coastal strip was a region of great historic importance. Its fertile soil, its textile industries, its commercial trade with the East Indies and the middle east made it a seat of wealth and power from pre-Christian times.

Earlier forming part of the Pandya, Chola and Pallava kingdoms, the whole of the coastal strip was incorporated during the Vijayanagar period into that empire. After the fall of the Vijayanagar empire in 1565 the governors of Madura, Tanjore and Kancheepuram (ancient Kanchi) became independent Hindu rulers while the Muslim kingdom of Golconda encroached from the north. In 1687 the Mogul emperor Aurangzeb overthrew Golconda and in 1692 appointed Zulfiqar Khan nawab or deputy for the Carnatic with his seat at Arcot. In the early 18th century the Carnatic became dependent on the nizams of Hyderabad, the first of whom, Asaf Jah, established himself in 1724 with only a nominal dependence on the Delhi emperors. Madura became tributary to the Carnatic in 1736.

After 1748 the rivalries of the English and French East India companies led to European intervention in Indian politics. Both sides supported rival claimants to the Carnatic, the French under Joseph Dupleix supported Chanda Sahib and the British upheld Mohammed Ali. In 1752, largely because of the leadership of Robert Clive, Mohammed Ali was successful; the Carnatic then became virtually a client state of the company. The nawab depended on the company for military support; his loans from the company and its servants demoralized both the state and the company and created the scandal of the nawab of Arcot's debts. Mohammed Ali died in 1795. The Carnatic was overrun and devastated by Haidar Ali of Mysore in 1769 and 1780. Lord Cornwallis (governor general of India during 1786–93) gave orders that the company should administer the state in time of war and enforced this arrangement in the third Mysore war. Lord Wellesley (governor general during 1797–1805) repeated this in the renewed hostilities against Tipu Sahib (1799). After Tipu's overthrow Wellesley decided to take over the Carnatic on the plea of the discovery of correspondence between the nawab and Tipu. This was effected in 1801, on the death of Mohammed Ali's son, in return for a pension and the retention of the title. In 1853 the nominal sovereignty was ended by the governor general, Lord Dalhousie, the title of "prince of Arcot" being later conferred on the head of the family. Under the British crown the coastal Carnatic became the core of the Madras presidency. *See* INDIA-PAKISTAN, SUBCONTINENT OF.

For the various applications of the name *see* "Carnatic" in *Imperial Gazetteer of India* (1908). *See* also *Cambridge History of India,* vol. iv (1937) and vol. v (1929). (T. G. P. S.)

CARNATION (*Dianthus caryophyllus*), a spice-scented garden and greenhouse flower of the pink family (Caryophyllaceae; *q.v.*), native in southern Europe, but occasionally found in an apparently wild state in England. One variety of it is the clove pink, an especially fragrant form, while some of the widely cultivated greenhouse carnations have lost much of their odour. The original type was pure white, but since its introduction into common cultivation many varieties have arisen, which are arranged by colour patterns as follows: (1) Bizarres have a clear ground flaked with two or three colours. (2) Flakes have a clear ground flaked with a single colour. (3) Selfs, of only one colour (as the common white carnation) and no other. (4) Picotee, having only the petal margined with a different colour from the basic one. (5) Fancies, those like none of the others, often mottled, flaked or spotted.

Besides these colour designations carnations are defined culturally into several well-marked groups. From the gardener's

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CARNATION (DIANTHUS CARYOPHYLLUS)

standpoint the most important, and most fragrant, are the hardy border carnations. Over much of the United States the climate is unsuited to these, but in England they are widely grown in many varieties, as they are also in southern France, northern Italy, Japan and elsewhere. They are readily grown in the open border, in full sun and in a light, rich loam, but tend to die out periodically and should be renewed from fresh cuttings. In any windy site they need wires or stakes as the stems are weak. As in the greenhouse varieties they should be disbudded if the finest blooms are desired. A few of these English varieties are offered in the United States.

The ordinary carnation of the florist is grown by the millions in England and the United States, and except in very restricted areas must be grown in the cool greenhouse (not over 55° F.). Rooted cuttings are planted outdoors when warm weather is assured and grown along until frost threatens. They are then moved into the greenhouse, and depending on the variety and management of light and temperature as well as feeding, will produce flowers from October to April. *See* Pink.

See M. C. Allwood, *Carnations, Pinks and All Dianthus*, 4th ed. (1955). (N. Tr.)

CARNEADES (214/3–129/8 B.C.), Greek philosopher, a native of Cyrene, was one of the heads of the Platonic Academy in its antidogmatic period. When on a diplomatic mission in Rome in 156/5 B.C. he delivered two orations, one praising justice (and asserting the existence of "natural" law and justice), the other praising injustice (and reducing the concept of justice to that of prudence and utility) as the only expedient way of handling private and public, particularly international, affairs, discussing in this context the problems of just and unjust war, dominion, etc. This arguing on both sides of a question expressed Carneades' attitude of suspending judgment (not one of dogmatic rejection), characteristic of what is called Academic scepticism. In the same spirit he criticized Epicurean theology (proofs of the existence of gods, doctrines concerning their nature) and, particularly, that of the Stoics (together with their theodicy, belief in providence, fate, divination, astrology, design) as inconclusive. Many of his arguments remained classic. Ultimately this noncommittal attitude was rooted in his denial that there existed any certain knowledge, either of the senses (all sensations being relative to the subject and there being no mark distinguishing true from false sense perceptions) or of the intellect.

Ever since Arcesilaus had, either as a means or as an end, urged the *epoche* or withholding of assent from any experience claiming to be knowledge, the Academy faced the objection that this attitude, even if it could be maintained, would make life impossible. Carneades met the objection by distinguishing objective (and unattainable) certainty (evidence) from subjective conviction resulting from the persuasiveness of sensations, this persuasiveness or "approvability" (*probabilitas*, usually translated "probability") being a sufficient guide for theory and practice and admitting of degrees (the highest of which was that of a sensation not contradicted by other sensations and comprehensively tested). In ethics he defended, rather than professed, the doctrine that the primary goods which man is prompted by nature to appropriate are neither pleasure nor absence of pain but rather integrity and full use of mind and body. He left no writings. His successor Clitomachus expounded his opinions. *See* also Academy, Greek.

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CARNEGIE, ANDREW (1835–1919), U.S. industrialist who established a number of foundations and endowments for education and research. In his famous essay "The Gospel of Wealth," published in 1889, he set forth his view that the life story of a rich man should fall into two periods—the first, that of acquiring wealth, the second, that of distributing it in such a way that the surplus would be used for the general welfare; this practice he followed in his own life. Carnegie was born in Dunfermline, Scot., on Nov. 25, 1835, and in 1848 emigrated to the U.S. with his family, settling in Allegheny, Pa. (later annexed by Pittsburgh). He began working as a bobbin boy in a cotton factory; later he was an engine tender, telegraphic messenger and operator, and for 12 years (1853–65) worked for the Pennsylvania railroad, where one of his achievements was the introduction of sleeping cars. In 1864 he bought the Storey farm on Oil creek, Pa., where much oil was brought in. Foreseeing the extent to which the demand for iron and steel would grow, he left the railroad and started the Keystone Bridge works, and from 1873 onward concentrated on steel. By 1888 he had under his control an extensive plant served by tributary coal and iron fields, a railway 425 mi. long and a line of lake steamships. In spite of the depression of 1892, marked by the bloody Homestead strike, the various Carnegie companies, aided by favourable tariff legislation, prospered. In 1901 they were incorporated in the United States Steel corporation; Carnegie then retired from business and devoted himself to the work of providing capital for social and educational advancement.

Among these activities the provision of public libraries in the United States and Great Britain (and similarly in other English-speaking countries) was especially prominent; his method was to build and equip, but on condition that the local authority provided site and maintenance. In 1900 he founded the Carnegie Institute of Technology at Pittsburgh and in 1902 the Carnegie institution at Washington, D.C. In Scotland he established a trust for assisting education at the Scottish universities, a benefaction which resulted in his being elected lord rector of St. Andrews university. He was a large benefactor of the Tuskegee institute, Macon county, Ala., under Booker T. Washington. He also established large pension funds—in 1901 for his former employees at Homestead and in 1905 for U.S. college professors (Carnegie Foundation for the Advancement of Teaching). Other notable contributions were his founding of Carnegie Hero funds, in America (1904) and in the United Kingdom (1908), for the recognition of deeds of heroism; in 1903 he donated funds for the erection of a Temple of Peace at The Hague and for a Pan-American palace in Washington, D.C., as the home for the International Bureau of American Republics. In 1911 he established the Carnegie corporation and endowed it liberally for the furtherance of civilization. (*See* Foundations, Philanthropic.) Carnegie died at Lenox, Mass., Aug. 11, 1919. His autobiography was edited by J. C. Van Dyke (1920).

See Burton Hendrick, *The Life of Andrew Carnegie*, 2 vol. (1932); in J. H. H. Williams, *Men of Stress* (1948).

CARNEIA, an important Dorian festival (Sparta, Cos, etc.). While many details of it are obscure the main features are tolerably certain. It was held in the month Karneios (roughly August). The name is connected with Karnos or Karneios (probably meaning "ram"), said to have been a favourite of Apollo, unjustly killed by the Heraclidae, and therefore commemorated to appease the god's anger; perhaps he was an old god of fertility displaced by Apollo. The festival contained an agrarian element. Five young men called *Karneatia* were chosen out of each tribe; one man, decked with garlands, ran away and the rest followed him. The latter were called *staphylodromoi* (*i.e.*, "grape-cluster runners"), hence they very likely carried bunches of grapes. It was a good omen if they caught the fugitive, bad if they did not. They were under the direction of a priest called *hagetes*, or leader. It seems reasonable to suppose that the person they chased was the temporary incarnation of some spirit of vegetation; perhaps to catch him signified that fertility was not allowed to go away, but was secured, to be used for the next year's crops. The Carneia contained an element apparently military, since a feast was held by nine groups, each consisting of nine citizens, representing the *obai* or divisions.

See L. R. Farnell, *Cults of the Greek States*, vol. iv (1907).

CARNELIAN (Cornelian), a variety of chalcedony, a native silica, is generally of a blood-red colour, though included under this name are specimens of a reddish tint varying in colour from yellow to brown. The colouring matter is probably iron oxide in various stages of hydration, though the particles are so small that only in thin sections under the microscope can they be distinguished from the colourless silica in which they are embedded. Though carnelians are recognized in all shades of red, it is convenient to distinguish three varieties; (1) flesh red or burned brick coloured—the typical carnelian, (2) honey coloured and (3) brown by reflected and deep red by transmitted light, usually called the sard, and formerly the most valued, because of its greater transparency and depth of colour.

Among the Greeks and Romans the carnelian was one of the most treasured stones, used especially for intaglios. Examples have retained their high polish better than many harder stones. The carnelian was also widely used for signets. Carnelians are embellished by burning and dyeing with salts of iron, and for trade purposes the natural colour is of little importance.

The chief localities are Ratanpur, India; Campo de Maia, Braz.; Surinam (Dutch Guiana); Siberia; Warwick, Queensland, Austr.; Tampa Bay, Fla.; and Chesil Bank, Dorset, Eng. *See* also GEM; QUARTZ. (W. A. W.)

CARNESECCHI, PIETRO (1508–1567), Italian humanist and reformer who wished nevertheless to remain within the Roman Catholic Church, was born at Florence on Dec. 24, 1508. He early enjoyed the patronage of the Medici, particularly of Pope Clement VII, to whom he became principal secretary. However, in 1540 he joined the circle of Juan de Valdés (*q.v.*) at Naples, and accepted Luther's doctrine of justification by faith, though repudiating a policy of schism. When a movement of suppression began (1546), Carnesecchi fled to Catherine de Medicis in Paris. In 1559 he returned to Rome but under Pius V the Inquisition renewed its activities in 1566 and Carnesecchi went to Florence, only to be betrayed by his patron, Cosimo de' Medici. He was executed as a heretic in Rome on Oct. 1, 1567. (G. HU.)

CARNIOLA (Ger. KRAIN), the western region of the Yugoslav republic of Slovenia, last had significance as an administrative unit as part of the Austrian empire, when it was bounded north by Carinthia and Styria, east and southeast by Croatia-Slavonia, and southwest and west by the Küstenland (Istria and Gorizia). Its centre was Laibach (modern Ljubljana). Part of the Roman province of Pannonia in ancient times, it was occupied by the Slovenes in the 6th century A.D. Later it belonged successively to the patriarchs of Aquileia (1077–1228), to the dukes of Carinthia (1228–69), to Otakar II of Bohemia (1269–76) and to the counts of Gorizia and Tirol (1276–1335). In 1335 it passed to the Austrian house of Habsburg, under which (apart from the period of French rule, 1809–14), it was a duchy until 1849, then a crownland until 1918. It was then incorporated in the kingdom of Serbs, Croats and Slovenes. After 1947 it was located entirely within Slovenia.

See YUGOSLAVIA. (K. LA.)

CARNIVAL, the celebration of merrymaking and festivity that takes place in many Roman Catholic countries in the last days and hours of the pre-Lenten season. The derivation of the word is uncertain, though in all probability it is directly traceable to the medieval Latin *carnem levare* or *carnelevarium* in the sense of "to take away meat" or "to remove meat," a conception which coincides with the fact that carnival is the final festivity before the commencement of the austere 40 days of Lent during which abstinence from flesh meat is observed. The historical origin of carnival is also obscure. Probably it is rooted in a primitive festivity in honour of the commencement of the new year and the rebirth of nature, though a more concrete and proximate connection may link the beginnings of the carnival in Italy to the pagan Saturnalian feast of ancient Rome.

The exact determination of the first day of carnival varies with both national and local traditions. Thus in Munich (Bavaria) carnival or *Fasching* begins on the feast of the Epiphany (Jan. 6), while in Cologne (Rhineland) it begins on Nov. 11 at 11:11 A.M. (11th month, day, hour and minute). In France the celebration is restricted to Tuesday before Ash Wednesday (Shrove Tuesday; *q.v.*) and to *mi-carême* or the Thursday of the third week of Lent. More generally the commencement date is Quinquagesima Sunday and the termination is Shrove Tuesday, though in some parts of Spain Ash Wednesday also is included in the carnival celebrations, an observance that stems from a time when Ash Wednesday was not an integral part of Lent.

The origin and development of this festivity is so intimately tied up with Rome, Venice, Florence and Turin that carnival itself can be regarded as distinctly Italian in character. Rome was most conspicuous as the centre of carnival activity, and the splendour and richness of the festivity that marked its observance there were scarcely surpassed elsewhere.

Though Sixtus V (1585–90) set himself to restrain its excesses and lawlessness, the papal policy toward carnival was generally tolerant and moderate. The carnival sports of Rome anciently consisted of the races in the Corso, the spectacular pageant of the Agona and that of the Testaccio.

In the course of its long history the carnival played a significant role in the development of the popular theatre, vernacular song and folk dances. It also exercised a certain amount of influence on the Jewish feast of Purim.

In the United States the most notable manifestation of carnival is found in New Orleans, La. (*q.v.*), where the carnival season opens on Twelfth-night (Jan. 6), with the Mardi gras season, commencing ten days before Shrove Tuesday, marking the climax.

In North America, the term carnival also applies to a traveling amusement enterprise, including rides such as merry-go-rounds and Ferris wheels, sideshows and games of chance, which operate separately or in conjunction with fairs and expositions. When combined with one of the latter, the carnival is distinguishable by the midway, a term used both for the brightly illuminated area where the rides, shows, games and refreshments are grouped and for a broad passageway through which the patrons walk. The size of a carnival (usually called a fun fair in Great Britain) varies from two or three rides to as many as 40 or 50 amusement devices of various kinds at state and national fairs.

When space permits, the various units are located in two long lines. The concessions—games and refreshments—are located just inside the midway entrance. The shows that display freaks, unusual animals and fun houses are located at the end of the area, and the rides—Ferris wheels, merry-go-rounds and others—are set up in the centre or along the border. (R. E. McN.; C. R. Bs.)

CARNIVORE, in the broadest sense, any animal that feeds on flesh; but more precisely, any mammal of the order Carnivora, which includes the most powerful beasts of prey, as the lion, tiger, leopard and jaguar, numerous fur bearers, as the seal, fox and sable, the domesticated cat and dog and other well-known animals. In general their teeth, especially the four long, piercing canine teeth, are adapted for tearing flesh, and the toes of many species are provided with strong sharp claws for seizing prey.

The body systems of carnivores are those of other placental mammals; *see* the article MAMMAL for information on respiration, digestion, reproduction, etc. The present article, concerned with those special features that figure prominently in the identification of various carnivores, is divided as follows:

I. General
II. Characteristic Structures
    1. Soft Parts
    2. Skull
    3. Teeth
III. Survey of the Order
    A. Dog and Dog Allies (Canoidea)
        1. Dog Family (Canidae)
        2. Bear Family (Ursidae)
        3. Raccoon Family (Procyonidae)
        4. Weasel Family (Mustelidae)
    B. Cats and Cat Allies (Feloidea)
        1. Civet Family (Viverridae)
        2. Hyena Family (Hyaenidae)
        3. Cat Family (Felidae)
    C. Seals and Seal Allies (Pinnipedia)
        1. Eared Seal Family (Otariidae)
        2. Walrus Family (Odobenidae)
        3. True Seal Family (Phocidae)
IV. Temperaments of the Carnivores
V. Extinct Carnivores
VI. Classification

I. GENERAL

For the most part the carnivores are very active, intelligent and courageous animals, with keen senses of sight and smell. In size they vary greatly, ranging from small weasels to huge bears, which may weigh $\frac{3}{4}$ of a ton. There are about 300 species, which in their relationships form 3 groups: the catlike, doglike and seallike carnivores. Besides the cats—lion, tiger, leopard, puma, wildcat and domestic cat—the civets, mongooses and hyenas are comprised in the catlike group. In the doglike group are found in addition to the dogs, wolves and foxes, such unlike types as the bears, the raccoons, cacomistls, kinkajous, pandas, the weasels, badgers, skunks and otters. Far removed from these typical carnivores is the fin-footed seal group, which in addition to true seals includes the sea lions and the walruses.

The carnivores are well represented in all parts of the world except the Australian region, which contains only the dingo, a dog brought there by man. The polar bear and the polar fox range farther north than all other land mammals, and sea lions are found in both arctic and antarctic waters. Some important groups, however, are restricted in their distribution. The numerous civets, for example, are confined to the old world; the raccoons, except the panda, occur only in America, while in most of Africa none of the true bears is found.

Though some carnivores are destructive to domestic animals, and even to human life, many are valuable fur bearers, as the sable, otter, marten, mink, fox and fur seal, and they also hold in check various animals, as rodents, which, if unrestricted in numbers, would become exceedingly injurious to agriculture. Besides the dog and the cat, which have been household animals since ancient times, the cheetah or hunting leopard, the ferret and the mongoose are domesticated. The black fox and the mink, successfully raised for their fur, may also be mentioned.

The term Carnivora, suggesting that all the animals so designated are flesh eaters, is not entirely appropriate. Certain highly organized species of the cat, wolf and weasel kind live almost wholly upon the flesh of warm-blooded animals, for the capture of which their habits and structure are admirably adapted; but others, like most bears, are almost wholly vegetable feeders and quite unfitted for the chase. The great variation in diet and mode of life exhibited by the order is accompanied by a corresponding variation in the limbs and other external organs and by the teeth and skeleton.

II. CHARACTERISTIC STRUCTURES

No single character absolutely distinctive of the Carnivora can be named; but by the combination of a number of structural features, it may be distinguished from other orders of mammals. There are never fewer than four toes on each foot, and the first is never opposable to the rest; the digits are usually armed with compressed claws, never with nails or hoofs; there are typically two tufts of tactile "whiskers" (vibrissae) on each cheek; the tail is always present; the anus and genital organs open by separate apertures; and the mammae are abdominal. The cranial portion of the skull is always capacious as compared with the facial portion, and the brain is well or moderately well convoluted. There are two sets of teeth, milk and permanent, differentiated into incisors, canines and cheek teeth. The incisors usually number 12—3 on each side of the upper and lower jaws—the centrals being smaller than the laterals. The canines are almost always long and piercing in both jaws. The cheek teeth are rooted, never of persistent growth, and the enameled crown is raised into simple or bladelike cusps.

1. Soft Parts.—*Vibrissae.*—The facial vibrissae consist of a tuft above each eye (superciliary), two tufts on each cheek (genal), half a dozen or more rows on the upper lip (mystacial), a few isolated on the chin and a median tuft (interramal) on the throat. As a rule they are well developed both in number and length in predatory species, especially those that hunt in foliage or undergrowth. In vegetable feeders like the bears they are, on the contrary, greatly reduced and apparently functionless.

Muzzle.—The nostrils are usually surrounded by a conspicuous area of naked, glandular skin, the rhinarium, continued in front to the edge of the upper lip as a strip of grooved skin, the philtrum. It is subject, however, to considerable variation.

Ear.—There is a well-developed erect external ear, or pinna, attached by a broad hollowed base the walls of which are strengthened by cartilaginous ridges. One of these ridges, the supratragus, is sometimes valvular, helping to close the ear opening. Another character of importance is the bursa, a pocket formed by a supplementary flap low on the posterior margin of the ear.

Feet.—In the generalized, and probably primitive, carnivore there are five digits more or less evenly spaced and forming with their tips a strongly and fairly evenly curved series. The third and fourth digits are the longest, the second and fifth shorter and subequal and the first the shortest. Each of them is supplied with a pad behind the claw; and they are all united by a flap of integument, or web, which extends nearly to the pads.

The sole is provided with a plantar pad composed of four united lobes. Behind the plantar pad there is on the forefoot a pair of large, lobate carpal pads; and on the hind foot there is a pair of elongated metatarsal pads, which extend nearly to the heel. This type of foot, called subplantigrade, passes by imperceptible gradations into feet contrasted as digitigrade (in which the digits are used for walking, as in dogs) and plantigrade (in which the whole sole is used).

There are two types of claw in the digitigrade foot: the short blunt claw of the dogs and hyenas and the sharp, retractile claw, found in some civets and most cats, which is modified for laceration of prey. The terminal bone of the digit is retracted by an elastic ligament and the sharp point of the curved claw is protected from wear by lobes of skin which ensheathe it. In the seals the feet are converted into paddles, but their structure suggests that they also are modifications of the subplantigrade foot.

Anal Glands.—The rectum is typically provided with a pair of glands opening, usually by a single aperture, just within the anal orifice. The secretion probably acts in normal cases as a lubricant or disinfectant; but in some genera, especially of Mustelidae, like the skunks, the secretion is abundant and nauseous and its forcible discharge is an important means of defense. In the bears (Ursidae) the glands are developed to a negligible extent; and they are absent in the seals.

2. Skull.—The skull is extremely variable in the length, breadth and height. The length of the muzzle is correlated with the number and size of the teeth. Its nasal chambers are filled with delicate scroll-like bones, the turbinals. Of these there are two main groups: the maxilloturbinals, rising from the sides of the inner surface of the maxillae, in front; and the ethmoturbinals, behind.

On the roof of the mouth (the palate) there is a pair of openings, the posterior palatine foramina, which are usually situated on the maxillopalatine suture but may be in advance of it.

The bone containing the ear capsule is covered by the auditory bulla, composed either wholly or partly of the tympanic bone, which always forms its anterior part. The posterior part is occasionally cartilaginous, but it may be ossified. In this type of bulla the cavity is always divided into two chambers by a bony partition, which passes from the line of junction of the two bones.

Behind the bulla there is an expansion of the occipital bone, the paroccipital process, and behind the auditory opening another process, called the mastoid. Low on the inner wall of the temporal fossa is frequently a bony channel, the alisphenoid canal, through which passes a branch of the carotid artery. The incidence of this canal is remarkable, and it has been much used in classification.

3. Teeth.—These vary in number and structure in accordance with diet. The primitive number was 44, as shown in the formula $I\frac{3}{3}\,C\frac{1}{1}\,P\frac{4}{4}\,M\frac{3}{3}$ (for one side of the jaw). This is an abbreviation of:

incisors: upper, 3 canines: upper, 1 premolars: upper, 4
lower, 3 lower, 1 lower, 4
molars: upper, 3
lower, 3.

Very seldom however, is the full complement retained; the numerical reduction takes place mostly from the suppression of one or more of the front and back cheek teeth. It reaches its extreme in predatory forms like the cats and weasels where the formula may be $P\frac{2}{2}$, $M\frac{1}{1}$.

The number, arrangement and shape of the cusps are also subject to great variation, but the extreme types of dentition are derivable from a more generalized intermediate type in which there is a gradual transition in size, shape and cusp armature throughout the series.

In the upper jaw the cheek teeth increase in size and complexity from the first to the fourth premolar and decrease from the latter to the last molar. The fourth premolar is triangular in shape and the inner portion or lobe is as broad at the base as the three-cusped bladelike outer portion of the crown. The third premolar and the first molar are also triangular and similar to the fourth premolar. In the lower jaw the teeth gradually increase in size and complexity from the first premolar to the first molar. The first three premolars have compressed three-cusped blades, with the median cusp the biggest. The fourth premolar is broader than those in front and has supplementary cusps on the inner side of the three-cusped blade, the shape of the tooth and the arrangement of the cusps clearly foreshadowing those of the first molar, in which the crown is differentiated into two subequal portions—an anterior armed with three cusps arranged in a triangle, and a posterior lower portion with an outer and an inner cusp. A first lower molar of this type is found in many genera of Carnivora.

The fourth upper premolar and the first lower molar, which are opposed in mastication, are similar to the teeth immediately before and behind them in the series, but they are larger, thus attesting to the concentration of biting power in the posterior half of the jaw. This difference in size, often accentuated, is found in many terrestrial species and, as a very general rule, these two teeth also differ considerably in shape from the others. Since this modification is an adaptation for shearing raw flesh and is particularly manifest in predatory forms, the teeth in question have been distinguished as the carnassials.

In the upper carnassial, or the fourth premolar, the modification is brought about by the reduction in size of the inner portion of the crown to a comparatively small lobe and the increase in size and compression of the median and posterior cusps of the outer portion to form a sharp-edged cutting blade. The lower carnassial, or first molar, is still more altered and may, as in the cats, be wholly converted into a cutting blade, which is formed by the enlargement and compression of the anterior median and the adjoining external cusp of the front portion of the primitive type of lower carnassial. High specialization of both carnassials as shearers, seen in the cats, hyenas, some weasels and others, is accompanied by shortening of the jaws, suppression of the second upper molar and reduction in size of the first, and loss of the second lower molar.

III. SURVEY OF THE ORDER

The existing Carnivora may be divided into two suborders: the Fissipeda or typical carnivores, with pawlike feet and cheek teeth of several kinds; and the Pinnipedia or seal group, with paddlelike feet and cheek teeth all alike. A third suborder, Creodont (*see* CREODONT), from which the two existing suborders have been derived, is a primitive stock, extinct since early in the Tertiary period (about 70,000,000 years ago).

The fissiped carnivores are divided into three superfamilies: the Canoidea, comprising the dog, bear, raccoon and weasel families with their various branches; the Feloidea, including the cat, hyena and civet families; and the fossil Miacoidea.

Pinnipeds, the fin-footed carnivores, are grouped into three existing families and one fossil family.

A. DOG AND DOG ALLIES (CANOIDEA)

In this superfamily, containing the dogs, bears and raccoons, the ethmoturbinals are excluded from the anterior orifice of the nasal chambers by the enlarged maxilloturbinals. The wall of the auditory bulla is composed entirely of the tympanic bone and its cavity is typically undivided. Cowper's glands are present in the male.

The families fall into three series: the dogs (Canidae) with their close relatives, the bears (Ursidae); the raccoons and their allies(Procyonidae); and the weasellike carnivores (Mustelidae).

1. Dog Family (Canidae).—*True Canines.*—The dogs, wolves and foxes (subfamily Caninae) differ from the rest of the canoids in possessing a caecum and a duodenojejunal flexure in the intestine, as in the feloids. Also, they are completely digitigrade and typically the formula of the cheek teeth is $P\frac{4}{4}$, $M\frac{2}{3}$, with the carnassials large and secant. The teeth, however, vary. The genus *Canis*, containing the dogs, wolves and jackals, many related genera from South America, and the foxes (*Vulpes*) have the teeth as recorded above.

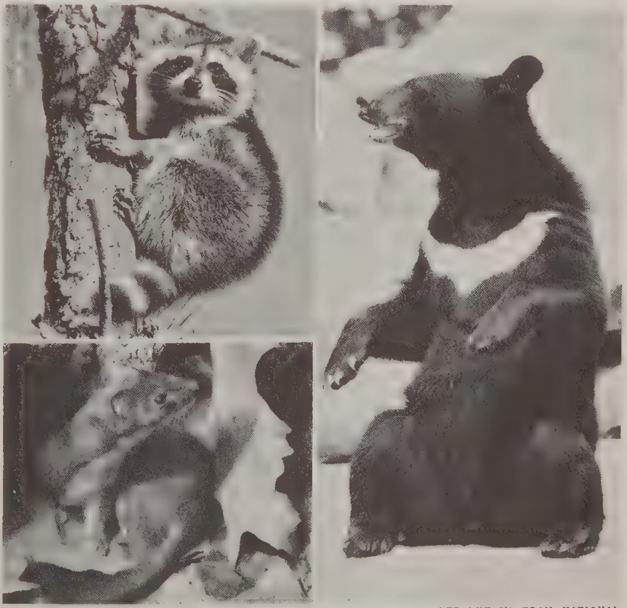
False Canines.—These are members of other subfamilies. The Asiatic dholes (*Cuon*) and the South American bush dog (*Speothos*) have lost the third lower molar. The most aberrant dentition, however, is found in the foxlike African genus *Otocyon*, in which there are not only four lower and three, occasionally four, upper molars, but the carnassial teeth are not differentiated from the rest either in size or function. Another somewhat aberrant type is the African hunting dog (*Lycaon*) in which the ears are large and rounded and the pollex is absent. (*See* DOG.)

2. Bear Family (Ursidae).—Although the bears and the dogs are shown by fossil forms to be modified descendants of the same stock, the living representatives of these families are widely divergent. The bears are heavily built, with broad, plantigrade feet, short tails, protrusible lips, reduced vibrissae and no bursa on the ear. The cheek teeth, although numerically as in the typical Canidae, are widely different in function and form, being adapted primarily for crushing hard vegetable fibre. The first three premolars above and below are practically functionless, closely crowded or widely spaced, and one or more often deciduous. The upper carnassial is small and not trenchant, and the molars have large flat tuberculated crowns.

There are several well-defined genera: *Ursus* containing the brown bear (*U. arctos*), the grizzly (*U. horribilis*) and the black bear (*U. americanus*); *Thalarctos*, the polar bear (*Th. maritimus*); *Selenarctos*, the Himalayan or Asiatic black bear (*S. thibetanus*); *Helarctos*, the Malay, or sun, bear (*H. maylayensis*); *Melursus*, the sloth bear (*M. ursinus*); and *Tremarctos*, the spectacled bear (*T. ornatus*). (*See* BEAR.)

3. Raccoon Family (Procyonidae).—This family is here considered to include the pandas (subfamily Ailurinae), the kinkajous, cacomistles and raccoons (Procyoninae).

Pandas.—Subfamily Ailurinae contains two forms, widely divergent in appearance and in certain anatomical features: the giant panda (*Ailuropoda melanoleuca*) and the common panda (*Ailurus fulgens*). The former inhabits Tibet and western China. It re-



(TOP LEFT) ALLAN D. CRUICKSHANK AND (BOTTOM LEFT) LEONARD LEE RUE III FROM NATIONAL AUDUBON SOCIETY, (RIGHT) H. ARMSTRONG ROBERTS

FIG. 1.—DOG ALLIES, CANOIDEA: (TOP LEFT) RACCOON (PROCYON LOTOR); (BOTTOM LEFT) LONG-TAILED WEASEL (MUSTELA FRENATA); (RIGHT) HIMALAYAN BEAR (SELENARCTOS THIBETANUS)

sembles a white bear with black legs, shoulders, ears and eyespots, but it lacks the alisphenoid canal in the skull and the molars are broad with numerous supplementary cusps. The common panda, which occurs in southern China and northeastern India, is a small, long-tailed, arboreal species, with subplantigrade, sharp-clawed, hairy feet with greatly reduced pads, the supplementary bone on the forefoot being quite small. It also differs from the giant panda in the loss of the third lower molar, in the cheek teeth forming graduated series and being simpler in pattern and in the presence of the alisphenoid canal. The anus is encircled by a glandular pouch and the penis is small and close to the scrotum, as in some feloids.

Raccoons, Kinkajous, etc.—The subfamily Procyoninae, confined to America, differs from the Ailuridae in having the penis long, the prepuce remote from the scrotum and the anal sac and alisphenoid canal absent, in the normally developed pads on the feet and the differentiation of the upper carnassial from the third premolar. There are several tribes.

The kinkajous (*Potos*) are arboreal vegetable feeders, with a prehensile tail and ventral scent glands; the jaws are massive and the molars flat crowned. Raccoons (*Procyon*) have long unwebbed digits, a shortish tail and a mobile snout; the crowns of the molars are broad and tubercular, recalling those of *Ailurus*. Coatis (*Nasua*) have webbed feet, with fossorial claws, a very long tail, an exceedingly mobile probing snout, slender jaws and smaller cheek teeth than the raccoons but larger tusklike canines. Cacomistles (*Bassariscus*) are active, predaceous, genetlike animals with small paws, a long tail and trenchant dentition. The cuataquil (*Bassaricyon*) closely resembles the kinkajous superficially but the tail is not prehensile and the cranial and dental characters are more like those of the raccoons.

4. Weasel Family (Mustelidae).—This family differs from the Procyonidae in the invariable absence of the second upper molar and in the presence, except in the sea otter, of a wide angular emargination, instead of a notch or slit, between the median and posterior cusps of the upper carnassial. The genera of this family exhibit greater range in structural variation and habits than any family of Carnivora. They may be referred to five subfamilies: the Melinae, the Mephitinae, the Mellivorinae, the Mustelinae and the Lutrinae.

Badgers.—The subfamily Melinae is characterized by the upper carnassial not larger than the molar, with a large inner lobe and bluntly cusped blade; the feet are fossorial. *Meles,* the true badger, is heavily built, with narrow head, short legs and tail and a glandular subcaudal pouch. The upper molar is larger than the carnassial, the bulla is undivided and does not open into the mastoid. The badgers are found in temperate Europe and Asia. *Arctonyx,* the sand or hog badger, occurs from northern India and southern China to Sumatra. It resembles *Meles,* but the muzzle is long, mobile and piglike, while cranially the long palate, continued posteriorly by the pterygoid bones, is unique. *Mydaus,* the teledu or stink badger of Sumatra, Java and Borneo, differs from the preceding forms in the absence of the subcaudal pouch, and in the skunklike development of the anal glands, the disclike rhinarium, divided upper lip, united toe pads, reduced ear and the bulla opening into the mastoid. It has a short tail and a white stripe runs from the crown to the tail. *Helictis,* the ferret badger, found in southeastern Asia, is long tailed like the skunks. The upper carnassial is larger than the molar, which has only a slightly broadened talon. There are no special glands. The bulla is divided by a septum. The nose is long, ending in a naked truncated snout; the ear retains a bursa. *Taxidea,* the American badger, is only distantly related to the typical old world species, the resemblances between the two being chiefly convergent. Its broad skull, the carnassial larger than the triangular upper molar, the bulla opening to the mastoid, the metatarsus without pads, the single carpal pad and peculiar glands associated with both male and female genitalia, are distinctive characters.

Skunks.—The Mephitinae, or skunks, restricted to America and represented by three genera (*Mephitis, Conepatus, Spilogale*), have the bony palate short while the mesopterygoid fossa is long. The penis is without a bone. The anal glands are excessively developed and secrete a nauseating fluid, which may be sprayed for a distance of several yards. The conspicuous pattern and fearless behaviour of skunks make them the stock instance of warningly coloured species.

Ratels.—The Mellivorinae includes only one species, *Mellivora capensis,* the ratel or honey badger, which occurs in tropical Asia and Africa. This animal is badgerlike in appearance but the teeth are sectorial, the upper carnassial larger than the molar, with a sharp blade. The anal glands are developed as in the skunks; the anus is sunk in a pouch and the ear is reduced.

Weasels, Minks, etc.—The Mustelinae have the upper carnassial long with a small talon. The feet are digitigrade and not fossorial, with short, partly united digits and short, sharp claws. The weasel, stoat, mink and polecat (*Mustela*) of Europe, Asia and America, have thick-walled auditory bullae, which open to the mastoid. The muzzle is short and the dentition especially sectorial. *Vormela,* the tiger polecat of southern Europe and Asia, is characterized by its variegated dorsal coloration and unconstricted upper molar. *Martes,* the martens and sables, have four premolars and thin-walled bullae. The feet have hairy metatarsus, the carpal pads separate from the plantar pad, like *Mustela* and the ear has a well-developed marginal bursa. *Gulo,* the holarctic wolverine, is a large plantigrade relative of the martens, with heavy dentition.

The tayra (*Galera* or *Eira barbara*), of South and Central America, is probably closely allied to the martens, but the ear lacks the bursa and the feet are naked, with confluent pads. The grisons (*Grison* and *Lyncodon*) occur in Central and South America; they are more distinct from the tayra than was formerly thought. The bullae are low, the tympanic ring in contact with their roofs and their cavities are small and undivided. The dorsal coloration is gray or whitish, while the underparts are dark brown or black, and the anal glands are well developed. The African muishonds (*Ictonyx, Poecilictis*) are also skunklike in coloration, being black with white stripes, but they are lighter in build and less fossorial. The cheek teeth are $\frac{3}{3}$ or $\frac{3}{4}$. The anal glands are highly effective. *Poecilogale albinucha,* the striped African weasel, is short legged and long bodied, but otherwise similar to the larger forms.

Otters.—The Lutrinae, or otters, represented by many genera (*Lutra, Aonyx, Pteronura,* etc.), differ from the preceding subfamilies mainly in their structural adaptations to aquatic life, and particularly in having the hind feet larger than the forefeet, with long distensible digits. The kidneys also are lobulate. The skull in shape resembles that of the Mustelinae, but the upper molar is as large as the carnassial. The family ranges all over the world apart from Madagascar and Australia.

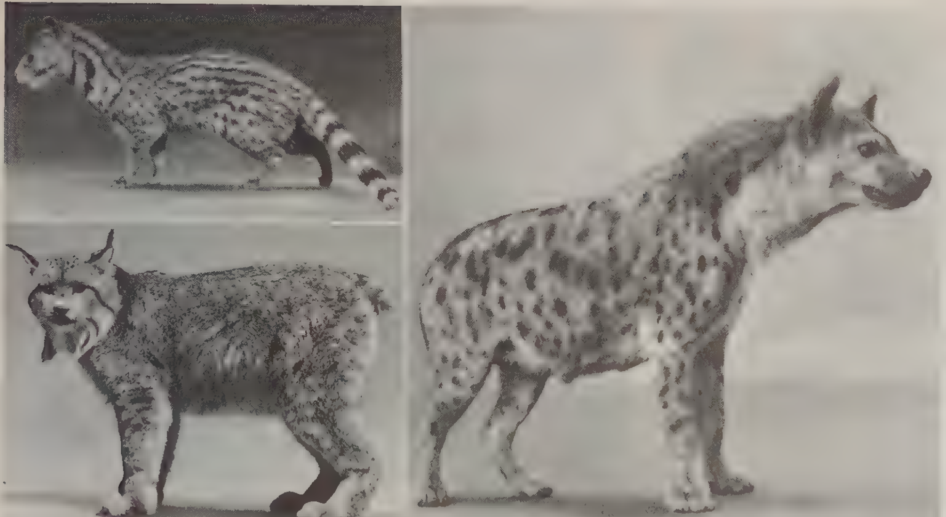
The sea otter (*Enhydra*), which is restricted to the North Pacific, differs from the other lutrinids in the structure of the feet. The forefeet have the digits very short and tightly fused, and the hind feet very large and paddlelike with the digits progressively increasing in length from the first to the fifth. Also the cusps of the teeth are all bluntly rounded.

B. Cats and Cat Allies (Feloidea)

Although the cats are highly specialized, their relatives the civets include some of the most primitive living carnivores. In the Feloidea the ethmoturbinal bones are extremely large and occupy the greater part of the nasal chambers, extending forward between and over the smaller maxilloturbinals almost to the anterior orifice of the chambers. The auditory bulla is composed of two elements: the tympanic and entotympanic, and when completely ossified, its cavity is divided by a partition springing from the line of junction of the two bones that compose its wall. Cowper's glands connected with the generative organs of the male are absent. The Feloidea are divisible into three families: Viverridae, Hyaenidae and Felidae.

1. Civet Family (Viverridae).—The Viverridae, civets, genets and mongooses, are a confusing group of small- to medium-sized mammals largely confined to Africa and Asia (except for a species of genet found in Spain and on a few Mediterranean islands).

Civets (Viverrinae).—The Viverrinae, represented in tropical Asia by the civets (*Viverra, Viverricula*) and in Africa by the



BY COURTESY OF (TOP LEFT, RIGHT) NEW YORK ZOOLOGICAL SOCIETY; PHOTOGRAPH, (BOTTOM LEFT) R. VAN NOSTRAND FROM NATIONAL AUDUBON SOCIETY

FIG. 2.—CAT ALLIES, FELOIDEA: (TOP LEFT) INDIAN CIVET (VIVERRA ZIBETHA); (BOTTOM LEFT) CANADA LYNX (LYNX CANADENSIS); (RIGHT) SPOTTED HYENA (CROCUTA CROCUTA)

typical civet cat (*Civettictis*) and the genets (*Genetta, Poiana*), differ from the palm civets (Paradoxurinae) in being digitigrade, generally with retractile claws, in having more elaborate scent glands and more trenchant teeth. The linsangs (*Prionodon* and *Pardictis*) are elegant genetlike animals found in southeastern Asia, with digitigrade feet and retractile claws; they are the only members of the Viverridae in which the penis is small and close to the scrotum. Also the scent glands, when present, are either wholly or partly perineal, never entirely abdominal in position. The subfamily exhibits great range in structural variation.

Palm Civets (*Paradoxurinae*).—The oriental palm civets, ranging from India to the Philippines and Celebes, are represented by the genera *Paradoxurus, Paguma* and *Macrogalidia.* In a related form, *Arctogalidia,* the scent gland is absent in the male, and in the binturong (*Arctictis*) the tail is prehensile and the teeth, as in *Arctogalidia,* are not so trenchant as in the typical palm civets.

The African tree or palm civet, *Nandinia,* differs from other Viverridae in having the cavity of the auditory bulla undivided and the wall of its posterior portion permanently cartilaginous; in the large size and shelflike form of the mastoid portion of the skull and the backward direction of the paroccipital away from the bulla it resembles many of the Canoidea (*see* below). In other characters it shows kinship with the oriental palm civets, with which it has been affiliated. The body and tail are long, the muzzle elongate and narrow; the full complement of facial vibrissae is retained; the ear has the bursa and a ridgelike supratragus; the legs are short, with the feet subplantigrade, and with short, curved, partially retractile claws, evenly spaced digits, a four-lobed plantar pad, continuous on the forefoot with the bilobed carpal pad and on the hind foot with the metatarsal area which is naked and has two ridgelike pads. Also, in the skull the palatine foramina are in front of the suture, and the cheek teeth are $P\frac{4}{4}$, $M\frac{1}{2}$ and moderately trenchant.

The single species of this genus, *N. binotata,* sometimes called the two-spotted palm civet, is a spotted, omnivorous, arboreal animal the size of a small cat, restricted to the forest region of west Africa. It is an extremely interesting primitive type, resembling in many cranial and dental characters, especially in the structure of the bulla, the extinct Miacidae of the Eocene.

Hemigales.—In the three oriental genera of the subfamily Hemigalinae (*Hemigalus, Diplogale, Chrotogale*) the teeth are sharper cusped than in the civets, the feet are more digitigrade and the scent pouch is reduced in size in both sexes.

The otter civet (*Cynogale*) is a fisheater adapted for aquatic life. The vibrissae are numerous and rigid, the rhinarium is on the summit of the muzzle, which is very wide, and the tail is short. The scent gland is reduced and the teeth are modified for holding fish and crushing the shells of crabs and mussels. The genus ranges from Malaya to Borneo.

In the preceding groups the scent gland is present in one or both sexes. In the following three it is absent: the genus *Fossa* is a civetlike animal inhabiting Madagascar, digitigrade but with nonretractile claws; *Eupleres* also comes from Madagascar, is remarkable for the degenerate character of the teeth and feeble jaws, and the feet are subplantigrade and fossorial.

Galidines.—In the Galidiinae or Malagasy mongooses (*Galidia, Galidictis, Hemigalidia*), the scent gland is restricted to the female, the feet are narrow with nonretractile claws, the jaws are short, the teeth sectorial and the bulla has a bony tubular meatus not found in the other groups.

Mongooses.—The subfamily Herpestinae, the true mongooses, differs from the Viverrinae in having a glandular circumanal sac into which the anus and anal glands open by separate orifices, and in the absence of the bursa on the ear. They have no perineal glands, the penis is short and close to the scrotum and there is a tubular auditory meatus in the skull. The feet are digitigrade or subplantigrade with fossorial nonretractile claws and the toes may be reduced to four on each foot. The teeth also vary, sometimes being bluntly, sometimes sharply, cusped and trenchant. This group contains a large number of genera and species found mostly in India and Africa. The best known are *Herpestes,* the typical mongoose; *Mungos,* the banded mongoose; *Ichneumia,* the white-tailed mongoose; *Suricata,* the meerkat; and others.

Foussas.—Subfamily Cryptoproctinae contains only the foussa (*Cryptoprocta*) of Madagascar. It resembles externally a large oriental palm civet, but differs in the absence of perineal scent glands, the possession of a capacious circumanal sac and of a large bone in the penis, this organ being highly complex in structure. The jaws of the skull are short and the teeth are sectorial, closely resembling those of the Felidae.

2. Hyena Family (Hyaenidae).—*Hyenas.*—The subfamily Hyaeninae includes the hyenas (*Hyaena, Crocuta*). They differ from other Feloidea in the large size of the tympanic bone, which composes nearly the whole of the bulla, the partition of the cavity lying far back. The feet are digitigrade, like those of a dog, but there is no pollex. The anal glands open into a capacious subcaudal pouch. There are no perineal glands and the prepuce is far in advance of the scrotum. The skull is massive and the teeth which are sectorial in type are very powerful. The genus *Hyaena* is represented by the striped hyena of southwestern Asia and northern Africa and by the brown hyena of southwestern Africa. *Crocuta,* the spotted hyena, which differs in the structure of the teeth and genital organs, is restricted to Africa. Hyenas are sometimes scavengers, feeding upon the carcasses of big game.

Aardwolf.—The subfamily Protelinae contains only the aardwolf (*Proteles*), found on the savannas and veld of tropical and southern Africa. It resembles a small striped hyena externally except for the presence of a pollex on the forefoot. It differs, however, from the hyenas in the normal structure of the bulla and from all the land carnivores in its remarkable dentition, the cheek teeth being widely spaced, all alike and peglike, with the jaws correspondingly weak. It eats carrion and white ants.

3. Cat Family (Felidae).—The family Felidae contains all the cats, distinguished by the position of the posterior palatine foramina on the maxillopalatal suture and the absence of the interramal tuft of vibrissae. Four subfamilies are fossil. All existing cats belong to the subfamily Felinae. As in the linsangs (Viverridae), the penis is small and close to the scrotum, the vulva close to the anus, and there are no perineal glands or glandular pouch above or around the anus; but although the feet have retractile claws, they are more digitigrade than in the linsangs, the pollex being more elevated, the hallux absent and the plantar pad three lobed. In the skull the jaws are short and the teeth highly sectorial, the important cheek teeth being the two-bladed carnassials. Recent cats are all closely allied and represent surviving members of a single group. Until recently all except the cheetah were generally considered to belong to a single genus, but at least five genera can be recognized. *Felis,* the typical cats, including the domestic cat and a number of near relatives, is characterized by fully ossified hyoid, well-developed claw sheaths and long tail. *Lynx* differs from other cats in the absence of an upper premolar, and has short tail and tufted ears. *Neofelis nebulosa,* the clouded tiger (or clouded leopard) of southern Asia and the Greater Sunda Islands, is characterized by very long upper canines. *Panthera* contains the lion (*P. leo*), the tiger (*P. tigris*), the leopard (*P. pardus*), the jaguar (*P. onca*) and the snow leopard (*P. uncia*), which have the larynx (voice box) loosely attached to the skull by the long ligamentous suspensorium of the hyoid. The cheetah (*Acinonyx*) is distinguished from other cats by the absence of the integumentary sheaths to the claws; the hyoid is as it is in the typical cats. (*See* CAT.)

C. SEALS AND SEAL ALLIES (PINNIPEDIA)

The seallike mammals are often considered a separate order, but they are related to land carnivores, and are here treated as a suborder, Pinnipedia. The upper limbs are short, the feet, swimming paddles. The first and fifth toes of the hind feet are larger than the rest. The cheek teeth are all similar.

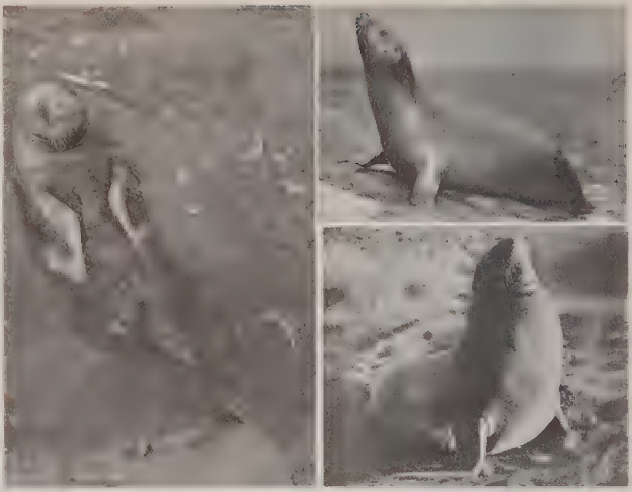
1. Eared Seal Family (Otariidae).—This family comprises the sea lions and fur seals; these have small external ears and progress on land in quadrupedal fashion by applying the naked soles of all four feet to the ground. The incisor teeth are present, the canines are of normal size and the cheek teeth have compressed crowns with one main cusp. They feed mostly on fish.

There are seven well-marked species, each of which has received a generic name based on cranial characters. Steller's sea lion (*Eumetopias jubata*) and the northern fur seal (*Callorhinus ursinus*) are found in the North Pacific; the California sea lion (*Zalophus californianus*) ranges from California to Japan; the Australian sea lion (*Neophoca cinerea*) inhabits Australia; the Patagonian sea lion (*Otaria flavescens*) frequents the coasts of South America; the southern fur seal (*Arctocephalus*) occurs in the South American, south African and Australian seas; and Hooker's sea lion (*Phocarctos hookeri*), also in the Australian seas. The family is thus restricted to the Pacific and southern oceans.

2. Walrus Family (Odobenidae).—This family contains the walrus (*Odobenus*), restricted to the northern oceans. Its limbs are like those of the *Otariidae,* but the external ear is absent and the skull is remarkably modified to carry the huge tusklike upper canines, while the cheek teeth are flat crowned for crushing the shells of mussels and oysters upon which the walrus mainly feeds.

3. True Seal Family (Phocidae).—This family comprises true seals. They are also without external ears, but the hind limbs are stretched backward to act as a tail fin and their soles, which like those of the forelimb are hairy, are incapable of being applied to the ground. The variation in cranial and dental characters is greater than in the *Otariïdae,* the common seals (*Phoca*) and the elephant seals (*Mirounga*) exhibiting the extremes. In *Phoca* the claws are all well developed, the digits of the foreflippers are subequal and the first and fifth of the hind flippers only slightly exceed the rest and the integument is not produced beyond their tips; the incisors are $\frac{3}{2}$, the cheek teeth are cusped and mostly two rooted, the muzzle is normal, its orifice is small and encircled by the long nasals and premaxillae which are in contact. In *Mirounga* the digits of the foreflippers decrease in length from the first to the fifth, those of the hind flippers have no claws and the fourth and fifth digits greatly exceed the rest and are lengthened by skin lobes; the muzzle of the male is developed into a distensible proboscis; the incisors are $\frac{1}{2}$, the small cheek teeth have simple crowns and one root, and the premaxillae and nasals are short and widely separated and do not surround the dilated nasal aperture. *Phoca* and its allies, *e.g., Halichoerus,* the gray seal, are found in the northern oceans. *Mirounga,* the largest of the pinnipeds, reaching a length of 20 ft., ranges from the antarctic to California; but there are many structurally intermediate genera in the northern and southern oceans.

(R. I. P.; J. E. HL.; X.)



BY COURTESY OF (LEFT, TOP RIGHT) NEW YORK ZOOLOGICAL SOCIETY; (BOTTOM RIGHT) A.N.A.R.E. PHOTOGRAPH BY S. CSORDAS

FIG. 3.—SEAL AND SEAL ALLIES, PINNIPEDIA: (LEFT) YOUNG ATLANTIC WALRUS (ODOBENUS ROSMARUS); (TOP RIGHT) COMMON SEAL (PHOCA VITULINA); (BOTTOM RIGHT) AUSTRALIAN SEA LION (NEOPHOCA CINEREA)

IV. TEMPERAMENTS OF THE CARNIVORES

It is a commonplace observation that cat and dog have characteristic and incompatible temperaments. Groups of cats do not join in chasing a smaller dog, and dogs do not patiently watch a mousehole. Little reflection is required to extend such observation to other types of carnivores. Indeed, each of the principal members of the carnivore group, wild as well as domesticated, insofar as it has been familiar to European peoples, has left its stamp on folklore and even in the structure of language. We speak of the gregariousness and loyalty of dogs, of the solitary nature and stealth of cats, of the cunning of foxes and of the ferocity of weasels. The bear has two familiar characters—he is a byword for surliness, as well as for good-natured inoffensiveness—but these correspond accurately on one hand to his behaviour when annoyed (well known from the medieval bearbaiting), and on the other to his character when unmolested in the wild. The comparative study of such psychic characters applying to families and genera deserves attention.

While such widespread impressions cannot be very exactly or scientifically formulated, the fact that the mental characteristics of the familiar domestic cat may be seen in its relatives in quite the same way as anatomical peculiarities, such as the sheathed claws or vertical pupil of the eye, has profound philosophic implications. Differences of temperament in other mammalian groups, and characteristic of whole orders, elephants or monkeys for example, may be detected in a still more general way. The topic was referred to by Clarence Day in a clever evolutionary essay, *This Simian World.*

The importation of the giant panda, which represents a distinct subfamily of carnivores, into U.S. and European zoological gardens made observation of this previously unfamiliar creature possible. Its instant popularity, equally with its keepers and with the visiting public, obviously had as its basis a novel and distinctive set of behaviour patterns.

For a person familiar with cats and dogs to undertake the breeding of ferrets means another insight into the family characters of carnivores. The ferret is a typical representative of the weasel family, and though as long domestic as the cat, retains much of the curiously intent ferocity of its wild relatives. The weasel temperament appears to have impressed itself on the behaviour of the smaller rodents and the rabbits that form the principal prey of the smaller members of the weasel tribe. These rodents display an unreasoning and helpless fear of the ferret, as of the weasel. The play of a tame adult ferret with a human being is startlingly different from that of a cat or a dog, and the play of young ferrets with each other is equally characteristic.

The skunks are very distinctive members of the weasel family confined to the Americas. They are still somewhat confused linguistically with the European polecat (the wild relative of the ferret). The skunk characteristic of complete fearlessness is obviously correlated with its conspicuous type of coloration and with its astonishingly effective means of defense by the spray of an overpowering scent from its anal glands. Even the fearlessness of the skunk, however, relates it psychologically to the weasel tribe, in which lack of fear of very much larger animals, even carnivores, is characteristic.

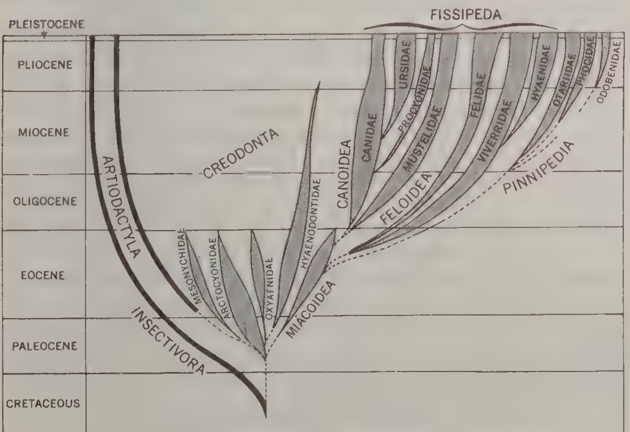
The raccoon represents still another type of carnivore whose peculiar habits and temperament have become familiar. Raccoons are said to exhibit exceptional intelligence in releasing themselves from cages, and intelligence may well be associated with their most highly developed characteristic, insatiable curiosity. It is curiosity, in turn, that makes the raccoon an easy prey to the trapper who baits his trap or snare with some unusual or glittering object.

The coati of tropical America differs radically from the raccoon in gregarious habits but betrays its relationship by an equally evident extreme of curiosity. The arboreal and nocturnal kinkajou, also thought to be a relative of the raccoons, is so distinctive in its habits that it may be expected to have quite as distinctive mental characters.

The observations and impressions of naturalists as to the minds of wild animals, and the frequently prejudiced observations of the keeper of pet animals obviously need critical sifting and experiment before the mental characteristics of animals can be associated properly with the taxonomic categories of orders, families, genera, species, races and individuals. The interrelations of habits, structure and mental characteristics likewise require more, and more critical, observation. There are, however, strong indications of such associations. (K. P. S.)

V. EXTINCT CARNIVORES

Fossil remains of the majority of the common modern genera of Carnivora are found in the Pleistocene formations along with a number of extinct types which were known to prehistoric man. Among these the most remarkable are the sabre-toothed tigers or machairodonts (*see* SABRE-TOOTHED TIGER), the *Arctotherium* or short-faced bear of North and South America. The cave bear of Europe (*Ursus spelaeus*) and the California lion (*Panthera atrox*) equaled in size the largest living species. The geographic range of hyenas, lions and dholes was then extended to northern Europe, while conversely the wolverine and other northern Carnivora have been found as far south as Arkansas.



FROM J. Z. YOUNG, "THE LIFE OF VERTEBRATES," CLARENDON PRESS, OXFORD, 1958

FIG. 4.—EVOLUTION OF CARNIVORA

All of the families of modern Carnivora are represented in the formations of the later Tertiary period, most of them by a wider variety of types than those that survive today, and the ancestry of many of the modern genera can be traced back through the Pliocene, Miocene and Oligocene into or toward a common ancestral stock which appears to be fairly represented by the Eocene superfamily Miacoidea (comprising the family Miacidae). The Miacidae, alone among the early carnivores, acquired the true carnassial or shearing teeth of the fissiped Carnivora, and on this account they are often included in the Fissipedia. However, for various reasons they have also been regarded as pro-fissiped creodonts.

In the Oligocene numerous genera of primitive fissiped Carnivora are known from Europe, North America and central Asia. They all appear to be rather nearly related, but the beginnings of the distinctions between viverroid, musteloid and cynoid groups can be perceived and the felids are already distinct. The faunas of the three regions have much in common and these Oligocene fissipeds are evidently descended from holarctic Miacidae of the Eocene. They had apparently not yet reached Africa, although the Creodonta had preceded them into that region, at least as far as Egypt. Neither creodonts nor fissiped Carnivora are found in South America at this time; the Carnivora did not reach the neotropical region until the Pliocene, their place being taken by carnivorous marsupials in the older Tertiary of South America.

All of these Oligocene Carnivora have the scaphoid and lunar bones united. Most of them have the tympanic ring expanded into a complete bulla, but the bulla is not infrequently loosely articulated to the skull and is then usually lost in the fossil specimens.

The canoid group has the dentition $I\frac{3}{3}C\frac{1}{1}P\frac{4}{4}M\frac{3}{3}$ (or $\frac{2}{3}$); the teeth behind the carnassial are moderately reduced and of crushing type. *Cynodictis* with only two upper molars leads through a number of intermediate stages (*Nothocyon*, Upper Oligocene; *Cynodesmus*, Lower Miocene; *Galecynus* and *Tephrocyon*, Upper Miocene) into the modern Canidae; while *Daphaenus* with three upper molars leads (through *Daphoenodon* of the Lower Miocene) into the Miocene *Amphicyon* ("bear dog") with enlarged crushing and reduced shearing teeth. These equaled the modern bears in size, but were still largely digitigrade with legs of moderate length and long heavy tail. They are connected with the true bears through *Hemicyon* (Miocene), *Hyaenarctos* and *Indarctos* (Pliocene) in which the teeth progressively assume the fully specialized crushing type of the true bears, the limbs become long and straight, the feet plantigrade and the outer digit of manus and pes the largest. How near this series comes to being a direct line of ancestry is not yet settled, but it unquestionably indicates that the bears are derived from primitive Oligocene cynoids. The raccoons also appear to be derived from this primitive cynoid stock, through *Cynodon* of the Oligocene and *Phlaocyon* of the Lower Miocene, but it is probable that the modern Procyonidae are several independent parallel branches from this stock rather than a single group.

The Oligocene musteloids have the postcarnassial teeth more reduced than in the cynoids and of more or less cutting type. Their dental formula is $I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}$(or $\frac{3}{3}$)$M\frac{2}{2}$ (or $\frac{1}{2}$). None of them has acquired the expansion of the inner half of m^1 nor the flattened tympanic bulla that characterize modern Mustelidae; these characters appear in a very rudimentary stage in most of the Lower Miocene and more fully developed in the Middle and Upper Miocene mustelines, but are assumed independently in a number of separate series that lead up more or less directly into the martens, weasels, wolverines, otters, skunks and badgers.

The viverroid group is hardly distinguishable in the Oligocene by tooth characters, but it shows in contradistinction to the cynoids and musteloids a certain tendency to extend the bulla backward and expand the paroccipital process over its posterior end. The well-developed parastyle on the upper carnassial, characteristic of most modern Viverridae and Felidae, is small and inconstant in their Oligocene ancestors, and is moreover not uncommonly found in Tertiary cynoids and musteloids (*Aelurodon*, etc.). In the Miocene Viverridae the limitation of the postcarnassial teeth to two above and one (the second true molar) below, both well developed, becomes more definite, the bulla more characteristic and the division between viverrine and herpestine genera begins to be distinguishable.

A number of intermediate genera in the Miocene and Lower Pliocene (*Ictitherium, Lepthyaena, Palhyaena*) are transitional to the hyenas, which are fully developed in the Lower Pliocene and are clearly derivable from primitive civets, although the known species of these intermediate genera are not directly ancestral. Hyenas and civets are found only in the old world Tertiaries, although fragmentary remains of hyenoid Canidae from the Tertiary of North America have several times (*Aelurodon, Borophagus, "Prohyaena," Chasmoporthetes*) been mistakenly referred to these old world families. The Tertiary canids, on the other hand, are chiefly North American, while the mustelids and ursids are holarctic.

The Felidae are quite distinct in the Oligocene, and all of them show, but in different degree, an enlarged and compressed upper canine, reduced lower canine and flanged or angulate chin. They appear to fall into two series; in one these characters and associated special adaptations in skull and skeleton are decidedly more marked and are progressively increased in the Lower and Upper Miocene to culminate in the sabre-toothed tigers of the Pliocene and Pleistocene. In the other series the above noted peculiarities, already much less developed, are progressively reduced to the nearly normal condition of the modern Felidae in which upper and lower canines are nearly equal, and the chin has lost its flange. The clouded tiger (*q.v.*) of Malaysia is the most primitive living species in these as in some other particulars. *Dinictis* of the Oligocene, *Nimravus* and *Archaelurus* of the Lower Miocene, *Pseudaelurus* of the later Miocene, are the successive stages in the ancestry of the Felidae, while *Hoplophoneus* and *Eusmilus* of the Oligocene and *Machairodus* of the Miocene lead into the more highly specialized sabre-tooths *Smilodon* and *Megantereon* of the Pliocene and Pleistocene. In both the feline and machairodontine series there is also a progressive specialization of the shearing teeth and reduction of the premolars, these teeth in *Dinictis* being not far beyond the stage reached in the modern viverrid genus *Cryptoprocta*. (W. D. M.; X.)

VI. CLASSIFICATION

The following taxonomic scheme of the order Carnivora is one of several subscribed to by mammalogists:

Suborder Creodonta, primitive carnivores (fossil and extinct)
" Fissipeda, footed land carnivores
Superfamily Miacoidea (fossil and extinct)
" Canoidea, dogs and dog allies
Family Canidae, dogs, etc.
Subfamily Caninae, true dog, wolf, fox, etc.
" Simocyoninae, dhole, cape hunting dog
" Amphicynodontinae (fossil and extinct)
" Amphicyoninae (fossil and extinct)
" Borophaginae (fossil and extinct)
" Otocyoninae, big-eared fox, motlosi (fossil and extinct)
Family Ursidae, all the bears
" Procyonidae, raccoons, pandas, etc.
Subfamily Procyoninae, raccoon, coati, kinkajou, etc.
" Ailurinae, all the pandas
" Cynarctinae (fossil and extinct)
Family Mustelidae, weasels, badgers, etc.
Subfamily Mustelinae, weasel, mink, marten, grison, wolverine, etc.
" Mellivorinae, ratel, honey badger
" Melinae, all the true badgers
" Mephitinae, skunk
" Lutrinae, otter
" Leptarctinae (fossil and extinct)
Superfamily Feloidea, cats and cat allies
Family Viverridae, civets, etc.
Subfamily Viverrinae, true civet, genet, linsang
" Paradoxurinae, palm civet, musang, binturong
" Hemigalinae, fanaloka, otter civet, etc.
" Galidiinae, Malagasy mongoose
" Herpestinae, meerkat, true mongoose
Subfamily Cryptoproctinae, foussa or fossa
" Stenoplesictinae (fossil and extinct)
Family Hyaenidae, hyenas and aardwolves
Subfamily Hyaeninae, hyena
" Protelinae, aardwolf
" Ictitheriinae (fossil and extinct)
Family Felidae, all the cats
Subfamily Felinae, lion, tiger, domestic cat, etc.
" Proailurinae (fossil and extinct)
" Nimravinae, false sabre-toothed tiger (fossil and extinct)
" Machairodontinae, sabre-toothed tiger (fossil and extinct)
Suborder Pinnipedia, fin-footed carnivores
Family Otariidae, all the eared seals including fur seals and sea lions
" Odobenidae, walruses
" Phocidae, all the true seals
Subfamily Phocinae, harbor seal, hair seal, harp seal, etc.
" Lobodontinae, Ross's seal, leopard seal, Weddell seal, etc.
" Monachinae, monk seal
" Cystophorinae, hooded seal, elephant seal
Family Semantoridae (fossil and extinct)

See also Mammalia and articles on various carnivores: CAT; DOG; BEAR; RACCOON; SEAL; etc.

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CARNIVOROUS PLANTS (INSECTIVOROUS PLANTS) are plants specially adapted for capturing insects and other tiny animals (*e.g.,* small crustaceans, nematodes) by means of ingenious pitfalls and traps and then subjecting them at once to the decomposing action of digestive enzymes, bacteria, or both. The approximately 500 known species of carnivorous plants constitute a very diverse group, in some cases having little more in common than their carnivorous habit. While the carnivorous adaptation is most widespread and conspicuous among green plants, some microscopic species of fungi also catch animal prey and digest it (the fungus *Arthrobotrys oligosperma,* for example, has minute loops by which it snares nematodes and sends special digesting-absorbing branches into them). All green carnivorous plants belong to the large group of flowering seed plants known as dicotyledons.

General Features.—The pitfall, as found among pitcher plants, is a passive trapping mechanism, because no movements on the part of the plant are required. The unwitting animal (usually an insect), attracted to a large showy leaf by sweet nectar, slips from a treacherous lip into a deep hollow leaf, which proves to be a cistern of digestive "broth" from which there is no escape. The active devices, the snares and traps, forcibly capture curious prey lured by nectariferous secretions to prowl among highly sensitive trigger hairs or to "drink" from glistening droplets perched atop mobile tentacles. The celebrated Venus's flytrap is a "bear trap" in miniature. Its menacing jawlike leaves clamp shut with amazing speed when properly stimulated and do not open again until the victim's soft tissue is digested.

Carnivorous plants, unlike carnivorous animals, do not devour their prey by chewing, but otherwise the process of chemical breakdown is quite analogous to digestion among animals, even to the extent of occurring outside the body cavity as in the alimentary canal. The end products, particularly nitrogenous compounds and salts, are absorbed by the plants. Their adaptations for digesting nitrogen-rich animal proteins are thought to enable these plants to survive under otherwise marginal or hostile conditions. However, some carnivorous plants have been shown to survive quite well without the animal diet, and "unfed" Venus's flytraps seem, curiously, to live longer than those that have captured and digested insects. Most carnivorous species are green plants that manufacture food by photosynthesis from the raw materials of sunlight, water, and carbon dioxide, in the presence of chlorophyll, and it is not correct to say that they are sustained by the animal diet alone.

The conspicuous trapping mechanism, always a leaf modification, draws special attention to these plants. Classification, on the other hand, is based primarily on the floral characteristics, as among flowering plants in general; on this basis some of the carnivorous dicotyledons appear to have had quite different paths of evolution. More than half of the species belong to the family Lentibulariaceae, marked by bilaterally symmetrical flowers with fused petals. The remainder of the species belong to several families characterized by radially symmetrical flowers formed of separate petals.

Three families of the latter group—Droseraceae, Nepenthaceae, Sarraceniaceae—comprise a natural group on the basis of their floral characteristics and are placed in the order Sarraceniales. Yet the species of Nepenthaceae and Sarraceniaceae, known collectively as pitcher plants, capture prey by means of pitfalls, while the Droseraceae have active trapping devices.

The family Droseraceae comprises four genera and from 90 to 95 species. Nearly all of these species belong to *Drosera*, the worldwide genus of sundews. The other three genera—*Aldrovanda, Dionaea, Drosophyllum*—have one species each and have more restricted geographic ranges. Some authorities place *Dionaea muscipula*, the Venus's flytrap, in a family by itself, Dionaeaceae.

The genera *Byblis* and *Roridula* are sometimes placed in the Droseraceae on the basis of their general morphology and method of snaring prey, but both are usually referred to families of their own, Byblidaceae and Roridulaceae. *Byblis* is a wide-ranging Australian genus of two species. *Roridula*, a South African genus of several species, traps insects by means of resinous secretions but does not digest them, and so is no longer regarded as truly carnivorous.

The 15 to 20 species of New World pitcher plants are placed in the family Sarraceniaceae, which comprises three genera—*Darlingtonia, Heliamphora*, and *Sarracenia*. Three-fourths of the species belong to the widely known and much studied genus *Sarracenia*, of eastern North America. The approximately 60 species of Old World pitcher plants constitute the only genus of the family Nepenthaceae, *Nepenthes*. *Cephalotus follicularis*, of southwest Australia, looks like a saxifrage with small *Sarracenia* leaves; it constitutes a pitcher-plant family of its own, Cephalotaceae, closely related to the Saxifragaceae.

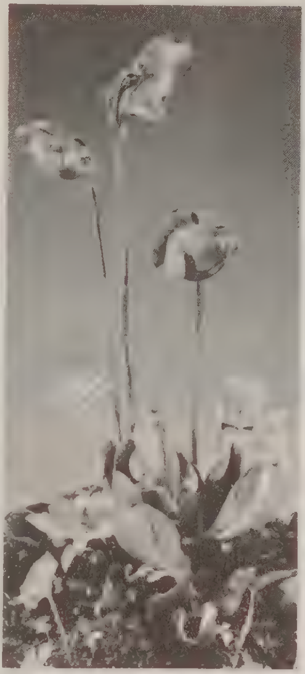
The Lentibulariaceae include the remaining carnivorous genera and more than 300 species. Perhaps 275 of them belong to *Utricularia*, the bladderworts, the most cosmopolitan of all the carnivorous genera. The two small genera *Biovularia* (2 species; Cuba, South America) and *Polypompholyx* (2 to 4 species; Australia) are very similar to *Utricularia* and also trap their prey by means of highly specialized "bladders." *Biovularia*, frequently confused with *Utricularia*, differs chiefly in having only 2 ovules in the ovary as contrasted with the 100 or more of *Utricularia*. *Genlisea*, a small tropical genus, traps its prey by means of tiny pitcherlike structures. The butterworts, genus *Pinguicula*, are quite different from the bladderworts and other genera and trap their prey by still a third method: on sticky flypaperlike leaves.

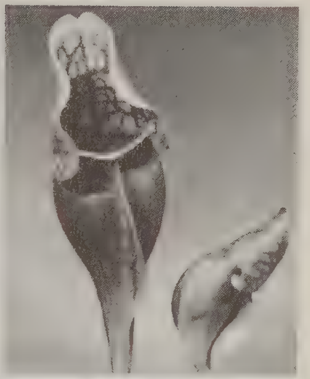
Whether aquatic, terrestrial, or amphibious, carnivorous plants have a basically similar ecology. Species of two or three genera (*e.g., Sarracenia, Drosera, Pinguicula*) are often found growing almost side-by-side. The majority are most likely to be found in damp heaths, bogs, swamps, and muddy or sandy shores, where water is abundant and where nitrogenous materials are often scarce or unavailable because of acid or other unfavourable soil conditions. *Drosophyllum lusitanicum* seems to be the one exception; this coarse, wiry sundew grows on dry gravelly hills of Portugal and nearby Morocco.

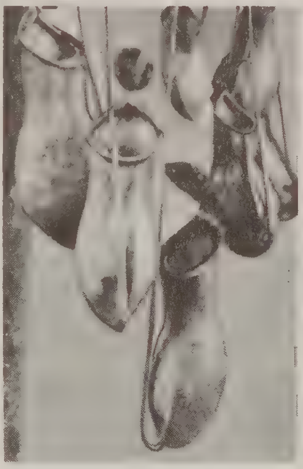
On the whole, carnivorous plants are relatively small, but size variation is enormous even within the same genus. The majority are herbaceous perennials less than a foot high, often only 4 to 6 in. However, some species of *Nepenthes* become large shrubby vines. *Drosera* species vary from a few inches to three or more feet in height (*D. gigantea*); the smallest are often hidden among the moss of a sphagnum bog.

Pitcher Plants.—The pitcher plants take their common name from their unusual, tubular leaves, which are shaped like urns, trumpets, or small pitchers.

Sarracenia.—This North American genus of about a dozen species was named by Linnaeus in honour of the Quebec physician, Michel Sarrasin de l'Étang (1659–1734), who first sent specimens of the common or northern pitcher plant (*S. purpurea*) to Europe. This species, sometimes called the sidesaddle flower, ranges from the Atlantic Coast to Great Bear Lake and south to northern Florida; it is the only *Sarracenia* found outside the Southeastern United States. The hooded pitcher plant (*S. minor*) and the yellow pitcher plant (*S. flava*) are relatively wide-ranging on the coastal plain and adjacent Piedmont.







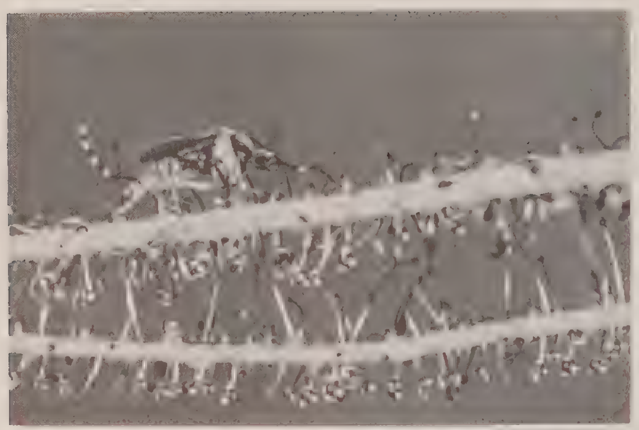
(LEFT, ABOVE) ROCHE, (BOTTOM LEFT) J. HORACE MCFARLAND COMPANY

PITCHER PLANTS: (Left) Sidesaddle flower, of eastern North America, with flower stalks rising from a rosette of leaf traps; (above) close-up of two traps showing ventral wings and arching hoods; (bottom left) *Nepenthes*, of Australasia, has leaf tendrils developed into hanging pitchers

The plant consists of a basal cluster or rosette of leaves arising from creeping stems or stolons; there is no leafy aerial stem. The leaves are recumbent (*e.g., S. purpurea*) or erect (*e.g., S. flava*), have a sheathing base, and widen gradually into pitchers. A prominent wing runs along the outer ventral surface of the leaf, which at the top becomes a narrow flange, the lip of the pitcher. On the back side a bladelike expansion, the lid or hood, arches over the mouth of the pitcher, in some cases effectively closing off the opening to light and rain. Leaf colour varies from yellow-green (*S. flava*) to deep green suffused with red (*S. purpurea*), the intensity of which depends in part on the amount of sunlight.

The inflorescence consists of a tall, leafless stalk with a single, nodding flower. The stalk normally grows to about a foot, but may be twice as tall. The large flower (several inches across) has five yellow, greenish-yellow, or dark red petals and five green sepals. The petals may be very short or long and showy as in *S. flava*, hanging down like a hound's ears. The firm sepals remain long after the petals fall.

The insect-trapping mechanism is basically the same among the various species of *Sarracenia*. Insects are attracted to the mouth of the pitcher by a trail of nectar-secreting glands extending downward from the lip along the outside, especially on the ventral wing. The lid is provided with stiff, downward-pointing hairs. Insects attempting to garner nectar here almost invariably fall into the pitcher. Just below the lip, in the steepest part of the throat, is a highly polished area without hairs, where the plant



(ABOVE) CHARLES E. MOHR FROM NATIONAL AUDUBON SOCIETY, (RIGHT) W. H. HODGE

SUNDEWS: STICKY TENTACLES ON THE THREADLIKE LEAVES OF DROSERA FILIFORMIS (ABOVE) AND THE ROUND LEAF OF D. ROTUNDIFOLIA (RIGHT) ENSNARE AND DIGEST INSECTS AND OTHER SMALL ANIMALS

secretes digestive enzymes. Like a greased slide, this zone sends the insect tumbling into the liquid below, which has a ready wetting power so that insects quickly become submersed and drown. The retrorse hairs at the mouth—too dense to crawl between and too stiff and downward-directed to climb over—prevent escape.

The enzymatic secretion at the bottom may be diluted by rainwater in some species in which the hood does not close the mouth of the pitcher (*e.g., S. purpurea*). Digestion is usually accomplished by the combined action of enzymes and bacteria. In one or two species bacteria may be wholly responsible for the process. The end products are absorbed by the leaves, and the indigestible chitinous coverings of the insects accumulate at the bottom until the leaf dies.

The decomposing mass of insect remains offers nourishment to certain insects. The small fly *Sarcophaga sarraceniae* lays its eggs among the remains; when the larvae hatch, they feed on the carrion for a time and then bore through the pitcher wall to pupate in the soil. These larvae are equipped with an antienzyme that protects them from the otherwise destructive digestive enzymes. The mosquito *Wyeomyia smithii* exploits the traps in a similar manner. Birds often slit open the pitchers and feed on the living larvae.

Ants, beetles, and flies seem to be the least suspecting prey of pitcher plants. Small toads, frogs, and centipedes occasionally fall victim. Tree frogs sometimes take shelter by day in the mouths, clinging to the inside walls with the suction pads of their feet. Probably, they also eat insects that come to the pitchers.

Several species of *Sarracenia* have more specialized luring devices resembling those of the next genus.

Darlingtonia.—The single species, *D. californica,* grows in wet meadows and marshes from sea level to about 8,000 ft. in the coastal belt and adjacent mountains of southern Oregon and northern California. The common name, cobra lily or cobra plant, alludes to the hood that arches over the opening of the pitcher in the manner suggesting a cobra in striking position. The curious "fishtail" landing ramp that protrudes from the mouth even suggests a tongue. Because of the domelike hood, entry has to be made from the side. Normally, the hood would darken the pitcher and discourage insects from entering. Compensating for this, however, are the numerous translucent "windows" that permit light to penetrate. The windows serve the double function of attracting insects that have entered the pitcher away from the true opening; they waste their energy trying to crawl through the translucent tissue. Eventually the insect tires, drops into the liquid below, and is decomposed entirely by bacterial action.

Heliamphora.—The 4 to 6 species of this genus are native to boggy savannahs in the Guiana Highlands of northern South America. The pitchers are constructed like those of *Sarracenia;* the inflorescence, however, differs by having more than one flower, arranged in a loose cluster, and the flowers themselves lack the peculiar umbrellalike stigma of *Sarracenia.*

Nepenthes.—The 60 to 65 species of this genus are concentrated mainly in the region of Borneo, but some are found from tropical Asia and the Philippines to Madagascar and North Australia. These vinelike shrubby plants creep over the soil or climb on vegetation, chiefly in moist rain forests but also sometimes in wet savannahs or even on dry sandy hillsides. The leaf blade narrows into a long tendril that twines around other plants. At its tip the tendril becomes transformed into a cylindrical, urn-shaped, or goblet-shaped, erect pitcher, which varies from the size of a thimble to that of a pint jar or larger (up to 20 in. long). The mouth of the pitcher has a corrugated rim, the peristome, which apparently strengthens the lip and helps to prevent the escape of insects. Large nectar-secreting glands are located among the corrugations. A lid (operculum), formed by a terminal outgrowth of the leaf, rests immobile over the mouth of the pitcher. The colour of the pitchers varies even on the same plant from yellow-green to dark green with all degrees of red markings, depending on age, light exposure, or soil conditions. The small, greenish flowers are borne in a cluster at the tip of the stem.

Insects, particularly ants, are lured to the mouth of the pitcher by numerous nectar glands scattered over the stems and leaves, including the tendrils and the inner surface of the lid. The peristome affords a perilous foothold, especially for insects trying to reach the nectar on the inner edge of the mouth. An insect that negotiates the peristome successfully, loses footing on a curious crumbly, waxy surface lining the upper half of the interior, and drops to its doom. The waxy lining has been called the conducting surface in contrast to the detentive or digestive region below, where the surface is crowded with up to 6,000 digestive glands per square centimeter. The presence of a victim stimulates secretion of a weak acid and a digestive enzyme. The nitrogenous parts are digested, and the products are then absorbed by the walls of the pitcher.

Cephalotus.—*Cephalotus follicularis,* the only species of the genus, has a pitcher about the size and shape of a large thumb, likened to a slipper with its heel upturned and serving as the lid overhanging the mouth. In addition to the pitcher leaves, the plant also has ordinary foliage leaves at its base. The flower stalk bears a cluster of small flowers.

The oval mouth of the pitcher is guarded by strong, hook-shaped claws pointing inward and downward. The lid overshadows the entrance and is provided with several translucent strips that present the insect with the illusion of a way of escape, which proves instead to guide it into the pitfall. The inner surface of the lid is lined with hairs that point toward the interior. Inside the pitcher is a thickened collar that ends abruptly in an overhanging shoulder, an effective barrier to escape. The enlarged lower portion of the pitcher has two specialized glandular areas.

Genlisea.—The approximately 10 species of this genus are tiny aquatic plants of Brazil and West Africa. The whole plant may be only a few inches high. Along with ordinary, spoonlike leaves, borne in a rosette from a short stem buried in the mud, there are trap leaves, consisting of a stalk with a bulbous, hollow enlargement. The whole trap leaf may be smaller than a thumbnail. Two arms guide minute animals (crustaceans, worms, larvae) into a tube that leads to the bulbous expansion. A series of stiff hairs and glands provide an obstacle course that the animal is unable to retrace once traveled. Digestive glands begin decomposition in the tube, and the process is completed in the bulb.

Sundews.—*Drosera.*—The centres of greatest diversity for the genus *Drosera* (about 90 species) are Australia and South Africa. There, in addition to the typical low herbaceous types, some tall species have wiry stems and climb with the aid of adhesive leaf blades. Only about a half-dozen species are found in the Northern Hemisphere. The most cosmopolitan species of the genus is *D. rotundifolia,* which grows in sphagnum swamps and bogs nearly throughout boreal and Arctic regions.

Most of the species have creeping rootstocks that terminate in rosettes of leaves and flowering stalks. Some species have leafy stems on which the flowers are borne. There are three main leaf forms: oval or rotund (*e.g., D. rotundifolia*); spoon-, club-, or strap-shaped (*e.g., D. intermedia*); and thread- or wirelike (*e.g., D. filiformis*). The leaves of the wide-ranging *D. rotundifolia* resemble tiny mittens or catcher's gloves.

In summer a sundew sends up a slender, arching flower stalk, bearing from 1 to 20 erect flowers that open only in sunlight. The stalk averages from 6 to 8 in. but may reach a foot or more. The flower measures up to an inch across in most species, with petals varying from white to pink or even deep red, depending on the species.

All species catch their prey by means of flexible tentacles on the upper surface of the leaf. As many as 400 tentacles have been counted on a leaf of *D. rotundifolia* about a centimetre in diameter. The tentacles are really stalked glands whose globular heads secrete a clear, sticky mucilage. Some of the cells of the glands have purplish sap, which shines through the mucilage and gives the glandular heads of the tentacles a glistening red appearance in sunlight that seems to attract insects. This dewlike glimmer on the leaves gives the plants their common name, sundew.

Several naturalists discovered in the latter part of the 18th century that sundews can capture insects, but the first real experimental studies were not made until about a century later. Charles Darwin's classic experiments, which stand as the most extensive ever carried out on these plants, confirmed what simple observations had shown: the tentacles were capable of motion. The movements of the tentacles are complex, but the net result is to bring the body of the prey toward the middle of the leaf blade, which, in the case of the broad-leaved species, can itself bend around the prey.

When a gnat or mosquito lands on the leaf, the alluring mucilage becomes the first snare, smearing and smothering the insect. Struggling only stimulates more secretion. Within minutes the inner tentacles bend inward and gradually pin down the insect. Soon the outer tentacles, which become successively longer toward the edge of the leaf, also begin to curl inward. In a matter of minutes or hours, depending on the species and amount of stimulation, the insect is hopelessly engulfed by a web of sticky stalks.

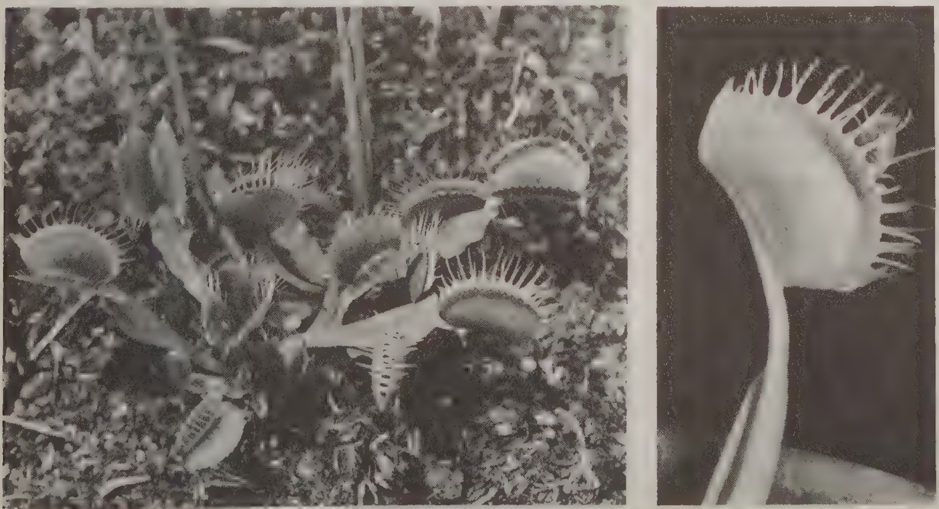
Bending and unbending are caused by differential rates of rapid growth. When the outer cells of the tentacles grow faster than the inner, incurving results. The tentacles straighten again when the inner cells grow faster. As a growth response, the action of the tentacles naturally has limits. Darwin found that bending and unbending could be repeated only about three times by any one tentacle.

The struggling of the insect also stimulates the tentacles to secrete a digestive enzyme that breaks down the nitrogenous materials in the insect body. The end products are absorbed by the same glands. Upward of a week or more may elapse before the leaf reopens and the trap is reset. The mucilage is antibacterial, and digestion is entirely enzymatic.

Flytraps.—*Dionaea.*—Venus's, or Venus, flytrap (*D. muscipula*) is surely the most remarkable carnivorous species known to science. Darwin called it the most wonderful plant in the world. It is found only on the coastal plain and adjacent Piedmont of North Carolina and South Carolina. Arthur Dobbs, colonial governor of North Carolina, first discovered the "Fly Trap Sensitive," as he called it, but his report of 1760 lay buried for 75 years. Linnaeus, provided with a description by the English amateur botanist John Ellis, first brought this plant to the attention of scientists. Both Ellis and Linnaeus were aware of the sensitivity of the leaves, but Linnaeus did not agree with Ellis that the plant caught insects.

The Venus's flytrap is a small perennial herb with a basal rosette of leaves and a flowering stalk up to a foot high with 2 to 15 white flowers similar to those of *Drosera.* The leaf is divided into a blade and a prominently winged petiole, narrowing to a slender isthmus at the base of the blade. The blade consists of two identical semicircular valves, or lobes, united along the middle by a thick midrib and standing at an angle to each other of about 50°. Together they constitute a hinged trap. The outer margin of each lobe is provided with a comb of long bristles, about 13 in number, that interlock like fingers when the trap closes. The leaf is from 2 to 6 in. long, and the expanded blade is only about an inch or two across.

On the face of the lobes are numerous nectar and digestive glands. The digestive glands, which become especially active after prey is caught, contain a red sap that gives the whole sur-



(LEFT) VIRGIL N. ARGO, (RIGHT) HUGH SPENCER FROM NATIONAL AUDUBON SOCIETY

VENUS'S FLYTRAP: (LEFT) A BASAL CLUSTER OF LEAF TRAPS IN DIFFERENT STAGES OF CLOSURE; (RIGHT) A TRAP CLOSED ON AN INSECT face a red cast. In the middle of each lobe are three trigger hairs, which are very sensitive to unequal pressure, such as that provided by insects when they brush past in search of nectar. The chief, though not the only, sensitivity of the blades resides in these hairs. Two stimuli are usually required to spring the trap, the second not less than 1.5 seconds nor longer than 20 seconds after the first. Either the same hair may be struck twice, or two different hairs may be struck once each. This causes the trap to spring shut in a fourth of a second at normal daytime temperatures. If the prey has been captured, the clamping movement continues slowly until the surfaces of the lobes press tightly against the body.

The trap can be sprung by a mechanical stimulation, such as with a pencil, but enzyme flow can be stimulated only by the presence of a trapped insect or other proteinaceous material (egg white, raw meat).

An insect is digested in about 10 days, after which the lobes reopen and the trap is ready for another catch. The absorption of the nitrogenous breakdown continues until only the dried exoskeleton remains; it is carried away by rain or wind when the trap reopens.

The mechanism of the opening and closing is not well understood. It involves growth in some way and can only be repeated about three times before maturity. Electrical disturbances, likened to those that occur in muscle stimulation, have been observed by some experimenters.

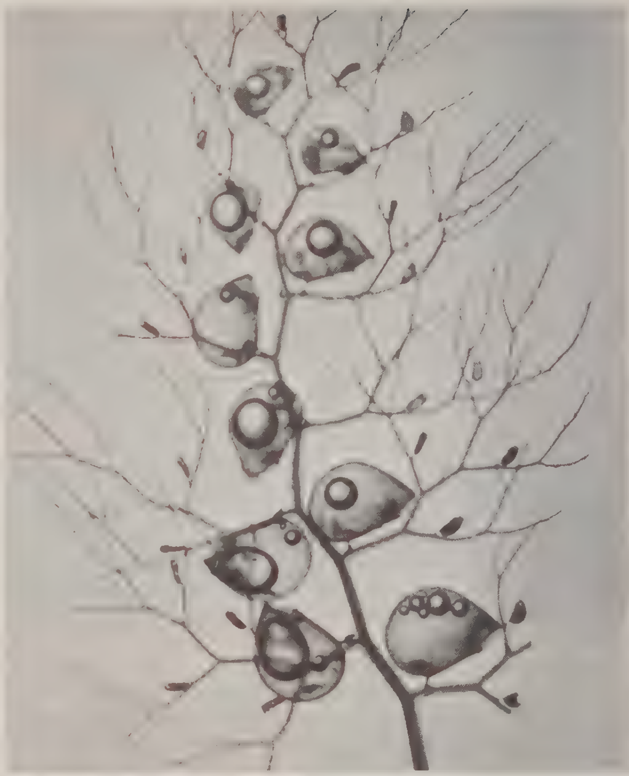
Aldrovanda.—The single species, *A. vesiculosa,* is a small (about 3 in. long) free-floating freshwater plant widely distributed from Spain to Japan and south to Mozambique, East Africa. The fingertip-sized leaves, miniatures of the Venus's flytrap kind, are attached to the stem in whorls of eight. The mechanism of closing is more or less analogous to that of Venus's flytrap. The number of stimuli required depends on the age of the leaf. Small insects, larvae, copepods, etc., that spring the trap are locked in an ovate hollow formed when the two lobes snap together. Digestive juices are released by glands lining the lobes.

Bladderworts.—*Utricularia.*—The large genus *Utricularia,* to which nearly all the bladderworts belong, reaches all quarters of the world, spanning latitudes from Greenland to South Africa. The bulk of the species, however, are found in tropical regions, and only about a dozen species occur in North America and about four species in Europe. Some species are aquatic, some terrestrial, and still others occur both on land and in the water. A few are epiphytic, in the manner of orchids. The plants vary in size from almost microscopic to a yard or more long. The largest aquatic species, *U. vulgaris,* is probably the most cosmopolitan, ranging throughout the boreal region. The land species usually recline, except for their erect flowering stalks, on wet sand, mud, or moss.

Utricularia species lack true roots. The plant body consists of a horizontal stem that bears usually much dissected leaves, especially among the aquatic species. The leaves have small, bearded vesicles that were long thought to be flotation devices. However, they occurred in both land and aquatic forms. Subsequent investigations showed them to be carnivorous traps. It is these bladders that give species of *Utricularia, Biovularia,* and *Polypompholyx* their common name.

The flowers, with fused petals, are white, yellow, blue, purple, or even crimson. They are 2-lipped, with the lower lip projecting downward as a spur. The throat is of the personate type, closed by a palate.

The trap differs in details from one species to another, but it can be described in simple terms for the common bladderwort, *U. vulgaris.* The trap of this species is 2 to 3 mm. across, flattened and pearshaped; it is attached to the plant by means of a stalk on one side. The mouth is at the narrow end. At the edge of the mouth are several branched antennae, and along the sides occur a number of long slender bristles. These antennae and bristles form a tunnel that guides the prey to the mouth of the bladder. The entrance is guarded by a small door attached above and hanging downward over the mouth, swinging free at the bottom. The bottom edge rests firmly against a semicircular collar or threshold. The outer surface of the door has many stalked glands, some of which secrete mucilage and others a sugary substance that presumably lures the tiny aquatic animals. This outer surface also bears four stiff bristles near the lower free edge, which constitute the tripping mechanism.



HUGH SPENCER FROM NATIONAL AUDUBON SOCIETY

AQUATIC BLADDERWORTS (UTRICULARIA), WITH FINELY DIVIDED LEAVES AND BAGLIKE TRAPS

When the trap is in the "set" position, the door is closed, and the trigger hairs are in position. The bladder is almost free of water, and the elastic sides are straight or concave. When a passing small crustacean (*e.g., Daphnia, Cyclops*) or other small organism brushes past the trigger hairs, the trap springs in the following manner. Purely by mechanical movement, the hairs distort the bottom edge of the door and cause it to swing clear of the threshold, while at the same time the bladder walls expand outward as the water rushes in, sweeping the animal with it. The bladder is now distended, and the trap is sprung or in the lax condition. Specialized cells on the ends of special hairs on the inside walls of the bladder are able to absorb the excess water and pass it out through the wall. Digestion is accomplished quickly. The trap gradually sets for another catch, taking from 15 to 30 minutes in *U. vulgaris* and up to two hours in other species. Whether digestion is accomplished by bacteria or enzymes or both is not fully established. Presumably, the nitrogenous products are absorbed by specialized cells in the walls of the bladder. Hard animal parts remain in the bladder. Some microscopic organisms (*e.g., Euglena*), apparently immune to digestion, thrive within the traps, living off the readily available food.

Butterworts.—*Pinguicula.*—The approximately 35 species of *Pinguicula* are distributed throughout the Northern Hemisphere and range down the Andes to Patagonia, in bogs and wetlands. Their leaves are greasy or soapy to the touch, whence the name butterwort. Their flowers, sometimes no bigger than a housefly, are similar to those of violets, whence the other common name, bog violet.

Oval or tongue-shaped leaves, several inches long, are borne in a compact rosette that lies flat on the ground. The edges curl inward above. One to several slender flowering stalks up to a foot high may arise, each bearing a single white, yellow, or violet flower. The leaf forms a shallow pan that becomes covered by a thin film of colourless mucilage, secreted by glands scattered abundantly over the upper surface. Another type of gland secretes digestive enzymes. Prolonged pressure by a solid body, such as a grain of sand or small animal, causes slow incurling of the leaf margins and stimulates secretion of the ensnaring mucilage. If the captive is nitrogenous, digestive juices are secreted.

A small insect (midge, aphid) landing on the leaf will quickly be glued fast. Struggling increases secretion and causes the sensitive margins to inroll. Small insects become completely entombed; larger ones are pushed toward the centre into the deepest part of the pan by the moving edges. The incurling may require several hours to a day. After 24 hours or more, when the digestive products have been absorbed, the leaf re-expands to its original position.

Bibliography.—C. Darwin, *Insectivorous Plants* (1875); F. E. Lloyd, *The Carnivorous Plants* (1942); S. G. Shetler, and F. Montgomery, *Insectivorous Plants,* Smithsonian Information Leaflet No. 447 (1965). (S. G. Sh.)

CARNOT, LAZARE NICOLAS MARGUERITE (1753–1823), French military engineer and statesman whose services to the Revolutionary armies won him the name of "the Organizer of Victory," was born on May 13, 1753, at Nolay in Burgundy, the son of a lawyer. He passed second into the Mézières school and became captain in the engineers in 1783. In 1784 his *Éloge de Vauban* won the award of the Dijon academy; and in 1786 he combated the views of the marquis de Montalembert (Marc René) on Vauban's system of fortification. He had been living at Arras from 1780 and was a colleague of Maximilien de Robespierre in the Arras academy. He married Sophie Dupont at St. Omer in 1791 and was elected to the Legislative assembly as deputy for the Pas-de-Calais. He sat on the left and was prominent in the military committee. He was one of the first deputies to be sent to the armies. On Aug. 11, 1792, the day after the attack on the Tuileries, Carnot and his friend C. A. Prieur-Duvernois (Prieur de la Côte-d'Or) were sent to secure and in fact to "purge" the army of the Rhine. Election to the Convention followed, and then a mission to Bayonne to study defense against Spain (he was to retain his interest in the eventual army of the West Pyrenees). Returning in Jan. 1793 for Louis XVI's trial, he voted death without appeal or postponement. In March he went to the army of the North, escaped by accident from C. F. Dumouriez (*q.v.*) and organized Lille and Douai against him before turning to his special point of interest, Dunkerque. On Aug. 14 he became member of the committee of public safety, and the relief of Dunkerque was the immediate objective.

In the committee, Carnot was in charge of military affairs, aided by Prieur with the war material, but was far from being in control. At the ministry of war were Noël Bouchotte and his secretary-general Nicolas Vincent, members of the extreme left—Hébertists whom Carnot detested as "anarchists." When Dunkerque had been relieved by J. N. Houchard and J. B. Jourdan, Carnot had to sacrifice Houchard to Vincent's enmity as Gen. A. P. de Custine had been sacrificed to Bouchotte's. The new general, Jourdan, was Bouchotte's nominee, and on Sept. 28 Carnot went himself to join him in the army of the North. Carnot and Jourdan had so little experience of operations that it is impossible to say which of the two won the battle of Wattignies. Carnot's increased prestige was reflected by the appearance of new generals: Lazare Hoche, Joseph Souham and J. V. Moreau, all of whom had been at Dunkerque; Charles Pichegru and Barthélemy Schérer, who were regulars on the Rhine; and J. B. Kléber and François Marceau, replacing the "anarchist" generals in the west. By the end of 1793 Carnot could plan the victorious campaign in Flanders of 1794 and, with Robespierre, the liquidation of the ministry of war.

Carnot dismissed both Bouchotte and Jourdan, but his own position was challenged by his colleague Antoine de Saint-Just in the feud between generals Hoche and Pichegru, and in spring 1794 the success of the plan of campaign in Flanders was precarious. Carnot had not the power to combine operations and disliked a single unified command, no doubt on political grounds. But the long line of divisions along the northern frontier gradually coalesced into two masses, and their numbers prevailed. Jourdan's victory at Fleurus (June 26, 1794) gave Carnot the unwelcome prospect of a conquest of the Netherlands and the consolidation of the army of Sambre-et-Meuse under Jourdan.

A month later Carnot's own colleagues were destroyed by the revolution of Thermidor, and he was in danger, for he disliked the Thermidorians almost as much as the "anarchists." He disavowed Robespierre, quoting the retort to his own plea for humanity: "What is the importance of 6,000 men when the case is one of principle?" He urged that public opinion should not give weight to "some signatures to acts which are regarded as reprehensible." He released imprisoned generals, many of them his own friends, and restored the credit of the regular officers and regiments of the line. Three months after Thermidor he gave the Convention the list of glory: "In 17 months' campaign 27 victories, 80,000 enemy killed, 116 places taken, 90 flags . . . ," adroitly including successes in eastern Spain and in Italy in which he had little personal part. In his last speech from the committee he again recalled the victories; then, on leaving the committee, he was at last promoted major in the engineers (March 21, 1795). In the Convention, however, he was constantly attacked as a terrorist and a vote for proscribing him came nearer until the debate of May 28, when the famous phrase was uttered, as reported in the *Moniteur:* "A member: 'Carnot has organized victory.' (Great applause)."

Carnot had escaped and he was not exiled from power for long. In Sept. 1795 he was chosen by 14 *départements* in the elections under the new constitution, and on Nov. 2 he was elected a member of the Directory. The next two years were the least satisfactory of his career: he could not dissociate himself from the other directors, and the generals were now strong enough to reject his plans. His two principal military operations, the campaign of Jourdan and Moreau in Germany and the Irish expedition of Hoche ended in failure—redeemed by the Italian victories of Napoleon Bonaparte which he did not plan. Politically, his past pushed him to the right farther than he wished to go, but he could not make the royalists his allies, and at the *coup d'état* of Fructidor (Sept. 1797) he had no support. All parties were glad that he escaped to Switzerland. His rejoinder from exile was effective: "Could anyone who had known me in the old days, solitary, preoccupied, a kind of philosopher, indeed an 'original', ever believe that after taking part in founding the most majestic of republics I would amuse myself by pulling it down?"

Carnot was still a lone figure when he returned to the better atmosphere of the consulate. Napoleon preferred him to the liberals. He worked with L. A. Berthier in the ministry of war and was minister for six months in 1800, dealing directly with his former protégé Moreau. He sat in the *tribunat* until 1807 but he voted against the consulate for life, and the Legion of Honour. He remained a member of the Institut and returned to his early studies in fortification. After two technical works in geometry he published *De la défense des places fortes* (1810), which influenced fortification for three generations. It was by appeal to this side of his varied talents that Napoleon after several attempts brought him back to service in Jan. 1814 as general of division and governor of Antwerp. Carnot secured the fortress when it was about to fall and held it to the peace. His conduct did him honour and his name had been useful in the last effort of the empire.

At the Restoration, Louis XVIII saw Carnot as a regicide wearing the king's own decoration of St. Louis, and would not speak to him. During the Hundred Days his republican patriotism suited the last phase of Napoleon's rule and he was minister of the interior. Once again Napoleon was using the effect of Carnot's name, but after Waterloo he gave him the compliment which was his last honour: "Monsieur Carnot, I have known you too late."

On Napoleon's abdication Carnot headed the provisional government of France until he was ousted by Joseph Fouché. Louis XVIII proscribed him and exiled him as a regicide. He died at Magdeburg in Prussian Saxony on Aug. 2, 1823.

There is an edition of his *Correspondance,* from Aug. 1793 to March 1795, by E. Charavay, 4 vol. (1892–1907). (I. D. E.)

CARNOT, (MARIE FRANÇOIS) SADI (1837–1894), French statesman, was fourth president of the Third Republic. The son of Lazare Hippolyte Carnot, he was born at Limoges on Aug. 11, 1837. Educated as an engineer he distinguished himself at both the École Polytechnique and the École des Ponts et Chaussées, and was appointed to the civil service. His hereditary republicanism recommended him to the government of national defense, by which he was entrusted during the Franco-German War in 1870 with the organization of resistance in the *départements* of Eure, Calvados, and Seine Inférieure, serving also as prefect of the last in 1871. In the same year he was elected deputy for the Côte-d'Or. In 1878 he was appointed secretary to the minister of public works, and in 1880 he became minister. After appointment as minister of public works in 1885, he became almost immediately minister of finance, remaining until 1886. On the fall of Jules Grévy in 1887 as a result of the scandal of Daniel Wilson's traffic in honours, Carnot was elected president of the republic. The republic was under strong attack by Gen. Georges Boulanger (*q.v.*). President Carnot's part during this agitation was mainly confined to augmenting his popularity by well-timed appearances on public occasions, which gained credit for the office of the presidency and for the republic. After Gen. Boulanger's fall and exile in 1889, President Carnot appeared as head of the state on two noteworthy occasions: the celebration of the anniversary of the Revolution and the opening of the Paris Exhibition. The popular success of both was regarded as a ratification of the republic, and though Carnot's administration was harassed by the formation and dissolution of many ministries, by Socialist outbreaks, and by the beginnings of anti-Semitism, his only serious crisis came with the Panama Canal scandals of 1892. These redounded against the prestige of the state but increased, if anything, the respect for Carnot's integrity. He was seemingly at the zenith of his popularity when on June 24, 1894, after delivering a speech at a public banquet in Lyons apparently indicating his unwillingness to seek reelection, he was stabbed by an Italian anarchist, Sante Caserio, and died almost immediately.

Carnot was buried in the Panthéon.

CARNOT, (NICOLAS LÉONARD) SADI (1796–1832), French physicist, made important contributions to the study of heat. He was born at Paris. Admitted to the École Polytechnique in 1812, late in 1814 he left with a commission in the engineers. He became captain in the engineers in 1827, but left the service altogether in the following year. He died of cholera in Paris on Aug. 24, 1832. He was an original and profound thinker. The only work he published was his *Réflexions sur la puissance motrice du feu et sur les machines propres à développer cette puissance* (1824). This contains but a fragment of his scientific discoveries, but it is sufficient to put him in the very foremost rank, though its full value was not recognized until pointed out by Lord Kelvin in 1848 and 1849. Fortunately his manuscripts had been preserved, and extracts were appended to a reprint of his *Puissance motrice* by his brother, L. H. Carnot, in 1878. These show that he had not only recognized the true nature of heat, but had noted down for trial many of the best modern methods of finding its mechanical equivalent, such as those of J. P. Joule with the perforated piston and with the friction of water and mercury. Lord Kelvin's experiment with a current of gas forced through a porous plug is also given. "Carnot's principle," that the efficiency of a reversible engine depends on the temperatures between which it works, is fundamental in the theory of thermodynamics. *See* also HEAT: *Carnot: On the Motive Power of Heat.*

CARNOTITE, a radioactive mineral that is an important source of uranium, was first described in 1899 and named after Marie-Adolphe Carnot (1839–1920), French mining engineer and chemist. It is a hydrated vanadium salt of potassium and uranium. Pure carnotite contains about 53% uranium and 12% vanadium and trace amounts of radium. It is canary to lemon-yellow and occurs as a powder of loosely coherent microcrystalline aggregates, rarely as crusts of imperfect platy crystals; it is chiefly disseminated in sandstone or locally as small pure masses, especially around petrified or carbonized tree trunks or other vegetal matter. Carnotite is of secondary origin and has formed by alteration of primary uranium-vanadium minerals. Commonly associated with carnotite is the calcium analogue, tyuyamunite, also known as calciocarnotite.

Carnotite is the most important of the secondary uranium ore minerals, having provided most of the uranium production from secondary deposits; it is also mined for both vanadium and radium. From 1911 to 1923 ores containing carnotite were intensively mined in Colorado for radium. From 1937 to 1943 carnotite was again mined, but primarily for vanadium. After World War II it became one of the most important ore minerals of uranium (*q.v.*) mined extensively in the United States. The greatest known concentration of carnotite deposits is in the western United States, particularly in the Colorado plateau area. Within the plateau, the Uravan belt in western Colorado, the San Rafael swell area in Utah and the Grants district in New Mexico are the principal mining areas. Other deposits are found in Wyoming, South Dakota and Pennsylvania. Although carnotite has been found in small quantities at a large number of localities throughout the world the only known commercial deposits, other than those in the United States, are in the U.S.S.R. Scattered deposits occur around the towns of Kokand and Ferghana in the southwestern part of Siberia near the borders of Afghanistan, India and Sinkiang.

Carnotite crystallizes in the monoclinic system as platy or lathlike crystals which are usually microscopic in size. The mineral is soft with a dull or earthy lustre and has a specific gravity between 4 and 5.

See C. Palache *et al., Dana's System of Mineralogy,* vol. ii, 7th ed. (1951); C. Frondel, *Systematic Mineralogy of Uranium and Thorium,* U.S. Geological Survey *Bulletin 1064* (1958). (R. G. C.)

CARNUNTUM, at Petronell, 20 mi. E of Vienna, the most important legionary camp on the upper Danube frontier of the Roman Empire. The position was also a starting point for the amber route to the Baltic at least as late as A.D. 65. Originally a Celtic town in the kingdom of Noricum, it was the emperor Tiberius' base for attacking the Marcomanni in A.D. 6 and soon received an earth fort for one legion, being added to the province of Pannonia. A stone camp was constructed about A.D. 73. The *legio XV Apollinaris* garrisoned it until about A.D. 114, and after that the *legio XIV Gemina.* The emperor Marcus Aurelius resided there during his campaign against the Marcomanni (171–173), when he wrote part of his *Meditations.* Lucius Septimius Severus, governor of upper Pannonia, was acclaimed emperor in the camp in 193. In 308 an important conference was held there between the emperor Diocletian and his colleagues. After destruction by barbarians the camp was rebuilt in 375, but was finally burned about 400. The adjoining settlement (*canabae*) was made a municipium (*q.v.*) by the emperor Hadrian and given colonial status by Lucius Septimius Severus. (G. E. F. C.)

CARNUTES, a Celtic tribe of central Gaul between the Sequana (Seine) and Liger (Loire) rivers, whose chief towns were Cenabum (Orléans) and Autricum (Chartres). In the 1st century B.C. they were dependents of the Remi who were friendly to Rome, but they broke with Julius Caesar in 53 B.C. and were the first state to move in the great rebellion next year, murdering the many Roman traders at Cenabum. Caesar retaliated by burning the town and massacring its inhabitants, but the tribe still had 12,000 men under arms in the later fighting of 52, and again gave trouble to Caesar in 51 by attacking their neighbours the Bituriges. Under the empire the Carnutes had the privileged status of *civitas foederata* (*see* MUNICIPIUM). Cenabum was made an independent *civitas* by the Roman emperor Aurelian in A.D. 275, and named *urbs Aurelianensis* (whence Orléans).

See T. Rice Holmes, *Caesar's Conquest of Gaul,* 2nd ed. (1911). (G. E. F. C.)

CARO, ANNIBALE (1507–1566), Italian poet admired for his elegant style, was born in Civitanova, in the Marche, on June 19, 1507. He was secretary to Msgr. Giovanni Gaddi in Florence and then in Rome, where in 1542 he passed into the service of Cardinal Pier Luigi Farnese. Only late in life did he acquire an independent livelihood. He died in Rome on Nov. 21, 1566.

As a lyric poet, Caro does not differ from the many contemporary imitators of Petrarch: his *Canzoniere,* containing about 100 sonnets, 5 *canzoni* and 1 *canzone* for music, is coldly academic. His satires, of which the *Nasea* is the best, belong to a literary genre already well established by Francesco Berni, and his ten polemical sonnets, *Mattaccini,* although vigorous, also conform to tradition. His *Lettere familiari* have been considered his masterpiece because of their liveliness of style. His free translation of Virgil's *Aeneid* was written to show the high standard reached by the vernacular language. Linguistically, stylistically and metrically, it is outstanding; it is written in *endecasillabi sciolti,* which became one of the classical metrical forms of Italian poetry. His *Straccioni* (1544), is one of the most original comedies of his time, being based on direct observation of popular life in Rome.

See, for a well-documented study of Caro's life and works, V. Cian's introduction to Caro's *Scritti* (1912). *See* also *Comedia degli Straccioni con una nota di B. Croce* (1949). (G. A.)

CAROB, also called LOCUST or ST. JOHN'S BREAD in reference to the belief that the "locusts" upon which John the Baptist fed were actually carob pods. It is a leguminous tree, *Ceratonia siliqua,* native to the eastern Mediterranean region and introduced elsewhere, grown as an ornamental and for the edible pods. The carob, reaching 50 ft. in height, has pinnate, glossy, evergreen leaves with thick leaflets. The yellow or red flowers, borne in racemes along the branches, are without petals and are unisexual or perfect. The flat leathery pods, 3–12 in. long, contain from 5 to 15 hard, brown seeds in a sweet pulp. The primary use of carob pods, which contain about 50% sugar, is for stock food, but they are also used as food by man, especially in times of scarcity.

Gum extracted from carob seeds is used much like gum tragacanth in various industries (textile, food, pharmaceutical, leather, rubber, cosmetic, etc.). One thousand pounds of carob pods yield about 100 lb. of seeds, from which 35 lb. of gum can be obtained. The gum-bearing tissue of the seed, removed by special machinery, is then roasted and extracted in boiling water. The liquor is evaporated, and the dried residue, carob gum, is powdered. Carob gum is imported into the U.S. from several European countries. (J. W. TT.)

CAROL I (1839–1914), first king of Rumania, was born on April 20, 1839, the second son of Prince Charles Antony of Hohenzollern-Sigmaringen, head of the south German and Catholic branch of the Hohenzollerns. His mother was the daughter of the grand duke Charles of Baden and of Stéphanie de Beauharnais. Educated at Dresden and at Bonn, Prince Charles (Karl Eitel), as he was called before he went to Rumania, became an officer in the Prussian army and served against Denmark in 1864. The leaders of the newly united principalities of Moldavia and Walachia (*see* RUMANIA: *History*), balked of their original desire for a foreign prince, looked abroad again after the overthrow of Alexandru Cuza and, failing the Belgian prince Philippe comte de Flandre, offered the throne to Charles, with the tacit approval of Napoleon III. By a plebiscite held in Rumania on April 20, 1866, Charles was almost unanimously elected prince; he had to be smuggled into the country because of the hostility of Russia, Austria and Turkey, but rapidly gained general recognition. Given wide powers under the constitution of July 11, 1866, he showed great tact in dealing with the struggles between the Liberal and Conservative parties, and his administrative, economic and military reforms earned him deep respect at home and abroad.

In 1869 he married Elizabeth (*q.v.*), daughter of Prince Hermann of Wied and a Lutheran; he had already undertaken to educate his children in the Orthodox faith, despite papal disapproval. The sympathy of Rumanians with France in the Franco-German War led to a wave of hostility against the German prince, which, coinciding with a railway scandal, led him to offer abdication. With difficulty persuaded to remain, Carol was later to win great popularity when he led a Rumanian and Russian contingent to victory at Pleven (Plevna) in the Russo-Turkish War of 1877–78. As a consequence of his vigorous action, Rumania secured recognition from the powers of its complete independence of Turkey in 1880 and was proclaimed a kingdom on March 26, 1881, Carol and his consort being crowned on May 22. As king, Carol proved most successful in home policy, greatly improving the financial and military position of his country. He and the queen, who became known as a poetess under the name of Carmen Sylva, gave special encouragement to the fine arts. In foreign policy Carol remained true to Germany, concluding a secret treaty with the Central Powers in 1883; the failure of Rumania, still Francophile, to implement that treaty in Aug. 1914 broke him down. On Oct. 10, 1914, he died in his palace at Sinaia. As the only child of his marriage, a daughter, had died in 1874, the succession was settled on his brother Leopold's son, who became Ferdinand I of Rumania.

See the official biography, *Aus dem Leben König Karls von Rumänien,* 4 vol. (1894–1900; abridged Eng. trans., 1899); also D. A. Sturdza, *Charles Ier roi de Roumanie: chronique, actes, documents,* 2 vol. (1899–1904). (B. BR.)

CAROL II (1893–1953), king of Rumania, was born at Sinaia on Oct. 15 (new style; Oct. 3, old style), 1893, the eldest son of King Ferdinand I (*q.v.*) and Queen Marie. He received a German military education at Potsdam but returned to Rumania when World War I broke out. He became crown prince on the death of his great-uncle Carol I in Oct. 1914. In 1918 he contracted a morganatic marriage to Zizi Lambrino, an officer's daughter, by whom he had a son, but this marriage was dissolved, and in March 1921 he married Helen, daughter of Constantine, king of the Hellenes. Carol and Helen had one son, Michael (Mihai), born in 1921, but their marriage was not a happy one. In 1925 Carol was obliged to abdicate his rights to the throne and went into exile—largely at the instigation of the Liberal party led by Ion Brătianu—on account of the scandal caused by his liaison with Magda Lupescu. He was also excluded from the Rumanian succession by an act of Jan. 4, 1926, which was confirmed in the will of King Ferdinand, who died on July 20, 1927. The young Michael was then proclaimed king under the regency council that had been set up in 1926 in view of King Ferdinand's ill-health.

Princess Helen, who had stayed in Rumania as her son's guardian, was persuaded by the Liberals to obtain a divorce (June 1928) in order to bar the way to Carol's return. The regency, however, proved unpopular, and the political opponents of the Liberals were regularly in touch with Carol during his exile in England and France. Finally in 1930 the National Peasant government under Iuliu Maniu invited him to return. Carol was offered a place in the regency provided that he would break with Magda Lupescu, but he was determined to become king and took the oath as such on June 8, 1930. Attempts at a reconciliation with Princess Helen failed, and Magda Lupescu returned in 1931.

From the first King Carol sought to establish his own power by undermining the political parties. To that end he at one time encouraged the Iron Guard (*see* RUMANIA: *History*). In Feb. 1938, however, alarmed at the Iron Guard's predominance, he proclaimed a new constitution and set up a personal dictatorship. After the outbreak of World War II he was unable to resist territorial and political demands on Rumania by Germany and the U.S.S.R. and incurred such unpopularity that he abdicated for the second time in favour of his son on Sept. 6, 1940, going again into exile. In July 1947, in Brazil, he married Magda Lupescu, who was thought to be dying. Carol died at Estoril, Port., on April 4, 1953. (B. BR.)

CAROL, in general usage, means a song, sometimes loosely a hymn, characteristically of religious joy, associated with a particular season of the year, especially Christmas. More particularly, the word is used of a late medieval English song on any subject "made up of uniform stanzas, and provided with a burden [an external refrain], which begins the piece and is to be repeated after each stanza" (R. L. Greene; see *Bibliography*).

In the Middle Ages the words *carol* and *carole* (in continental French and Anglo-Norman) were used to mean: a popular dance-song with pagan associations, a courtly dance or dance-song, a song of popular piety, a polyphonic song in a certain style, and a popular religious procession. In the golden age of the English carol (*c.* 1350–*c.* 1550) the second definition covers the majority of those songs that may properly be called carols; but the formal category (consisting of burden, verse^1, burden, verse^2 . . . burden) is not in itself sufficient to describe the carol, which seems to have crystallized in the early 14th century essentially as a popular religious song.

The medieval carol is the English member of a European family of popular religious songs, among them the Spanish *Cantigas de Santa Maria*, the German *Geisslerlieder*, the Italian *laude spirituali*, and the French *noëls*. Each of these is originally a monophonic (*i.e.*, one-voiced) song with words in a popular, direct, vernacular style; the tunes tend toward balance, brevity, and catchiness; in many cases the alternating burden-verse form of the carol is also used. There are reasons for thinking that the English carol was also originally, and remained essentially, a monophonic song: a handful of carol tunes survives, including two lullaby-carols, the macaronic (*i.e.*, in two languages) *"Nova, nova: Ave fit ex Eva,"* and "Nowell: Tidings true"; a few carol texts without music name tunes ("and I were a mayd," "bryd on brere," etc.); and many refer to the song and the singer.

More than 500 carol texts survive from this period, and most are popular religious songs. Their main theme is praise of the Virgin Mary, the Infant Christ, the saints whose feast days are celebrated in the week after Christmas—SS. Stephen, John, and Thomas of Canterbury—and the Innocents. They are, in fact, Christmas carols. There are very few medieval Passiontide or Easter carols, but some texts survive of religious and moral counsel, death, and doomsday, with some miscellaneous amorous, satirical, or topical texts. The spirit of the religious carols is very like that of the mystery plays (*see* Drama: *Medieval Drama;* Theatre: *The West: Christian Revival*); *i.e.*, the mood ranges from the matter-of-fact to the tender, and from stern admonition to penitent appeal. The versification shows skill, ingenuity, and assurance. An example illustrating some of these points follows:

Burden: *Laus, honor, virtus, gloria*
Et tibi decus, Maria.
Verse: A songe to syng Y haue good ryght,
And myrth to make in this presens,
For now ys borne a baron of myght,
Mundum pugillo continens.

The contrast here between the homeliness of the vernacular and the stately liturgical Latin is characteristic of the macaronic carol. Earthly rejoicing in heavenly mysteries is especially a feature of Franciscan spirituality. The *jubilo del core* ("heart's rejoicing") of the Italian *laude spirituali* (13th–14th centuries; *see* Italian Literature: *The Beginnings*) is perhaps sunnier than the "merthe" of the English carol; but both were inspired by St. Francis and his followers. The names of William Herebert and James Ryman are among those that link the carol with the movement for religious teaching in the vernacular and the missionary zeal of the Franciscans. The close connection between carol and mystery play is shown by the two carols in the Coventry Corpus Christi plays, and by the survival in folk song (as, for example in the "Cherry-Tree Carol," not written in the set burden-verse form) of scenes treated in the plays.

During the 15th century the carol developed in two ways. While continuing in the main tradition as a popular, religious, monophonic song, it developed musically and as a literary form. Musically, the carol is the most important English *forme fixe* ("fixed form"), comparable to the French *rondeau, virelai,* and *ballade.* The 15th-century carol repertory is one of the most substantial monuments of English medieval music. It survives in four manuscripts: the Trinity Roll, the Selden MS, the Egerton MS, and the Ritson MS. The earliest carols, in a long vellum roll at Trinity College, Cambridge, are mainly for two voices; the latest, in the Ritson MS (British Museum Add. MS 5665), are for two and three. In these the musical form is often elaborated—a burden for two soloists is followed by another for three-part chorus, and the two-voice verse may be punctuated by a choral refrain. The rhythmic style of the early carols is straightforward: modern $\frac{6}{8}$ time, with a strong lilt emphasized by the words, which are subordinated to the music. In the mid-15th-century sources, the Selden MS (Oxford, Bodleian MS Selden b. 26) and the Egerton MS (B.M. Add. MS 3307), the basic rhythm is $\frac{3}{4}$ with many cross-rhythms ($\frac{6}{8}$ and $\frac{3}{2}$). The upper part or parts are more elaborate than the tenor (*i.e.*, the bottom part) which usually seems to carry the tune, as in the famous "Agincourt Carol" (Trinity Roll). As in other music of the period—the Burgundian *chanson,* for example—the chief musical interest of these carols is not harmonic but melodic and rhythmic. The musical development of the carol takes a new turn at the end of the 15th century. The Fayrfax MS (B.M. Add. MS 5465) contains elaborate carols, mostly on themes connected with the Passion, and written for three or four voices in a flexible, sophisticated style based on duple rhythm, in which the dramatic nature of the words often decisively determines the musical effects. In this period (roughly during the reign of Henry VII) the composers are often named—William Cornish, Robert Fayrfax, John Browne; the Fayrfax MS is a court song-book. A decade or two later we find the only surviving examples of what may be called the court carol: in the so-called Henry VIII's MS (British Museum Add. MS 31922) light songs of apparently popular origin appear in simple versions by court composers—for example, Henry VIII's own "Green groweth the holly."

The musical carol is emphatically professional music written by professional composers for professional choirs, such as that of the Chapel Royal. The professionalism of the literary carol is less easily identified and defined; but again it manifests itself in the sophisticated use, by clerkly and courtly writers, of a style simple in origin: the structure of the verse is lengthened and elaborated (James Ryman uses the rime royal, *q.v.*); and the vocabulary becomes more ornate in accordance with contemporary literary fashion. The increasingly sophisticated literary treatment of the carol form does not, however, form a cultural phenomenon of similar importance to that of the rise of the polyphonic musical tradition. Richard Kele's *Christmas carolles newly inprynted* (*c.* 1550) still contains carols in the traditional popular style, some of them then at least 100 years old.

The social function of the medieval English carol is disputed. No one doubts that the *genre,* whether as popular song or polyphonic choir music, was a public one. But whether these public uses should be described principally as "convivial" (Greene), "ceremonial" (Stevens), "processional" (Sahlin, Miller, Stevens, Robbins), or "quasi-liturgical" (Harrison) seems to depend partly on which section of the repertory is in mind. The "Boar's Head Carol" is clearly an example of a convivial carol; it belongs to the great hall, at the Christmas feast. The "Agincourt Carol" seems equally clearly to be a ceremonial song of welcome. James Ryman's *"Pater de celis, Deus"* is based on the Litany of St. Joseph, and may have been chanted in procession (no positive evidence exists, however, that carols were sung in either liturgical or less formal processions). *"Novo profusi gaudio,"* on the other hand, may have been used, as Harrison suggests, as a substitute for the *Benedicamus* in the Mass at a festive season.

The existence of some kind of close connection between the medieval carol and the liturgy of the medieval church would help to explain the swift, almost complete, disappearance of the carol at the Reformation. In Elizabethan times there is a paucity of both polyphonic and popular-song carols, and the rift between the two extends also to the words. It is at this period, too, that the essential definition of the carol by form ceases to be valid. Significantly, it was William Byrd (1543–1623), a devout Catholic, who wrote two of the best carols of the period, "An earthly tree an heavenly fruit doth bear" (burden: "Cast off all doubtful care") and the "Lullaby Carol"; both are in the traditional carol form. During the 17th century the carol, or Christmas song, as it had become, is indistinguishable from other compositions in fashionable styles. Henry Lawes's "Hark, shepherd swains" is a verse-anthem; his "A Glee at Christmas: 'Tis Christmas now, 'tis Christmas now," is musically a light song in the style of many of his "ayres." The words, too, have a mock-classical, not a Christian or genuinely pagan, ring.

The popular carol, on the other hand, becomes merged with the broadside ballad (the cheap printed street-ballad) and the metrical psalm. The first merger produced, for example, the carol on St. John the Baptist (to the tune of "Oh no, oh no, not yet") in *New Christmas Carols* (1662), in which the crude and gruesome effects of popular journalism are apparent. The second merger produced "While shepherds watched" (Tate and Brady's metrical psalter, 1696); but it would be truer to say that the carol had been replaced by a new type of popular religious song, the metrical psalm, than that it had been assimilated into it. English Puritanism, with its emphasis on "the pure Word of God," and opposition to the apocryphal and legendary in religion, was hostile to the carol. There may, of course, have been a flourishing tradition of folk song in which carols played a part. But just as there are no records of this in the Middle Ages (the 15th-century carol is not in any sense, musical or literary, a folk-art), neither are there in the 16th and 17th centuries.

The carol revival began in the second half of the 18th century, when the original traditions of both popular and art carol had reached their nadir. We owe the best Christmas hymns of the period to the poets and musicians of Methodism (*e.g.,* Charles Wesley's "Hark, how all the welkin rings," revised as "Hark, the herald angels sing"); but these lack the distinctive carol touch. The revival, still in progress at mid-20th century, gathered way slowly. It incorporated some of the enthusiasm of the antiquarians on the literary side of the Gothic revival from the publication in 1765 of *Reliques of Ancient English Poetry* by Bishop Thomas Percy (*q.v.*) onward; but it built most firmly on collections of traditional broadsides such as Davies Gilbert's *Some Ancient Christmas Carols, with the tunes to which they were formerly sung in the West of England* (1822). To him and to those who followed him (William Sandys, William Husk, William Hone, and others) we owe such carols as "The Lord at first did Adam make," "A Virgin most pure," and "The First Nowell." Sandys' collection, *Christmas Carols, Ancient and Modern* (1833), added two elements to the grand pastiche which constitutes the modern carol: the true folk-carol ("I saw three ships," "The Cherry-Tree Carol," "The Holy Well"); and the translated foreign carol ("Patapan," and other "specimens of French provincial carols," *i.e., noëls*). The next great impetus came with the Oxford Movement. For Edmund Sedding (*Collection of Antient Christmas Carols,* 1860), carols were part of Catholic doctrine and worship; as also with John Mason Neale, one of the great 19th-century hymn writers and translators (*see* HYMN). With Thomas Helmore he produced *Carols for Christmastide* (1853) and *Carols for Eastertide* (1854). They were fortunate in their principal source: the Swedish *Piae cantiones* (1582), the famous collection of church and school song, which gave us the tune (though not the words) of "Good King Wenceslas." The collection of J. Stainer and H. R. Bramley (1871) summed up 19th-century endeavours and set the revival firmly going. It was later enriched by the fine harvest of folk song (Ralph Vaughan Williams, Cecil Sharp); by still wider borrowings from foreign repertories; by new music to medieval words; and by the rediscovery of the rich musical tradition of the English medieval carol.

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CAROLINE OF ANSBACH (1683–1737), queen consort of George II of Great Britain and Ireland, was born at Ansbach on March 1, 1683, daughter of John Frederick (d. 1686), margrave of Brandenburg-Ansbach. She married George Augustus, electoral prince of Hanover, in Sept. 1705. In Oct. 1714, when her father-in-law became king of Great Britain as George I, Caroline came with her husband to London, where her liveliness and tact helped to ease the difficult situation caused by the quarrel between George Augustus, now prince of Wales, and his father. During the period of complete estrangement from the royal court (1717–20), the prince and princess attracted many distinguished men and women of the day to their residences at Leicester house in London and at Richmond. A formal reconciliation with George I took place in 1720. In 1727 when George II succeeded to the throne, Queen Caroline's influence was effective in keeping Sir Robert Walpole in power. She caused some difficulties by sponsoring unorthodox prelates for high office in the church. She was regent of the kingdom during the king's absences from England in 1729, 1732, 1735 and 1736–37. In her relations with her husband, to whom she bore eight children, Caroline proved herself a clever and patient woman, and retained her influence over him until her death at St. James's palace, London, on Nov. 20, 1737.

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CAROLINE OF BRUNSWICK (CAROLINE AMELIA ELIZABETH) (1768–1821), queen of George IV, king of Great Britain and Ireland, second daughter of Charles William Ferdinand, duke of Brunswick-Wolfenbüttel, and of George III's sister Augusta, was born on May 17, 1768. On April 8, 1795, she was married to the prince of Wales (*see* GEORGE IV), but soon after the birth of their only child, Princess Charlotte (Jan. 7, 1796), they separated, and she went to live near Blackheath. In Dec. 1805 she was accused of having given birth to a child (William Austin) but a committee of the privy council which investigated the matter acquitted her of the serious charge though it censured her levity of manners. Excluded from court after her husband became regent (1811), she went abroad in Aug. 1814 and was presently accused of "adulterous intercourse" with her Italian courier Bartolomeo Pergami (in England often called Bergami), with whom she had become infatuated. On her husband's accession in 1820 she returned to England to claim her rights as queen, whereupon the government introduced into the house of lords a bill to dissolve the marriage and deprive her of the title of queen. After a lengthy hearing of the evidence the bill was abandoned on Nov. 10, the third reading having been carried in the house of lords by a majority of only nine. Her name remained excluded from the liturgy and she was denied a royal residence, though parliament voted her an annuity of £50,000 for her maintenance. She was refused admittance to Westminster abbey at the coronation (July 19, 1821), became ill a few days later and died on Aug. 7, 1821. Although she said she had committed adultery but once—with the husband of Mrs. Fitzherbert (meaning George himself, who had been secretly married to Mary Anne Fitzherbert as early as 1785)—there can be little doubt about the guilty character of her relationship with Pergami; and had the truth about her been known, her popularity as an injured woman, which was great, would quickly have vanished. It was not until she was living abroad that her husband was told that she had tried to promote the seduction of her own daughter when she was about 16 by locking her in a bedroom with a young officer, Captain Hesse. If she was not mad, said the 3rd baron Holland, she was a worthless woman, and with that verdict posterity may agree.

BIBLIOGRAPHY.—For contemporary material see *The Letters of King George IV, 1812–1830,* ed. by A. Aspinall, 3 vol. (1938); *The Letters of Princess Charlotte, 1811–1817,* ed. by A. Aspinall (1949); *The Greville Memoirs, 1814–1860,* ed. by Lytton Strachey and R. Fulford (1938). For biography, *see* Sir E. A. Parry, *Queen Caroline* (1930); E. E. P. Tisdall, *The Wanton Queen* (1939). (A. AL.)

CAROLINE ISLANDS, part of the trust territory of the Pacific Islands administered by the United States, extend from longitude 130° to 166° E. and from the equator to latitude 21° N. Pop. (1963) 57,352. There are four administrative districts: Palau (pop. 10,280), Ponape (17,707), Truk (23,344) and Yap (6,021). Land area 457 sq.mi., with 3,283 sq.mi. of lagoon.

A major geological division in the surface of the earth occurs between Truk and Yap. Designated as the sial or andesite line, it divides the Caroline Islands into oceanic islands and continental islands. The oceanic islands to the east of the sial line are great mountains of volcanic origin rising from the floor of the ocean while the continental or arcuate islands to the west of the sial line are folds in the earth's crust. On both sides of the sial line high islands rise to elevations of 500 ft. or more and low islands caused by sinking are only coral caps appearing above the surface. The continental islands contain more minerals than the oceanic islands.

While the Carolines were in Japanese possession between World War I and World War II, the high continental islands were mined for copper, iron ore, bauxite, manganese and other minerals.

The mean monthly temperatures commonly range from 79° to 83° F. Rainfall varies greatly and exceeds 180 in. on a few of the high islands. In an average year about 25 typhoons originate in the central Caroline Islands; the centres of 5 typhoons once passed over Yap within three months.

Copra is the chief export of the Caroline Islands with handicrafts a poor second. Experiments have been made in raising cacao, for which conditions have been found to be ideal in the islands.

History.—According to carbon-14 tests, the earliest dated settlement on Yap was in the 2nd century A.D., but the eastern Carolines were probably settled before that date. Great diversity of physical types, cultures and languages prevail within the Caroline Islands. Twelve languages and several dialects are found among less than 50,000 persons. Considerable Polynesian influence is found in the eastern Carolines and pure Polynesian intrusions on the islands of Kapingamarangi and Nukuoro. The western Carolines show an intermingling of Melanesian and Philippine influences. There is evidence of Chinese trade goods reaching the western islands by the 7th century A.D. Although Spanish ships visited many of the islands after their discovery in the 16th century, the Spanish did not permanently occupy them until late in the 19th century. After the Spanish American War (1898) the islands were sold by Spain to Germany. In 1914 they passed to Japan, which held them after World War I as a mandate from the League of Nations. During World War II the islands, which then had large Japanese naval and air bases, were invaded by the United States. They became a United States trust territory under the United Nations on July 19, 1947. Along with the Marshalls and the Marianas they were designated as a strategic area with ultimate responsibility resting in the security council rather than in the general assembly, as is the case with other trust territories (*see* TRUSTEESHIP SYSTEM: *Strategic Areas*). (C. A. MR.)

CAROLINGIANS, the name of a family that became a sovereign dynasty in western Europe. It is derived from the fact that a number of its members were called Charles (Lat. *Carolus;* Ger. *Karl*), eight being so named between the beginning of the 8th and the end of the 9th centuries. The most famous among them was Charlemagne.

Although it did not attain regal dignity until Pepin the Short supplanted the last Merovingian king in 751, the family had long wielded great political power. It stemmed from the marriage of a certain Ansegisel with Begga, a daughter of Pepin the Old. Ansegisel was one of the two sons of Arnulf (d. 641) and his wife Doda. This Arnulf, a counselor of Clotaire II, the Merovingian king of Austrasia, eventually became bishop of Metz (*c.* 614), whereupon his wife entered a convent. The Carolingians of the 9th century, seeking to improve their remotest ancestry, represented Arnulf, already popularly regarded as a saint, as having been of Gallo-Roman and Aquitanian origin. Probably he was a Ripuarian Frank.

Pepin the Old, also called Pepin of Landen (the name of one of his estates near Trier), served Clotaire as mayor of the palace for Austrasia. He survived a short period of disgrace and at his death (*c.* 640) was greatly honoured and immensely powerful. This power was derived not from his office but from the vast extent of his lands, which were continually enlarged by his descendants up to the 9th century. These estates, situated mainly in Brabant, around the lower Meuse and between the Rhine and the Moselle, brought to the family a steady and invaluable revenue. They used it for the defense of Austrasia, to buy the allegiance of clients and in religious and monastic endowments.

Pepin had another child besides Ansegisel's wife Begga: his son, Grimoald, who succeeded him as Austrasian mayor of the palace. Rich and able, Grimoald attracted sufficient partisans to consider, when King Sigebert III died in 656, that the time was ripe to supplant the Merovingians. The Austrasian aristocracy, however, reacted violently against him, and he, his son and his brother-in-law Ansegisel were assassinated (662). Begga and Pepin, Ansegisel's son, were the sole survivors among the family, which disappeared from politics for about 14 years, though its material prosperity seems to have been undiminished.

The second Pepin, usually called Pepin of Heristal or Herstal, gradually regained the influence previously wielded by his family and became mayor of the palace in Austrasia. Profiting by his uncle's experience, he made no attempt to depose the Merovingians and instead devoted all his energies to the reunification of the kingdom, which from the end of the 6th century had been divided almost continuously between rival and warring states. The main opponent of this plan was Ebroïn, mayor of the palace for Neustria, supported by all who disliked the prospect of Austrasian hegemony. After some inconclusive encounters, Pepin, by his decisive defeat of the Neustrians at Tertry, near Péronne, in 687, became master of the entire Frankish territory which he had administered by putting the mayoralties of Neustria and of Burgundy into the hands of his own dependents.

At Pepin's death (714) the succession was uncertain. His only legitimate son had been assassinated and the claim lay between two young grandsons and a bastard, Charles, later known as Martel ("the Hammer"). Pepin's widow Plectrude, anxious to retain power, turned for support to the opponents of Austrasian hegemony, and it took Charles ten years of ceaseless fighting to establish his authority. His power, not fully assured until after 725, was unassailable after his famous victory over a Muslim army near Poitiers (732). No less prudent than his father, he maintained the fiction of Merovingian rule.

At Charles Martel's death (741) his authority was divided between his two sons; but the younger, Pepin the Short, soon held the palace mayoralties of all three kingdoms, and it was he at last who dared, by deposing Childeric III, to substitute his own family for the Merovingians (751; or at the latest Jan. 752). One element of the change was politically of the utmost significance: Pepin was the first king in France anointed and hallowed to his office by the church.

Under four succeeding generations of Carolingians, from Pepin of Herstal to Pepin the Short's son Charlemagne (*q.v.*), the Frankish kingdom was gradually enlarged, until its territory reached from the Elbe to the Pyrenees and from the borders of Denmark to Rome. The Carolingians' domination over western Europe already recalled that of the Roman emperors when, in 800, circumstances led Pope Leo III to revive the imperial title for Charlemagne (Charles I both as emperor and as king of France).

The Carolingian power, however, was menaced by the traditional Frankish practice of dividing an inheritance among all the male children. At first the problem was not particularly severe: when Pepin died (768) only one of his two sons was capable of effective rule over the kingdom; and Charlemagne (d. 814) was survived by only one legitimate son, the emperor Louis I the Pious. Trouble began in Louis's reign, as his sons started disputing the allocation of territory in 830, and after Louis's death (840) a civil war broke out, to be terminated only by the division of the empire into three sections at the treaty of Verdun (843).

The eldest son of Louis the Pious was Lothair I (d. 855), who in 843 received the imperial title and Francia Media, the middle kingdom, a long central strip comprising territory which lies today in the Netherlands, Belgium, western Germany, eastern France, Switzerland and Italy. The northern part of this kingdom was in 855 made into a separate kingdom for Lothair's second son, Lothair the younger, from whom it got the name of Lotharingia or Lorraine (*q.v.*), but on Lothair II's death without heirs (869) it was divided between his uncles, Lothair I's brothers. Lothair I's other two sons, Charles, king of Provence, and the emperor Louis II (the eldest of the three), who had been king of Italy, likewise died without male issue, in 863 and in 875 respectively, whereupon more complicated partitions ensued.

Francia Orientalis, the country east of the Rhine, went in 843 to Louis the Pious' third son, Louis the German, whose descendants managed, despite difficulties, to reign there until 911. Louis the German's sons, Carloman (d. 880), Louis the Younger (d. 882) and Charles the Fat, at first divided the East Frankish territory but Charles the Fat reunited it. He moreover held the imperial title, as Charles III, from 881 to his deposition in 887. Subsequently Arnulf, a bastard of Carloman, was emperor from 896 to 899. By this time, however, the Carolingians in the east had lost real authority, and at the death of Arnulf's son, Louis the Child, in 911, the vacant German crown was not offered to the surviving head of the Carolingian dynasty, Charles the Simple (Charles III of France). Germany needed a strong ruler, capable of organizing the defense against Hungarians. Such a one was found, in 918, in Henry I the Fowler, progenitor of the new Saxon dynasty. (*See* Germany: *History*.)

The civil war during and after the reign of Louis the Pious was caused by the reluctance of the elder sons to give a share of territory to Charles II the Bald, child of their father's second marriage. However, after 842, with the help of Louis the German, Charles made good his claim to Francia Occidentalis (the West Frankish kingdom; *i.e.*, France) and was recognized as its ruler in the treaty of Verdun. He was also emperor in succession to his nephew Louis II from 875 to his death in 877. Then his son and successor in France, Louis II le Bègue, died in 879, leaving the kingdom to his sons Louis III and Carloman, who lost the southeast of it to Boso of Vienne (*see* Burgundy). Their ineffectual rule and their early deaths (882 and 884) led to the kingdom being put under the protection of Charles the Fat. After his deposition the last Carolingians in France (Charles III the Simple, Louis IV d'Outremer, Lothair and Louis V le Fainéant) were challenged continually by rival kings of other families. From the end of the 9th century they retained only the appearance of authority and had lost the personal domains which had assured the power of their ancestors, and in 987 the kingdom was finally usurped by Hugh Capet. (*See* France: *History*.)

A fourth branch of the Carolingian dynasty originated when Louis the Pious assigned Aquitaine as a kingdom to his second son, Pepin. This Pepin, however, died in 838, before his father, and his son Pepin II was dispossessed by Charles the Bald.

See L. Halphen, *Charlemagne et l'empire carolingien* (1947); H. Fichtenau, *Das karolingische Imperium* (1949). *See* also the bibliographies to articles throughout *Encyclopædia Britannica* on individual Carolingians mentioned above. (J. De.)

CAROLUS-DURAN: *see* Duran, Carolus.

CARORA, a town in Lara state, Venez., on the Morere, an affluent of the Tocuyo river, about 50 mi. W. of the city of Barquisimeto and 1,128 ft. above sea level. Pop. (1959 est.) 18,115. The town is comparatively well built and possesses a fine parish church, a Franciscan convent and hermitage. It was founded in 1754, and its colonial history shows considerable prosperity, its population at that time numbering 9,000 to 10,000. Horses, mules and cattle are raised locally; and in addition to hides and leather, the town exports coffee and rubber.

CAROSSA, HANS (1878–1956), German novelist and poet, a masterly writer of autobiography and autobiographical fiction which propounds an affirmative and ethical attitude to life. Born in Tölz in Upper Bavaria on Dec. 15, 1878, Carossa studied medicine in Munich, Würzburg and Leipzig and was later a practising physician in Passau, Nürnberg and Munich. His autobiographical writings—*Eine Kindheit* (1922; Eng. trans., *A Childhood,* 1930), *Verwandlungen einer Jugend* (1928; Eng. trans., *Boyhood and Youth,* 1931), *Das Jahr der schönen Täuschungen* (1941; Eng. trans., *The Year of Sweet Illusions,* 1951), *Rumänisches Tagebuch* (1924; Eng. trans., *A Rumanian Diary,* 1929), *Führung und Geleit* (1933); and *Ungleiche Welten* (1951)—give a reticent, yet revealing, account of his life. His autobiographical fiction—*Dr. Bürgers Ende* (1913), *Der Arzt Gion* (1931; Eng. trans., *Dr. Gion,* 1933) and *Geheimnisse des reifen Lebens* (1936)—are lacking in plot and vivid characterization but skilfully present a contemplative view of nature and humanity. His lyrical poetry (*Gesammelte Gedichte,* 1948) is also mainly philosophical, but is at its best when, more rarely, he conveys a purely emotional experience. He died on Sept. 12, 1956, at Rittsteig near Passau.

See G. Schaeder, *Hans Carossa* (1947); A. Langen, *Hans Carossa* (1955). (H. S. R.)

CAROTHERS, WALLACE HUME (1896–1937), U.S. chemist, who developed nylon, was born at Burlington, Ia., on April 27, 1896. After taking degrees at Tarkio college, Mo., and at the University of Illinois, he specialized in research and teaching in organic chemistry, first at the latter university and later at Harvard. In 1928 he was appointed director of research in organic chemistry by the du Pont company at their laboratories in Wilmington, Del. There he directed a series of fundamental investigations into the structure of substances of high molecular weight and into the mechanism of their formation by polymerization. These investigations led to the development of several materials of commercial importance. One of these was a polymer which could be drawn out into an artificial fibre with properties in many respects superior to those of natural fibres; it was subsequently called nylon. Another was a synthetic rubber known as Neoprene. Carothers died in Philadelphia, Pa., on April 29, 1937. (S. E. J.)

CAROTO (Carotto), **(GIOVANNI) FRANCESCO** (*c.* 1480–1555), Italian painter, born at Verona *c.* 1480, was a pupil of Liberale da Verona; but a stay in Mantua, where he came under the influence of Mantegna, was decisive in forming his early style. On returning to Verona he became the leading artist there until his death. His later style owes something to Raphael.

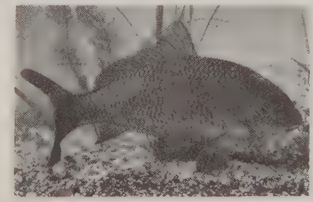
Verona was a provincial centre during this period and Caroto was on the whole a derivative artist. Nevertheless, his works remain distinguished by the sound craftsmanship of the Quattrocento and by the traditional sense of colour of the north Italian schools. He painted not only religious works in oil, tempera and fresco but also individual portraits. Many of his paintings are in the gallery at Verona; some are still in the churches there for which they were painted; for example, the "Madonna in Glory With Saints" (1528) in S. Fermo Maggiore, and the "St. Ursula" (1545) in S. Giorgio. Among his earlier works is a very attractive "Entombment" in the National Gallery of Art, Washington, D.C. The landscape backgrounds of his enchanting half-length "Madonnas" sometimes convey a feeling of mystery suggestive of Leonardo da Vinci.

His younger brother, Giovanni Caroto (*c.* 1490–1562?), was also a painter and an architect. He was responsible for a new edition (1540) of a book on the antiquities of Verona.

See Bernard Berenson, *North Italian Painters of the Renaissance* (1907). (M. W. L. K.)

CARP (*Cyprinus carpio*), a member of the minnow family (Cyprinidae) characterized by large scales, a long dorsal fin and two barbels on each side of the upper jaw. Wholly or partly scaleless varieties are known. It is a native of eastern Asia and has been introduced into Europe and from there into North America.

Carp inhabit warm-water lakes or ponds and slow-moving rivers; they prefer weedy places with a muddy bottom. They are omnivorous, but their favourite food apparently is midge (Chironomidae) larvae. During their efforts to obtain these larvae from the bottom of their habitat, carp roil the water. The increased turbidity has an adverse effect on many plants and animals. As a result carp are often considered undesirable and much effort has been devoted to killing them.

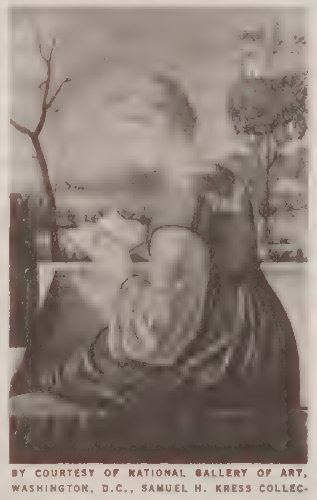

JOHN MARKHAM

CARP (CYPRINUS CARPIO)

The eggs usually are laid in the spring when the water temperature is between 58° and 68° F.; the eggs are deposited on vegetation or detritus, usually in regions recently inundated with shallow water. One female may lay up to 2,000,000 eggs. The eggs hatch in four to eight days. In nature, young carp reach a length of about 6 in. in one year, but in fish ponds they may grow to over 14 in. in one year. Carp reach sexual maturity in their second year and may live 47 years. They sometimes grow to more than 50 lb., and individuals of 25–30 lb. are not rare. Growth is greatest in warm seasons and apparently ceases at temperatures below 50° F. Because it is possible to produce more than 1,000 lb. per acre, carp are often raised for food, especially in Europe and Asia. The fast-growing pond-cultured individuals are reputed to have a superior taste. *See* Fish: *Catfishes, Characins, True Minnows, etc.* (C. Hu.)

CARPACCIO, VITTORE (*c.* 1460–1525/6), the great narrative painter of the early Venetian school, was born in Venice probably about 1460. Carpaccio is mentioned for the first time in a document of 1472, and the date of his birth has been conjecturally fixed as early as 1455 and as late as 1465.

The dominant influences on Carpaccio's early works were those of Gentile Bellini and Antonello da Messina. One of Carpaccio's few indisputable early paintings is "Christ With Four Disciples" in the Contini-Bonacossi collection, Florence. Between 1488 and 1490 Carpaccio received the commission for a cycle of scenes from the legend of St. Ursula for the Scuola di Sta. Orsola, now in the Accademia in Venice. These paintings comprise an altarpiece of "St. Ursula in Glory" dated 1491, followed by nine scenes illustrating the legend of St. Ursula. In these admirably organized designs Carpaccio emerges as a mature artist of great originality, with an unrivaled gift for narrative and a masterly command of light. The genre scene of the "Dream of St. Ursula" in particular, with its wealth of naturalistic detail, is one of the most popular Venetian paintings.



BY COURTESY OF NATIONAL GALLERY OF ART, WASHINGTON, D.C., SAMUEL H. KRESS COLLECTION

"A SAINT READING" BY VITTORE CARPACCIO. IN THE NATIONAL GALLERY OF ART, WASHINGTON, D.C.

Carpaccio's later career can be charted in terms of three further narrative cycles. The first of these survives intact in the Scuola di S. Giorgio degli Schiavoni in Venice. In the three scenes from the life of St. Jerome in this cycle (1502) the factor of direct observation plays an even larger part than in the St. Ursula cycle, and these paintings, from an artistic standpoint, represent the climax of Carpaccio's art. A cycle of scenes from the life of the Virgin, executed after 1504 for the Scuola degli Albanesi, is distributed between the Brera gallery in Milan, the Ca' d'Oro and the Museo Correr in Venice, and the Accademia Carrara at Bergamo; a still later cycle of scenes from the life of St. Stephen, painted between 1511 and 1520 for the Scuola di S. Stefano, is now divided between the Kaiser Friedrich museum, Berlin, the Brera gallery, the Louvre, Paris, and Stuttgart. Concurrently with the beginning of this cycle Carpaccio executed (1510) for S. Giobbe the great altarpiece of the "Presentation in the Temple," now in the Accademia, Venice. Carpaccio's last dated works are two organ shutters for the Duomo at Capodistria (1523).

Carpaccio died in Venice between Oct. 28, 1525, and June 26, 1526.

In the 19th century Carpaccio's rendering of architecture and the luminous atmosphere of his paintings were praised by John Ruskin, but only in recent criticism have his childlike love of pageantry and his interest in storytelling come to be accepted as incidental features in a style of great seriousness and originality. Capable of psychological subtlety and (in the "Meditation on the Passion" in the Metropolitan museum, New York, and the "Dead Christ" in Berlin) of deep compassion, Carpaccio was also the first and greatest Venetian painter of *vedute* ("townscapes"), while his altarpieces in the Accademia at Venice and at Capodistria (1516) are some of the most majestic achievements of their time.

See P. Molmenti and G. Ludwig, *The Life and Works of Vittorio Carpaccio* (1907); G. Fiocco, *Carpaccio* (1942); T. Pignatti, *Carpaccio* (1955). (J. W. P.-H.)

CARPATHIAN MOUNTAINS. These arcuate ranges form the east-central European counterpart of the Alpine fold mountain system, though not so spectacular nor so intensively surveyed. They strike off from the Danube at Bratislava in southwestern Slovakia, swinging northeastward and then east, forming the frontier with Poland and then curving southward into Rumania and finally westward to return to the Danube at Orsova, at the defile known as the Iron Gate. The Carpathians are similar in east-west extent and area to the Alps but are much lower in average elevation (highest peak, Mt. Gerlachovka, in the High Tatra, 8,711 ft.), in spite of their comparable structure and age. Except in the High Tatra (Vysoky Tatry), there is a lack of rugged peaks, permanent snow and glacial lakes, though features resulting from mountain glaciation are found in the Transylvanian Alps. In the centre of the arc, the mountains decrease from a maximum width of 180 mi. to only 60 mi. and in this region there are a number of routes connecting the headwaters of the Tisza (Tisa, Theiss, Viseu) and the Prut.

Relief and Structure.—The Western Carpathians consist of a series of Tertiary fold ranges flanking the crystalline rocks of the High Tatra and including a series of Tertiary intermontane basins. The outer ranges, known as the Western and Eastern Beskids, extend east of the upper Morava valley to the headwaters of the Tisza (*q.v.*). They consist of a series of erosion platforms uplifted since Miocene times and they are developed on Cretaceous limestones and Flysch, a Tertiary conglomerate. The valley trenches are the sites of villages around which the land is cultivated under strips. These valleys are isolated by parallel fold ranges whose steep slopes are thickly forested, often to the summits, with beech mantling the lower slopes and conifers above. The highest ranges reach several hundred feet above the tree line, and, above the zone of *Pinus pumilio* or dwarf pine, found in the High Tatra, are the summer pastures or *halas*. Among the outer, lower ranges are the White Carpathians (Bile Karpaty), culminating in Velky Javorina (3,182 ft.). The Western Beskids are crossed by the Jablunkov pass. The Eastern Beskids attain their greatest elevation of more than 5,600 ft. in the Magura range, around the eastern end of which the Poprad valley offers a routeway, while, farther east, lies the Dukla pass on the frontier between Slovakia and Poland. There the ranges seldom exceed 3,000 ft. and are quickly wooded with fir and beech. The inner zone of the High Tatra is highly complex, consisting of a core of granite and gneiss against which Mesozoic sedimentary rocks have been folded and overthrust. This crystalline "window" is limited to the High Tatra, though "basement" rocks also occur in the High Tatra to the west and in the Low Tatra (Nizke Tatry) to the south, and again in the western part of the Slovak Ore mountains (Sloyenske Rudohorie). In the south and east of the Slovak Carpathians, extensive faulting and fracturing was accompanied by volcanic extrusions in Miocene times, notably in the Matra massif in Hungary and in the north-south ranges east of Presov and Kosice, known as the Slanske Pohorie, Hegyallya or Hegyalya range. This southern region also experienced subsidence, preceding the advance of the Pliocene sea over the Pannonic basin or plain of Hungary. The region of greatest uplift and also of Pleistocene glaciation is that of the High Tatra (*see* TATRA MOUNTAINS), where rugged mountain scenery, pyramidal peaks and arête ridges characterize the range. There glacial lakes occur, such as Strba (Strbske Pleso) and Popradske Pleso in Slovakia and Morskie Oko in Poland. To the south, the Low Tatra culminate in Dumbier (6,703 ft.). The Slovak Ore mountains are generally lower and more broken and in the east are noted for their mineral reserves, especially iron ore. In this limestone region are found the famous ice caves at Dobsina (*q.v.*), while there are caves and grottoes with stalactites and stalagmites at Demanova. Other attractions include the cold geyser at Herlany, in the volcanic hills east of Kosice.

The structure of the Eastern Carpathians is less complex. A series of arcuate ranges form a semicircle east and south of the Transylvanian basin, culminating in the Transylvanian Alps. The Rumanian Carpathians differ widely in structure from their Slovak counterpart, though the outer zone of Flysch is a continuous feature. The system, which forms the mountain backbone of Rumania, consists of three elements: the Moldavian Carpathians, the Transylvanian Alps and the Bihor (Bihar) massif within the Transylvanian basin. The Moldavian Carpathians are a continuation of the Flysch ranges of the Eastern Beskids. Their steep, forested slopes rise to flat-topped summit ridges under 6,000 ft. In places the forest has been cleared for pastoral settlement. In contrast, the Transylvanian Alps consist of a core of metamorphic and igneous rocks, flanked by sedimentaries which have been highly folded, fractured and overthrust. The range is deeply dissected by mountain torrents which flow through deep-cut valleys incised into flat-topped ridges. As in the High Tatra, there is much evidence of local mountain glaciation, especially in the Fagaraș mountains, which rise to 8,343 ft. (Moldoveanu mountain). There cirques and arête ridges occur, and also hanging valleys (Vales Arpașuliu). The ridges are known as *plaiuri,* that is "routeway," since they often lead to summer pastures above the tree line. To the north lie a complex series of massifs of similar structure but at a generally lower level. They include the largely crystalline Bihor massif which rises asymmetrically from the Transylvanian basin to a culminating height of 6,063 ft. in Cucurbeta to the west. These massifs are faulted and fractured highlands, differentially uplifted in the Miocene, when volcanic outpourings also occurred.

Climate and Vegetation Zones.—The Carpathians lie in a transitional zone between central and eastern Europe, where the local climate is modified by varying elevation. The highest ranges experience considerable winter snowfall, especially on the slopes exposed to polar continental air. Whereas the heaviest precipitation exceeds 55 in. on the windward slopes of the Western Carpathians, the mean annual precipitation is under 25 in. in the Transylvanian basin and in some of the enclosed mountain valleys. These lowland regions also experience continental extremes of temperature between winter and summer; Sibiu, at 1,360 ft., recording a mean January minimum of 24° F. and a mean July temperature of 67°; so that long, cold winters with light snowfall contrast with warm summers, when the maximum rainfall occurs. Some stations record a secondary maximum in October. Climate and soil, combined with marked differences in elevation, favour a zoning of vegetation belts according to altitude. The ranges over 7,000 ft. rise into the zone of subarctic vegetation, with an alpine flora and mountain pasture, succeeded by stunted coniferous forest below 6,000 ft., especially in the High Tatra, where there are fine stands of spruce and mountain pine. The lower slopes are mantled by mixed stands of timber in which beech and oak predominate among the deciduous trees. The intermontane basins and valleys are generally cleared for pasture, as the basis of cattle and sheep rearing, while the arable land around the villages is parceled out under rye, oats and potatoes. The Transylvanian basin has a sufficiently long growing season for maize (corn) to ripen and viticulture is carried on on the terraced slopes of the southern Slovak Carpathians and in the Matra.

Settlement.—Whereas the whole of the Carpathians have been settled by peasants basing their livelihood on stock farming and subsistence agriculture, there are marked regional differences, depending on local factors as well as on ethnographic history. The Western Carpathians were occupied by Slavs (*q.v.*), both Slovak and Ruthenian, though there has been much infiltration of Magyars (*q.v.*), along the valleys opening southward, where, prior to 1919, there were the large estates of Hungarian landowners. Wine, grain crops and livestock are commercially produced. Elsewhere, remoteness from major lines of communication, combined with severe physical circumstances, have meant that life in the primitive Slovak villages follows traditional peasant lines. There has been constant depopulation, in view of the overpopulation of these largely Roman Catholic villages, and much former emigration to the United States. In contrast, the mountain and lake scenery and the abundant winter snow have made possible the development of the High Tatra for winter sports and also as a summer health resort. Exploitation of timber resources and mineral ores was neglected during Hungarian rule but, under the Czechoslovak republic, a beginning was made. After 1960 the Communist regime envisaged the development of water power and industry in this hitherto neglected part of the state. The total population of Slovakia in 1957 was 3,816,037, the Carpathian towns of Kosice accounting for 79,198; Presov, 31,244, Zilina, (1959 est.) 34,234; and the ancient castle town of Nitra, (1959 est.) 32,506. The language spoken is almost entirely Slovak and the religion Roman Catholic or Greek Orthodox.

The Rumanian Carpathians formed part of the Roman province of Dacia and the Rumanian language is derived from Latin. The mountains to the east of the Transylvanian basin served to deflect the main streams of migrants passing along the plains of Wallachia into Hungary or along the sub-Carpathian zone into the loess-covered plains of Galicia and Upper Silesia. The first agricultural settlement was in fact made by Saxons in the 12th century in the Olt (Oltu) valley, afterward known as the *Altland,* to distinguish it from the later crusading settlements made in course of the struggle between western Christendom and the Huns and Turks. Sibiu (Hermannstadt) and Brașov (Kronstadt) date from this period. Transylvania experienced centuries of incorporation in the Ottoman empire and, on the retreat of the Turks, there was a considerable influx of Germans and Magyars who came under the auspices of the Habsburgs in the 18th century as stock breeders and agriculturalists. In the later part of the 19th century the Carpathians were opened up by the construction of railways through the Iron Gate, the Surduc or Vulcan pass, the Turnu Roșu or Red Tower pass (in the transverse valley of the Oltu) and the Predeal pass. Deposits of gold have been located in the Bihor massif and petroleum has long been exploited on the flanks of the Carpathians. In contrast with the compact German townships and the agglomerations of the Magyar farmsteads are the dispersed farms of the Rumanian pastoralists. The typical peasant house, like that of the Slovaks, is built of timber, with a roof of crude thatch or wooden shingles. Most of the Rumanians are herders of sheep and cattle, and the practice of transhumance from the plains to the mountain pastures is much more widespread than in Slovakia. The more southerly location of the Transylvanian Alps also enables permanent settlement to ascend 1,000 ft. higher than in Slovakia, that is to more than 3,000 ft. In the remoter parts of the Carpathians, bears, wolves, lynxes and birds of prey still exist. On the whole, on account of general inaccessibility, the Carpathians, especially the intermontane basins, have served as havens of refuge during times of war and as nuclei for the development of separate community groups, with traditional ways of life, folklore and costume.

The Carpathians were first mapped and surveyed during the later years of the 19th century, when maps on a scale of 1:200,000 were produced by the Austrian general staff. These maps were reprinted by the Czechoslovak government, with Czech place names, between World Wars I and II.

See also POLAND: *Physical Geography;* RUMANIA: *Physical Geography.*

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CARPATHUS: *see* KARPATHOS.

CARPEAUX, JEAN BAPTISTE (often called JULES CARPEAUX) (1827–1875), French sculptor, whose works expressed a rhythm and variety that were in complete opposition to contemporary academic classicism, was the son and grandson of stonemasons, was born at Valenciennes (Nord), May 11, 1827. He went to Paris in 1842 and, at first working as a messenger and as a porter in the Halles, studied at the free Petite École.

In 1844 he entered François Rude's studio at the École des Beaux-Arts. He won the Grand Prix de Rome in 1854, after a prolonged struggle.

In Rome (1854–61) he was greatly impressed by Michelangelo and the later technique of Donatello. To these influences, especially in his single figures and portrait busts, were added the elegance of smaller works by Verrocchio and the tranquility of the Rossellinos. Among Carpeaux's best-known works are "Ugolino and His Sons" (1861, in bronze for the Tuileries gardens), "The Dance" (1869) for the façade of Charles Garnier's Paris opera house, and the fountain at the Luxembourg gardens, Paris (1874). Carpeaux's work, prelude to that of Rodin, was under constant attack. Despite this, and the feelings of persecution that oppressed him, he gained the friendship of Napoleon III. He died at Courbevoie (Seine), Oct. 12, 1875.

CARPENTARIA, GULF OF, a southward extension of the shallow Arafura sea and with it covering the Sahul shelf that links New Guinea with the continental block of Australia. It is connected with the Coral sea to the east by Torres strait. The gulf is about 480 mi. from north to south and about 420 mi. (maximum) from east to west. It is shut off from all oceanic circulation, except for the summer monsoon drift that enters from the northwest and passes southward along the east coast. Except in the northwest, where the edges of the Arnhem Land plateau have sunk to form a drowned coast with numerous inlets and islands (Groote Eylandt, about 36 mi. long, maximum elevation, 520 ft.), the gulf floor rises from shallow depths (average 30–40 fathoms) to form an unindented lowland fringe, perhaps a raised sea floor—50 to 100 mi. wide in the south-southwest and 100–150 mi. in the south and east, with a few off-lying islands (Sir Edward Pellew group; Wellesley Islands). Behind the often dead-flat plains the land rises gradually to the Barkly tableland (about 1,000 ft.) in the south and to the highlands of Cape York peninsula in the east. The plains—the gulf country proper—are largely floored with silts and muds washed down by the numerous rivers, some of which (Roper, McArthur, Flinders, Batavia) are navigable for varying distances inland. They have, however, markedly seasonal regimes; in summer wide areas are flooded and in winter the rivers are brackish far up their courses as the tidal range is high, although only one full tide is experienced each day in most areas. The soils, except in the alluvial flats and pockets, are perhaps poorer than would be expected and climatic conditions lead to grasslands. Mitchell grass covers extensive areas with occasional forest clumps, dense palm groves and mangrove belts near and along the coasts. The rivers abound in crocodiles and the gulf waters afford good fishing. The climate is tropical (mean annual temperature, 85°–65°; average annual rainfall 20–40 in.) and there are only two seasons, the wet (November to April) and the dry. The gulf country is, apart from mining in the Croydon area, devoted entirely to pastoral farming. There are many natives, but the scanty European population lives mainly in the inland cattle stations, in mission stations (*e.g.*, at some river mouths) and at such settlements as Normanton, Burketown and Borroloola. Normanton, 23 mi. up the Norman river, is the port for a large, rich pastoral area, as well as for the mining (gold and silver) field of Croydon, with which it is linked by a railway (94 mi.). There are air services from Cloncurry to Mornington Island by way of Burketown and to Normanton, and a cross service between the latter two places.

CARPENTER, EDWARD (1844–1929), English writer, social reformer and pioneer of a return to rural simplicity, was born at Brighton, Sussex, Aug. 29, 1844. He entered Trinity hall, Cambridge, in 1864 and was elected fellow and ordained in 1869, but in 1874, revolting against the social and religious assumptions of his time, he became a lecturer for the newly founded university extension movement.

In 1877 he visited the United States, and met Walt Whitman, whose poetry had been influential in altering the course of his life and whose verse forms he followed in his long, unrhymed poem *Towards Democracy* (1883; expanded 1905). In 1883 he bought a small holding in Derbyshire, where he lived until 1922 with a succession of working-class friends.

As a Socialist, he was a follower of William Morris, and more interested in the reform of society and return to rural crafts than in political revolution. His papers on social subjects (*England's Ideal,* 1887; *Civilization: Its Cause and Cure,* 1889, enlarged, 1921) brought many admirers to visit him. These, and his later works on the relation of art to life (*Angels' Wings,* 1898; *The Art of Creation,* 1904), and, influenced by Havelock Ellis, on relationships between the sexes (*Love's-Coming-of-Age,* 1896; *The Intermediate Sex,* 1908) were widely translated. He died at Guildford, Surrey, on June 28, 1929.

See *A Bibliography of E. Carpenter* (1949); T. Swan, *E. Carpenter: The Man and His Message,* rev. ed. (1922).

CARPENTER, JOHN ALDEN (1876–1951), U.S. composer of the 1920s, was born at Park Ridge, Ill., Feb. 28, 1876, and studied music in Chicago and at Harvard university. He became vice-president of his father's railway and shipping business, but maintained his interest in music and in 1906 studied for a short time with Sir Edward Elgar in Rome, continuing his studies from 1908 to 1912 with Bernhard Ziehn in Chicago. His orchestral suite *Adventures in a Perambulator* (1915), inspired by a child's view of city life, shows his gift for musical humour and effective orchestration. The piano *Concertino* (1917) was similarly successful. His ballets include *Krazy Kat* (1922), using jazz idioms, and his powerful *Skyscrapers* (1926), written at the suggestion of Diaghilev. Carpenter's output was small but of a generally high quality. It includes settings of poems of Rabindranath Tagore and chamber works. He died in Chicago on April 26, 1951.

CARPENTER, MARY (1807–1877), English philanthropist, social reformer and founder of free schools for poor children, the so-called "ragged schools," was born at Exeter, Devon, on April 3, 1807, the eldest child of the Unitarian minister Lant Carpenter. Having studied in her father's school in Exeter, and after a short experience as a governess, she opened, with her mother, a girls' school in Bristol in 1829.

In 1833, through the Boston philanthropist Joseph Tuckerman, she became interested in India, which she visited four times during her life. In 1846 she founded a ragged school in a slum area of Bristol, and a reformatory for boys in 1852, followed by another for girls in 1854.

After her third visit to India (1869–70), she decided that she could supervise the work there more effectively from England and inaugurated in 1870 a National Indian association to inform English opinion on the needs of India. In 1873 she visited the United States and Canada and pointed out the defects in the American prison system. She also studied the prison system of Louis Guillaume at Neuchâtel. She supported the movement for higher education for women and wrote pamphlets and books on ragged schools, reformatories, juvenile delinquency and Indian social reform. These aroused much interest and were responsible for government legislation in regard to reformatories and industrial schools. Mary Carpenter died at Bristol on June 14, 1877.

See J. Estlin Carpenter, *Life and Work of Mary Carpenter* (1879). (S. J. C.)

CARPENTRY, the art and trade of cutting, working and joining timber into structures. The carpenter may be distinguished from his fellow craftsman, the joiner, by the fact that he is responsible for work on the skeleton of a building. He is thus concerned with the stability of the structure rather than its appearance, and a great deal of his work is carried out with unplaned timber and is normally hidden by subsequent finishes. Joinery (*q.v.*) is concerned with the wrought work and finishes in a building, such as windows, doors, paneling, cupboards, etc.

In the past, when buildings were frequently wholly constructed of timber framework, the carpenter played a considerable part in the construction of buildings and, apart from the mason, was the principal building worker. The scope of the carpenter's work has, however, altered. The increasing use of concrete and steel, especially for floor and roof construction, means that the carpenter plays a smaller part in the construction of buildings except for those of domestic scale; on the other hand, the part played by the carpenter in the construction of temporary forms for concrete casting has increased enormously.

The relative rise in the cost of timber since World War II has also called for revision in traditional practices and the application of engineering calculation, rather than empirical and rule-of-thumb methods, to the design of timber structures. Much traditional timber construction is wasteful from the point of view of the amount of timber used to the amount of work done, and developments such as stress grading of timber, improved mechanical joints and the exploitation of the inherent strength of laminated timbers have all brought new developments to carpentry. These changes have placed a new emphasis on factory work (indeed, laminated and specially glued framework units can only be made under precision factory conditions), but traditional carpentry methods are still widely used, and the ease with which timber can be cut and worked on the job will always mean that for many uses the traditional methods are both speedy and economical.

The work of the carpenter at building sites may be divided broadly into two main categories: the structural work, such as floor and roof framing, which is permanently incorporated into the building; and the temporary work, which enables excavators, masons, bricklayers and concreters to complete theirs. The considerable employment of cast concrete work in modern buildings calls for the extensive use of timber formwork. Although this work is only in use for a short while, it is frequently as complicated in design and construction as a permanent structure and occupies a good part of the carpenter's time on building sites.

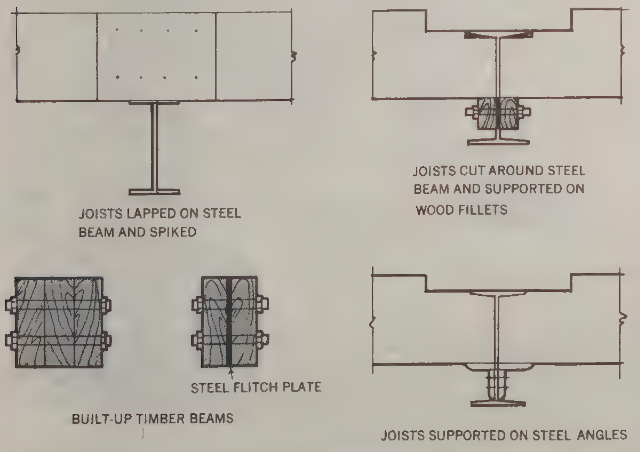
Timber Preparation.—Timber used by carpenters reaches the site as sawed in the mill, either in scantlings (beams and small sections) or in planks ready for incorporation into the work. Much of the timber imported into countries is already cut to section and seasoned. The principal timbers used in carpentry are in the softwood group and include redwoods (pine, fir, etc., from Baltic sources), Canadian spruces and Douglas fir, British Columbian pine (from Canada), Oregon and pitch pine (from the United States) and western red cedar. The latter can be used not only for framing and structural purposes but also because it needs no special preservation treatment, for external covering such as weatherboarding and roof shingles. The timbers traditionally used in framework, such as oak and elm, are now used only in the repair of historic buildings.

Joints.—The principal task of the carpenter on the site is to cut and fix the timbers with such jointing as is necessary. In this work the traditional hand tools are still largely used, although powered hand tools are coming increasingly into use. The latter are most useful for saving time, especially when there is much repetitive work; for example, in the cutting, squaring and birdsmouthing (*see* fig. 3) of roofing rafters. Some work, such as framed partitions or built-up roof trusses, may be cut and fitted in the workshop and then delivered to the site ready or partially ready for fixing. The principal hand tools in use are rules, axes, saws, mallets, hammers, chisels, gouges, augers, pincers, compasses, bevels, marking gauges and planes (*see* Hand Tools, History of; Woodworking Machinery).

Joints are made in different ways according to the use to which they are to be put and the stresses or thrusts which they must resist. In addition to specially designed steel connectors, now widely used in roof framing, much use is made of wire nailing, which is mechanically very strong. Where timber joints are used for special purposes, they are usually of well-recognized traditional design and may be broadly grouped as follows:

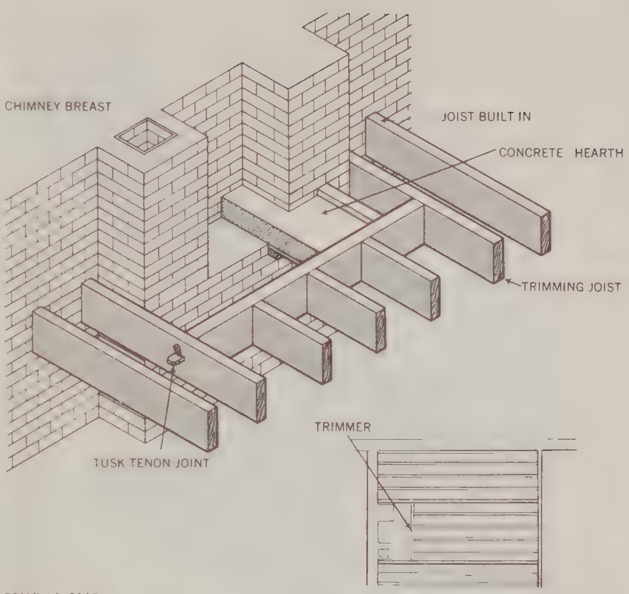
Lap joints, fish joints and scarf joints are used generally for lengthening heavy timbers, using iron bolts and straps, and for jointing long runs of timbers such as wall plates which, for convenience, are inserted in short lengths. Scarf joints are used for lengthening beams, particularly in the case of repairs to defective timber structures when the ends of beams or rafter feet have rotted.

Flitched joints have considerable mechanical advantage; they consist of a built-up beam using two or more timbers of small cross section with the addition of a steel flitch plate (fig. 1). Strength is thus achieved along with a reduction in the depth of the beam. Flitched joints are especially useful in alteration work or where depth is restricted.


JOISTS LAPPED ON STEEL BEAM AND SPIKED
JOISTS CUT AROUND STEEL BEAM AND SUPPORTED ON WOOD FILLETS
STEEL FLITCH PLATE
BUILT-UP TIMBER BEAMS
JOISTS SUPPORTED ON STEEL ANGLES

BRIAN SAVEGAR

FIG. 1.—FLITCH JOINTS



BRIAN SAVEGAR

FIG. 2.—SINGLE UPPER FLOOR SHOWING TRIMMED OPENINGS AROUND FIREPLACE

The ends of floor joists and rafters are often notched over plates to obtain satisfactory support. Cogging consists in taking a small portion out of the underside of one timber crossing another in order to secure and level the two. It also assists in keeping the two timbers in position. Cogging was frequently used in the past, when timbers tended to vary in section owing to poor preparation and there was a correspondingly greater need for leveling.

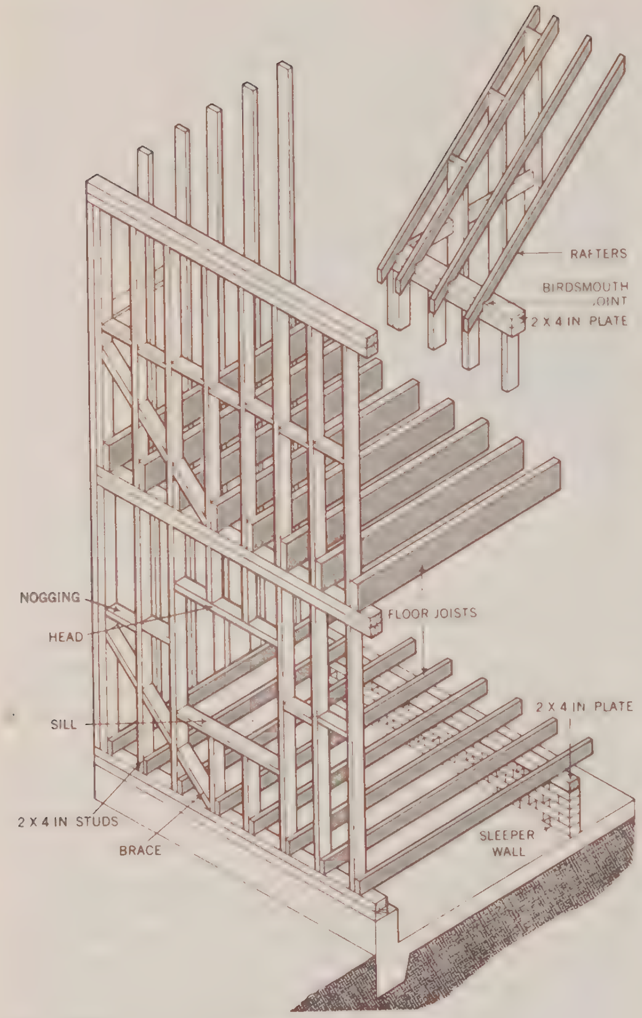
A number of special joints are used in floor construction, especially where it is necessary to form a trimming. A trimming is a framing formed in a floor (or roof) for, *e.g.*, a staircase well or skylight, or to run a floor around some obstacle into which it is either not possible or not permitted to fix timbers, such as a fireplace (*see* fig. 2). Most of these special joints are housed joints.

The end of one timber cut so as to leave one-third of its thickness forms a tenon, and the piece of timber which is to be joined to it has a mortise or slot cut through it to receive the tenon. The two are then pinned or nailed together to form a joint. This joint is used for preventing sliding movement between two members. The tusk tenon joint is a more complicated version used in flooring; it is provided with a wedging arrangement so that the joint can be kept tight at all times.

A birdsmouth joint is formed when it is required to secure a timber which is at an angle to another which is level in order to prevent slipping. It is commonly used at the feet of roofing rafters (*see* fig. 3).

Mitres and dovetailing are mostly used in joinery work, but may be used by carpenters in the lining of openings or trimmings.

Floors.—*Suspended Ground Floors.*—The use of solid concrete ground floor construction is now quite popular, but up to 1939—and afterward for certain work—the suspended timber ground floor was used (*see* fig. 4). A concrete slab is laid over the area of the building between the walls. Its function is to seal off the ground, prevent the growth of vegetation or entrance of vermin and provide a level surface on which the supporting walls for the ground floor may be laid. Since no clear space is required under the floor, it is the normal practice to use joists of small section, either 2 × 3 in. or 2 × 4 in., supported by brick "sleeper" walls. These walls, which are one brick thick, are built in honeycomb form for the efficient circulation of air and may be spaced between 3 to 6 ft. apart according to the size of joist used. A timber wall plate,



BRIAN SAVEGAR

FIG. 3.—TIMBER FRAMED CONSTRUCTION

usually 2 × 3 in. or 2 × 4 in., rests on top of the brick support and carries the joists, which are usually spaced 16 in. apart. A dampproof course, *i.e.*, a layer of material impervious to moisture, must be inserted immediately under the wall plate so that any moisture that may find its way through the concrete and up the brickwork will be checked before it reaches the timber floor.

Good ventilation of the space between the timber floor and the concrete is essential; it is usually provided by placing perforated air bricks in the outer wall of the building and so arranging them that a current of air passes through the underfloor space.

There is danger of fungus attack on the timber forming a suspended ground floor if the precautions mentioned above are not taken. The air is liable to be damp, and if the ventilation is not efficient the moisture content of the timber may become such that in the presence of the spores fungus decay may take place (*see* DRY ROT).

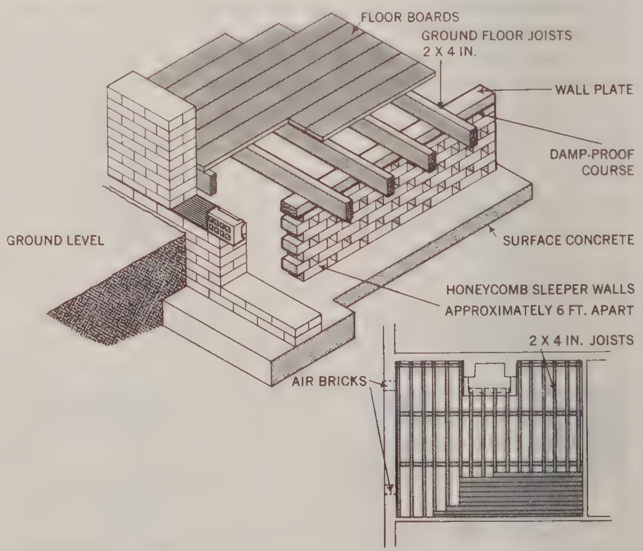
If the timber is well seasoned and the dampproof course and ventilation effective, it should not be necessary to treat the timbers with preservative, although this is frequently done as an added precaution. It is, however, advisable to treat the ends of any timbers which are in contact with wall plates or which for any reason must be built into brickwork. Good practice requires that timbers should not be built into walls unless this is absolutely unavoidable.

The main advantage of a suspended timber floor at ground level is its resilience, but from the point of view of thermal insulation it has considerable drawbacks. The boarding laid over joists is usually tongued and grooved to prevent draft and dust entering the room. Even when this has been done, however, drafts often occur, especially when some shrinkage of the timber has taken place. Since underfloor ventilation is essential for suspended floors, it follows that there must be considerable heat loss, and the insulation efficiency of a boarded floor on joists with good underfloor ventilation is seldom as high as that of a solid concrete floor with suitable covering.

Suspended ground floors of this type are not suitable for carrying heavy loads, and their use is confined to houses and smaller public buildings.

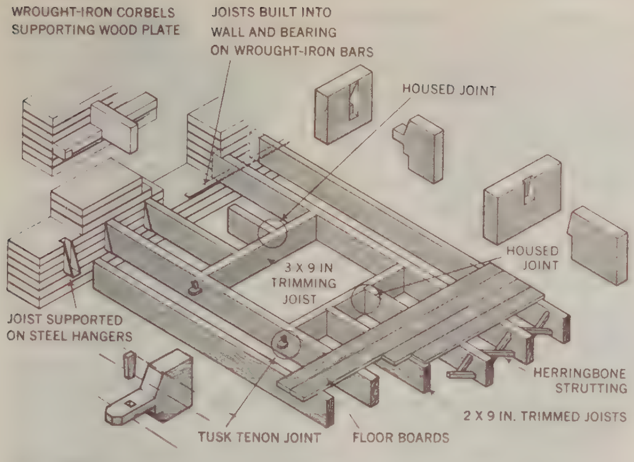
Timber-Joisted Upper Floors.—This familiar construction is used for light loads and small spans and, like the suspended ground floor, mainly for buildings of domestic scale and in conjunction with load-bearing brick walls. The joists are usually spaced 16 in. apart, and the depth is selected according to the span, the joists being 2 in. in thickness. Three-inch-thick joists are used where it is required to carry extra load, as is the case with a trimming joist. The joists are covered with hardwood or softwood planks and lined underneath with plaster, boarding or other suitable finish. The rule-of-thumb method for calculating the depth of a timber joist is to divide the span, in feet, by two and add two to the quotient to give the depth in inches. This will obviously sometimes result in the joist selected being unnecessarily deep, and there are published tables of joist sizes related both to span and spacing which, being drawn up on a basis of calculation, will offer some economy in the amount of timber used. Alternatively the floor may be designed in accordance with normal engineering practice for its special conditions and loadings. As the depth of a joist increases (with the span) the cost of the timber becomes relatively higher; it is not economical to increase the depth of timber joists over about nine inches. If spans requiring more depth than this are to be covered with a timber-joisted floor, it is necessary to introduce an intermediate support in the form of a strengthened timber or steel beam, thus reducing the size of the common joists (*see* fig. 1). Further economy also follows in that in order to secure clear heights, a double floor of this type requires less over-all height in the building.

Fig. 5 shows the principal joints and fixing methods used in upper floors constructed of timber. The joists may be supported at the wall by means of pressed steel hangers or spiked to, or notched over, timber plates. Joists may also be built into the brickwork, in which case it is usual to rest them on a steel strip. The building in of joist ends of upper floors is less objectionable when they rest on the inner leaf of a cavity wall, but building in should be avoided in solid wall construction and under no circumstances should wood plates be built into brickwork or masonry.



BRIAN SAVEGAR

FIG. 4.—SUSPENDED TIMBER GROUND FLOOR CONSTRUCTION


WROUGHT-IRON CORBELS SUPPORTING WOOD PLATE
JOISTS BUILT INTO WALL AND BEARING ON WROUGHT-IRON BARS
HOUSED JOINT
HOUSED JOINT
3 X 9 IN TRIMMING JOIST
JOIST SUPPORTED ON STEEL HANGERS
HERRINGBONE STRUTTING
2 X 9 IN. TRIMMED JOISTS
TUSK TENON JOINT
FLOOR BOARDS

BRIAN SAVEGAR

FIG. 5.—UPPER FLOOR CONSTRUCTION SHOWING METHODS OF SUPPORTING JOISTS AND FORMING OPENINGS

Upper floors are not normally ventilated, and built-in timber should be treated with a suitable preservative. Where chimneys pass through timber floors, a trimmed opening must be formed so that no timber is built in near the flues, and all structural timber should be kept 1½ in. away from brickwork protecting flues unless the brickwork is at least 9 in. thick.

Water and gas pipes and electricity conduits are for convenience often run through the first floor, and braces may be provided between the joists to support them. Wherever possible, these pipes and conduits should run parallel with the joists, but if it is necessary to carry them through a joist this should be done by boring through the centre of the joist and not by notching the top. If notching is done, it should be near the point of bearing and not at the centre of the span.

Herringbone strutting, shown in fig. 5, should be used to steady the joists against lateral movement whenever the length of the joists exceeds 50 times the thickness.

An ordinary timber floor of this type with three-fourths inches of plaster forming the ceiling is rated as fire-resisting for one-half hour. Any longer resistance period, such as two hours, which is normally demanded for public buildings, will require a concrete floor of some kind.

Sound Insulation in Timber Floors.—The acoustic insulation of a normal timber floor is not good, but can be considerably improved by pugging (*see* fig. 6). Pugging consists of filling the space below the boards and between the joists with a material such as dry sand, lightweight concrete or lightweight material manufactured for this purpose. The improvement in sound insulation depends directly on the amount of material used, and in some cases the weight of the pugging may necessitate an increase in the size of the floor joists. Pugging reduces both air-borne and impact noises. Another method of insulation is the use of a floating floor. In this, the floor boards are nailed not to the structural joists but to battens placed between them. The load is carried from the boards to the joists via a glass silk quilt. Wood floors may be floated on concrete subfloors by the same method. A floating floor may also be used in conjunction with pugging. (*See* ACOUSTICS OF BUILDINGS.)

Roofs.—Floors and roofs form the bulk of the carpenter's construction work. The traditional pitched roof with various coverings (tiles, thatch, wood shingles, etc.) still remains the most commonly used method of covering houses and similar small buildings (*see* fig. 7).

The carpenter's framework will be influenced in its design both by the weight and type of the covering to be used and by the span to be covered. The weight of the roof covering is transmitted by means of boarding or battens or both to the common rafters, which are the key members in the design of the roof. They are usually placed about 16 in. apart, span from the eaves to the ridge of the roof and are usually of timber of small cross section, either 2 × 3 in. or 2 × 4 in. In small roofs the common rafter may be all that is required, but as the length of the rafter increases it is necessary to provide it with intermediate support to prevent sagging. If suitable support can be found (on the cross wall or above partitions, for example), a purlin, running horizontally and at right angles to the rafters, is introduced at the mid-point of the rafter span to give extra support. Light ceiling joists are also required; these span from wall to wall and are secured to the feet of the rafters.

Where no walls or partitions are available to give support to purlins, or for any reason a large clear span is required (as in a hall, for example), it is necessary to use a truss. A truss is an independent framed unit spanning from wall to wall on which the purlins can be carried. The traditional method was to use king-post or queen-post trusses (*see* ROOF). These use a large amount of timber and are in consequence very heavy; for these reasons they are rarely used today. Instead, the rule-of-thumb design methods for trusses have been displaced in favour of design by calculation. For this, the timber must first be stress graded, and calculations must then be made in accordance with the known loads and stresses which the members will have to carry. The result is that, while much smaller members are in general being used, the timber is used more efficiently. Standard designs have been produced for various spans and slopes, and the trussed rafter roof and the trussed purlin roof have entirely displaced the older and heavier trusses. By using specially laminated and formed beams and portal frames it is possible to construct timber roofs of virtually any span, but such work is outside the scope of what is normally understood by the term carpentry.

Framed Partitions.—Framed timber partitions for the subdivision of rooms and similar requirements have been in use for centuries and are still quite popular, especially in the construction of homes. Traditionally, they consisted of oak posts secured at the foot and head and plastered on both sides. Essentially this arrangement is still used, except that the framing is normally of softer timber (*see* fig. 8).

The timber frame, which is usually constructed of light members, consists of uprights or studs fixed to headplates and soleplates. The fixing may be by spiking or screwing or by mortise joint. Intermediate horizontal members, calling noggings, are also inserted for stiffening, for special fixings such as skirtings or for carrying cupboards or fittings.

The spacing between the studs is determined by the nature of the job and also by the dimensions of the covering to be used, but

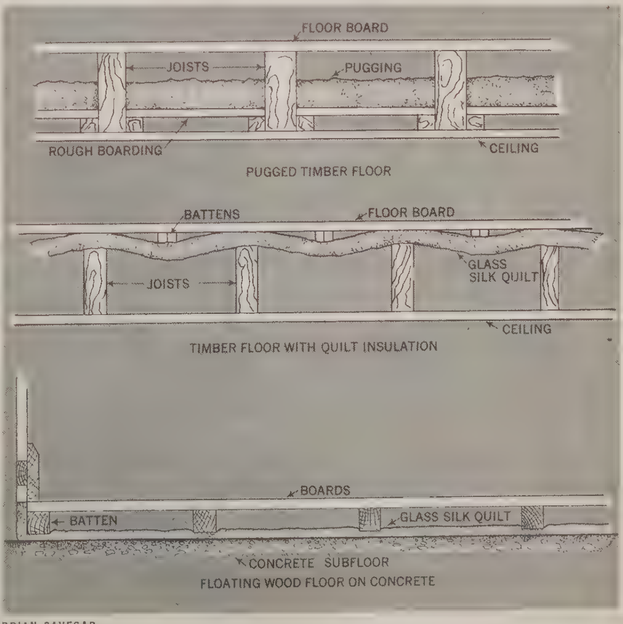


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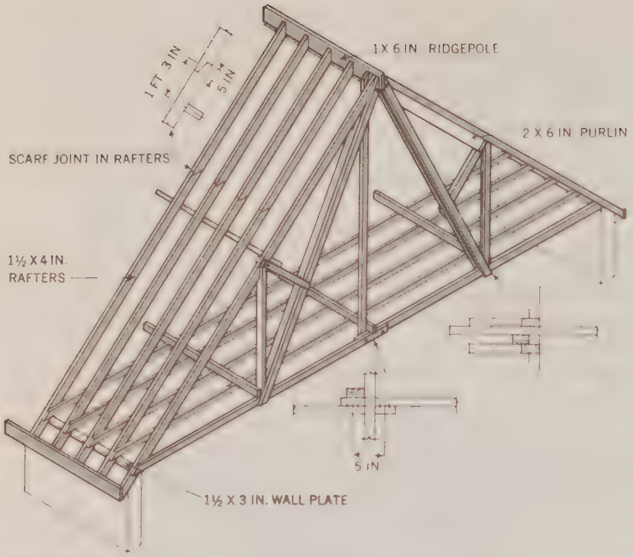
FIG. 6.—INSULATION OF TIMBER FLOORS



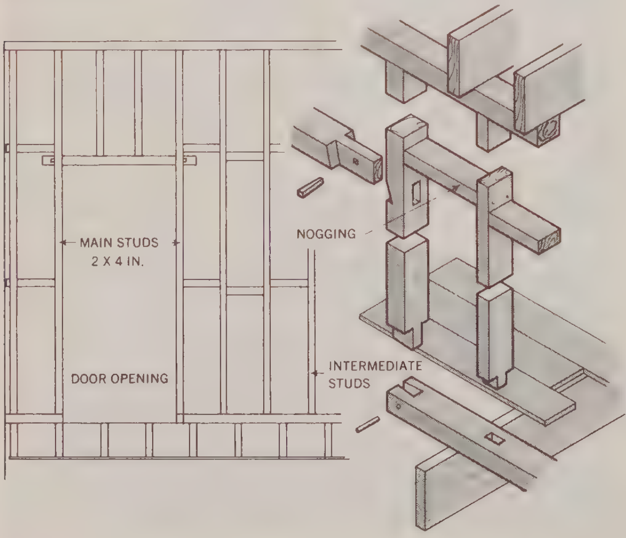
BRIAN SAVEGAR

FIG. 7.—TIMBER ROOF CONSTRUCTION

is likely to be about 18 in. In addition to lath and plaster or plasterboard covering, insulating fibreboards, plywood, hard boards, veneered boards or plastic impregnated sheeting may be used.

Buildings With Timber Framework.—The principles outlined above for the construction of partitions may be satisfactorily combined with the design of roofs and floors to produce a completely timber-framed building. They are particularly suitable where it is required to use a light cladding, *i.e.*, a nonload-bearing covering, either of timber or of some other material, and a light roof. It may be necessary to pay particular attention to the thermal insulation of the walls; this may be improved by the incorporation of a quilt of glass wool or a suitable insulating fibreboard.

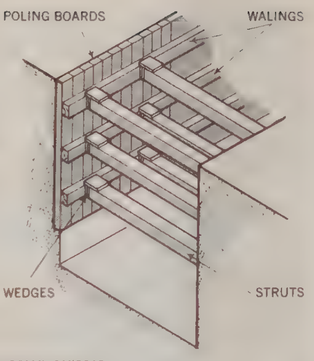
Carpentry in Temporary Work.—As mentioned earlier, the carpenter is frequently called upon to erect temporary timberwork for the assistance of other tradesmen during the course of building construction. This temporary work falls principally into three main groups: timbering for demolition and excavation work; the provision of centring for the construction of arches and vaults in brick or masonry; and the construction and erection of formwork or shuttering for the casting of concrete columns, beams and floors.



BRIAN SAVEGAR

FIG. 8.—TIMBER FRAMED PARTITION

Timbering for Excavation.—Where trenches are required to be excavated on a building site for foundations, drains or the construction of basements, it is usually necessary, in order to prevent earth from falling and to safeguard those working below, to support the sides of the excavation by timbering (*see* fig. 9). The arrangement and the amount of timberwork needed depends on various factors—the depth, the condition of the ground and the width of the trench. Vertical boards called poling boards, which may be spaced at intervals in firm ground or set closely butted if the ground is loose or waterlogged, are set in contact with the earth. The poling boards are held in place by horizontal timbers called walings, and struts are then driven tight between the walings across the trench.



BRIAN SAVEGAR

FIG. 9.—TIMBER SHORING FOR EXCAVATION

Centring for Arches.—For simple brick arches of a flat, segmental or cambered outline, the centre is formed by cutting a piece of timber to the required curvature; when made in this way the centre is called a turning piece (*see* fig. 10). It is supported in the opening on props with folding wedges which allow not only easy adjustment but the removal of the centre after the arch has been completed. Where arches have a width over six to nine inches, the centre is constructed on two or more ribs set parallel to each other with their top edges conforming to the curvature of the intrados of the arch to be built.

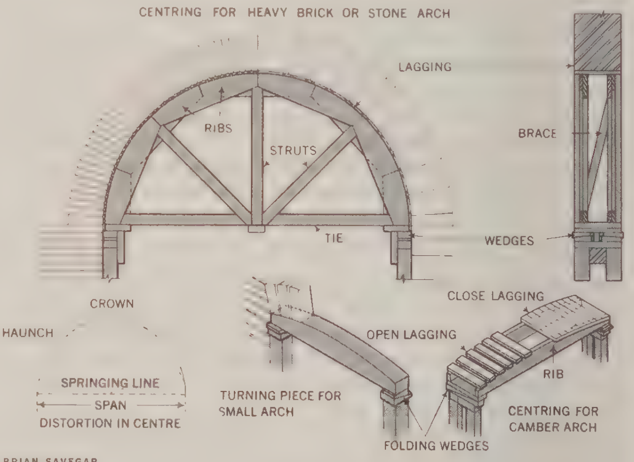


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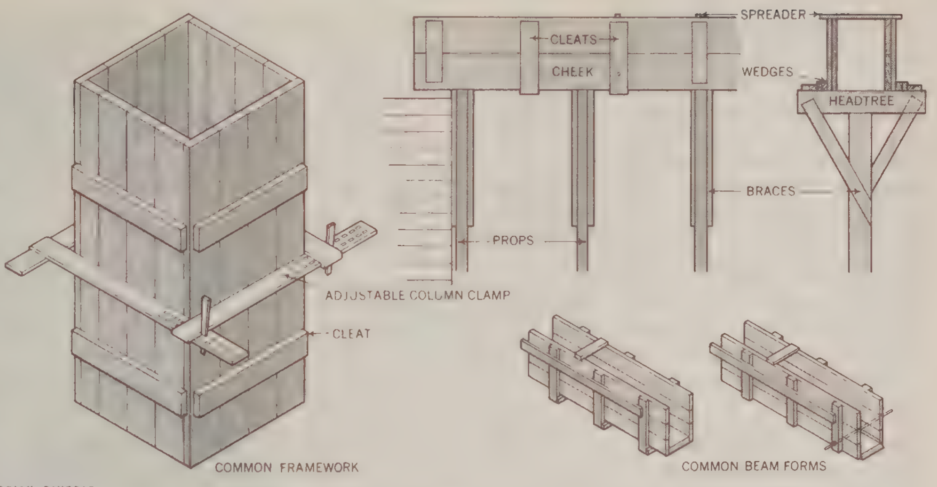
FIG. 10.—CENTRING FOR ARCHES

The main consideration in the design and construction of a centre is that it shall remain rigid and not alter in shape or form during the building of the arch. The tendency, especially in the case of arches over a considerable span, is that as the building of the arch around the centre proceeds, the weight of the superimposed masonry tends to compress the centre at the haunches and in so doing forces up the crown. The reverse tendency is experienced when the weight is put on the crown as the arch nears completion. The ribs in a large centre must be built up to the required outline from small sections of timber, and it is essential that these be adequately jointed together and supported by braces and struts to insure that distortion cannot take place. In heavy arches or vaults, it is usual to design the centre to allow for distortion of this kind so that the final form which the centre assumes under load is the correct one.

The various ribs are connected together by laggings; *i.e.*, small pieces or strips of wood which actually carry the brickwork or stonework. The laggings are placed close together for brickwork



BRIAN SAVEGAR

FIG. 11.—FORMWORK FOR CONCRETE LINTEL AND CONCRETE COLUMN

but are spaced out for heavier masonry so that the workman may use wedges for close adjustment of the heavy arch voussoirs.

Formwork.—Formwork or shuttering is the term applied to all wooden molds used for the casting of concrete. The special considerations in the design of formwork are that it must adequately support the weight not only of the concrete but also of the men placing it and the load of hand or mechanical ramming. In addition, it must be designed so that it can be erected, taken down and if necessary re-used during the progress of the work. Formwork is used mainly in foundations, columns, beams and floors. The sides and bottoms of formwork are constructed of boarding which may in some cases be specially lined with plywood or hard board, the boarding being supported and stiffened with cleats and uprights or walings to prevent distortion (*see* fig. 11).

Beam forms may be constructed in various ways. It is usual to arrange the formwork so that the centring at the sides of beams can be removed without disturbing the centring supporting the underside. This is because the side timbers may be removed as soon as the concrete has set, in a matter of 24 hours, but the concrete is not ready to support considerable weight for several weeks. The formwork for a long lintel, shown in fig. 11, is similar in principle to that used for beams.

Bibliography.—For the traditional and older methods of carpentry construction, the following may be consulted: T. Tredgold, *Elementary Principles of Carpentry,* ed. by E. W. Tarn (1919); P. Nicholson, *The Carpenter and Joiner's Companion* (1826); W. N. Twelvetrees (ed.), *Notes on Building Construction* (1875); C. F. Innocent, *The Development of English Building Construction* (1916); F. H. Crossley, *Timber Building in England: From Early Times to the End of the Seventeenth Century* (1951); W. B. McKay, *Building Construction* (1955); D. B. Nield, *Building Construction Illustrated* (1952). For more recent developments and modern carpentry methods, the following should be consulted: British Standards Institution, *Code of Practice for the Structural Use of Timber in Buildings* (1952); W. F. Cassie and J. H. Napper, *Structure in Building* (1952); C. C. Handisyde, *Building Materials* (1950); R. Greenhalgh (ed.), *Joinery and Carpentry,* 6 vol. (1939). (A. Rd.)

CARPET: *see* Rug and Carpet.

CARPETBAGGER, slang term for an unwelcome stranger coming, with no more property than he can carry in a hand satchel (carpetbag), to exploit or dominate a region against the wishes of some or all of its inhabitants. The term was used in the United States to describe speculative bankers in the early settlements in the west. Gen. Ulysses S. Grant used the carpetbag as a symbol for the northern cotton speculators who traded with the enemy along his lines in the Mississippi area during the American Civil War. In U.S. politics the term came into widespread use as an epithet for northern Republican politicians or financial adventurers who in the Reconstruction period that followed the Civil War used the recently enfranchised Negroes as a means of obtaining office or fortune in the southern states. Not all of them were evil. There were among them idealists concerned with freedom and education as well as adventurers seeking state offices or opportunities for financial gain. (Jo. D.)

CARPET MANUFACTURE. This article deals with hand and machine methods for making carpet. Included among the hand, or oriental, methods are those for producing tapestry, Persian, Turkish, Caucasian, Indian and Chinese carpet. The machine methods discussed include those for making velvet, Wilton, Axminster, chenille, tufted and knitted carpet. For information on the history, classification and appearance of the various types of rugs and carpets, *see* the article Rug and Carpet. Many of the techniques used in the manufacture of carpets by machinery have their origin in hand craftmanship. The earliest machinery employed hand power and water power to duplicate processes originally done by hand. Some carpet materials, used thousands of years ago, are still in use. Carpets have been produced by hand since the Assyrian and Babylonian empires and are still made by hand in the orient. Machine-made carpets, since they cost less to produce, replaced the hand-made types for general use many years ago. Commerce continues, however, in new, semiantique and antique oriental carpets.

HANDMADE CARPET

Ancient Origins.—Handmade carpets have been a part of the development of most civilizations. From the use of animal skins by primitive tribes to the creation of highly complex and beautifully designed silk tapestries by artists of Italy and France, the relative technical and artistic advancement of a culture could be measured by the craft of rug making. Oriental cultures have left the most lasting influence on carpets, and the term oriental has long been synonymous with the art of handcrafting carpets. North American and South American Indians developed the art to an advanced state early in their history and continued to make carpets of designs traditional to the history of their culture. The Navaho rug made by the North American tribe became one of the best known of the American Indian rugs. (*See* Navaho: *Arts.*)

Hooked, braided and embroidered rugs have been made in European countries and particularly by colonials of European origin since 1725. These carpets served the colonists' needs exclusively except for the rare importation of oriental types by wealthy landowners or merchants.

Early Materials.—Native materials were used in the first handmade rugs. Sheep were raised in most areas, and wool became the most widely used fibre. Silk was used in the east. Other animal hairs, such as those of the goat, horse, camel, alpaca and llama, were employed where they were available. Rags salvaged from discarded clothing were used for braided and hooked rugs. Cotton, jute and later some linen were used as the base of the carpet and to anchor its surface. The first dyestuffs were derived from vegetable matter. The design of these carpets reflected the experience of the weaver or the lore or history of his people. Most designs became classic and were used by generation after generation.

Oriental Carpet.—Iran (Persia), Turkey, India, Egypt and the Caucasian region have long been the centres of oriental carpet production. Various carpets with individual characteristics are identified with the town or area in which they are made. The best-known Persian types are Kerman, Ferraghan, Kurdistan, Sehna and Isfahan. Recognized Turkish carpets are Ghiordes, Kulah, Oushak and Ladik.

Production Methods.—These carpets are produced on hand looms. The warp or lengthwise yarns are wound on top and bot-

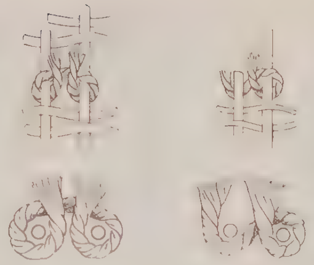


FIG. 1.—PRINCIPAL KNOTS USED TO TIE PILE YARN IN HAND-WOVEN CARPETS: (LEFT) GHIORDES, OR TURKISH, KNOT; (RIGHT) SEHNA, OR PERSIAN, KNOT

tom beams or poles. The width of the beams determines the width of the carpet. The beams are supported by upright pillars, and the yarns are stretched vertically. Weavers, often members of one family, sit in front of the frame and by hand tie row after row of pile tufts into the warp stretched on the frame. Pieces of yarn for the pile are cut about two inches in length; each pile piece is knotted around two warp threads according to the paper design in front of the weaver. As each row or part of a row is finished, two weft threads are put in, one in the shed formed between the front and back halves of the chain (*i.e.*, the front and back strands of warp yarn) and a second in an alternate shed formed when the weaver pulls the back half of the chain temporarily in front of the front half. The second weft is put in straight, the first one loose, zig-zag or vandyked, so as to fill up the back of the carpet and also to avoid the tendency toward lateral contraction. The weft is forced down into place by a heavy fork or beater. This interlocking of warp and weft with the tuft forms the weave of the carpet and has been imitated more or less in all mechanically woven carpet fabrics.

Two kinds of knot (fig. 1) are employed: (1) the Ghiordes or Turkish, and (2) the Sehna or Persian. In the Ghiordes knot the tufts of yarn appear in pairs between two warp threads; in the Sehna knot each tuft end appears singly between a pair of warp threads. In either case the tufts do not stand up vertically to the plane of the fabric but lie over obliquely toward the starting end of the carpet, forming a characteristic feature of handmade carpets.

Designs and Colours.—Certain designs and colours have characterized oriental carpets from each producing region. Some of the best-known Persian designs and the carpets in which they were used are as follows: The Herati design used in Ferraghan, Sehna, Khorasan and Mahal rugs consisted of a series of rosettes, each series between two long, curved leaves. The resemblance of the leaves to the form of a fish caused this pattern to be called the fish pattern. Alternate rows of rosettes were enclosed in diamond-shaped devices. This design was set off by a dark blue background and bordered by a palmette or lotus design. The Guli Hinnai pattern was used especially in Ferraghan carpets and consisted of rows of small yellow plant shapes united by many flowers in diamond arrangements. The pear design was favoured by the makers of Sehna, Saraband and Shiraz rugs. It is actually a pear form but was thought to have represented a bend in the Ganges river, or a river in Kashmir. This design spread to India and the Caucasian regions, where it was used in shawls as well as in carpets. Other marks of Persian rugs were leaf, bud and flower motifs, and animal designs. Patterns were ordinarily flowing and graceful as opposed to geometric. Colours were shaded and used in harmonious tones.

Carpets from Asia Minor used the brightest colours and often put strongly contrasting colours next to each other in designs. Strong rectangular lines were evident. Animal designs were not used, perhaps because of the weavers being Muslims. The two best-known carpets in this group were the Ghiordes and Kulah. The Ghiordes rugs excelled over all other rugs in Asia Minor and equaled the best in Persia. Prayer rugs, with the entrance to a mosque as their principal figure, were bordered by intricate designs. The Kulah rugs were similar but were coarser in weave, had higher pile and usually had narrower borders.

Caucasian rugs were predominantly geometric in design with patterns of elongated stars and octagonal devices bordered by barber poles and latch hooks. Strongly contrasting colours, reds, blues and yellows predominating, were separated by strips of latch hook ribbons. Only the Ghiordes knot was used. The Kabistan became the best known of this group.

Turkoman carpets were made by nomadic tribes that roamed from the Caspian sea to the China border. No other group held more firmly to designs and colours through the years. The finest example of their work is the Tekke rug, more popularly known as the Bukhara. The field of the Tekke was a dull red divided into oblongs with octagonal shapes centred at the intersections of the lines forming the oblongs. Red, black and white were the main colours used. Often the webbing of the base, sometimes up to 12 in., of these carpets was left exposed at the ends.

India.—Princes of India imported Persian rug makers during the 16th century to teach the art to the people; consequently, Indian rugs are similar in design to Persian rugs. In the 17th century India began weaving operations in prisons; this competition with the caste weavers led to a decline in quality. Rugs from northern India were of better quality than those from the south, where wool was scarce and cotton and jute were often substituted for pile yarns. The Agra and Mirazapur are typical Indian rugs.

China.—Chinese rugs, which have become popular in Europe and America, received their character from an exchange of weavers with central Asia. During the late 17th century, the emperor K'ang Hsi and later his grandson Ch'ien Lung gave great impetus to rug making. Chinese rugs were scarcely known outside China until the Boxer rebellion and did not reach wide popularity until after World War I. Exports were heavy until the Chinese Communists stopped shipments.

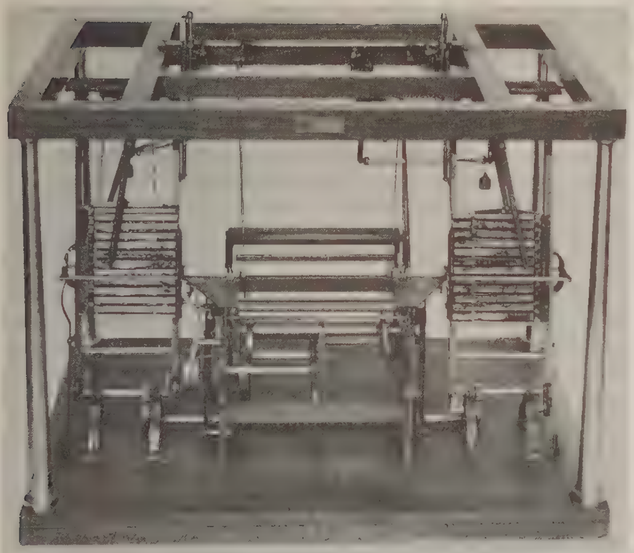
Chinese rug designs date back to the 12th century and were taken from porcelains and paintings typical of early Chinese culture. Colours used were blue, yellow, white, red and black. No more than three or four colours were used in a single rug, and large areas of monotones were typical. Symbolism was drawn upon heavily for design inspiration—the swastika, for example, symbolized good luck; the five-clawed dragon was originally reserved for the royal court but later was used generally; flowers represented seasons. Cloud bands were found only in these rugs, sometimes singly and sometimes in clusters. Chinese rugs were made with deeper pile than any other handmade rugs.

Tapestry Weave.—Another kind of hand weaving is the tapestry method, wherein the coloured weft threads, wound upon wooden needles, are threaded around and between the warp ends, leaving a flat or slightly ribbed surface. Since a tapestry carpet lacks a tufted pile, it does not make a luxurious carpet, even though a fine pitch (number of warps per inch) can be employed and the richest and most delicate effects of design and colour obtained. Carpets of this type have long been made at Les Gobelins, Paris, Aubusson and Beauvais in France and Tournai in Belgium. This work of producing tapestry carpet is slow and required great skill; the product therefore is expensive. (*See* TAPESTRY.)

MACHINE-MADE CARPET

Beginnings.—For several centuries preceding the Industrial Revolution carpets were manufactured in Europe and the British Isles by skilled handicraftsmen; prices were high and sales few. During the Industrial Revolution the British and later the Americans created a modern system of carpet manufacture, the British developing a systematized factory production on a sizable scale even though manufacturing was done entirely with hand looms. The carpet industry in the United States started by adapting the British system on a more modest scale and was largely a home industry organized by agents who also sold the small amount of carpets produced. Most sales were made in the major cities. At the time the United States began to make carpet, the basic styles and weaves had already been developed in Europe; their names were taken from the cities where they originated, such as Axminster, Wilton, Kidderminster, (all in England) and Brussels (Belgium). These weaves, with some variations, were copied in the United States.

By 1830, the use of carpets had become widespread in the eastern part of the United States and several factories had been established in New England, New York and Pennsylvania, although British carpets dominated the U.S. market. The U.S. industry was not able to compete successfully with the greater skill and lower



BY COURTESY OF THE SMITHSONIAN INSTITUTION

FIG. 2.—POWER LOOM DESIGNED BY ERASTUS B. BIGELOW; USED FOR WEAVING TWO- OR THREE-PLY, INGRAIN CARPET

costs of British labour. During this period imports of British carpets into the U.S. averaged 660,000 sq.yd. a year and usually exceeded the total output of the U.S. carpet factories. This situation led the management of U.S. mills to encourage the development of power equipment. Spinning and other yarn-preparing processes had been mechanized by this period, but it was the invention of the power loom by Erastus B. Bigelow in 1841 that truly revolutionized the industry. Bigelow had previously invented a lace-making machine and was commissioned to develop power equipment for carpet making by the Lowell Manufacturing company of Boston. Bigelow's first loom was for ingrain carpet, but he later developed power-driven looms for Wilton, Brussels and tapestry carpets. The Axminster loom was invented by Halycon Skinner in 1876 and perfected a few years later by Alexander Smith. The Axminster loom copied the technique used in hand tufting carpets but was a new mechanical principle. Previous power looms had merely added power operation to the principle used in hand looms.

The power loom with its cost-cutting advantages soon came to be used in other technically advanced countries. Industries developed in Belgium, France, Germany and Canada. In Britain the already established industry was quick to adapt the power loom, and this industry continued to grow as the chief exporter of carpet while the U.S. industry, which came to be the largest in the world, sold exclusively in its home market.

Types of Machine-Made Carpet.—During the 19th and early 20th centuries, the types of carpet construction in widest use were the Brussels and ingrain, including an inexpensive variety of ingrain known as Venetian. In the late 1800s Axminster construction became popular and was the most widely used process from early in the 1900s until 1950. The Brussels type was replaced by the modern Wilton, and the ingrain carpet dwindled in popularity early in the 20th century. Tapestry carpets, also in wide use in the 19th and early 20th centuries, came to be known as velvet. Construction of the velvet and modern Wilton types remained constant without particular change until the tufted process, in which the pile is sewn into a prewoven back as opposed to weaving the entire carpet, was developed during the 1930s. Another recent innovation has been the development of a process of manufacture that fabricates the backing and pile in one continuous operation by means of the knitting principle. Chenille, a deep-piled luxury carpet, is still manufactured on a small scale.

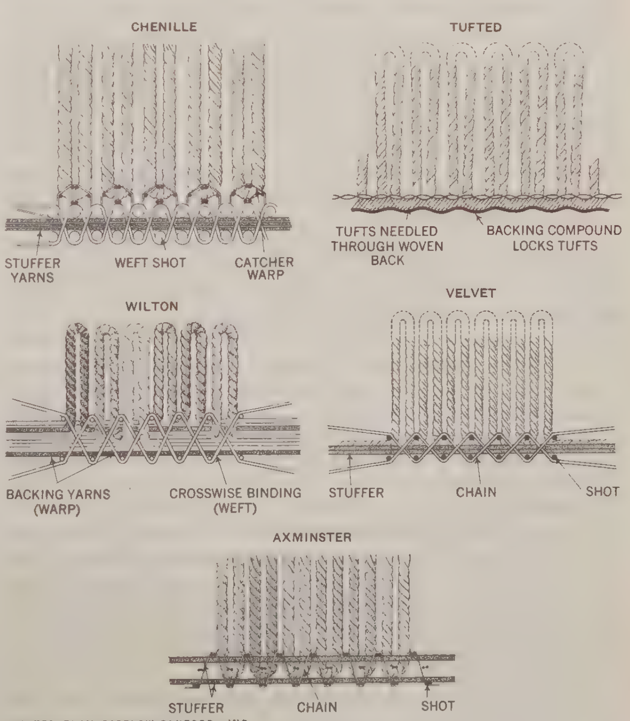
Until the early 1900s all machine-made carpet was manufactured in widths of either 27 or 36 in. From that time loom widths gradually became wider, and the "broadlooms"—those over 12 ft. in width—accounted for an ever-increasing portion of total production. In recent years 12-, 15- and 18-ft. widths have become most prevalent, although there is some production in 9- and 6-ft. and 54- and 27-in. sizes.

Regardless of the type of construction used in manufacturing carpet, the preparation of its component parts closely follows the processes used generally in manufacturing all textile products. Most carpet manufacturers buy already prepared yarns for backing. Many mills that produce woven carpet spin their own surface yarns; many manufacturers of tufted carpets, however, buy all of their yarns and prewoven backing from other manufacturers.

All woven carpets have certain manufacturing characteristics in common. (*See* WEAVING.) The warp (lengthwise) yarns are called "chain," and the weft (crosswise) yarns are called "shot." Additional weft strands placed in the body of the carpet to provide extra bulk or to secure pile yarns are termed "stuffer" yarns.

Velvet.—The velvet loom loops warp strands over raised wire strips to form the pile of the carpet. The wire strips are inserted across the loom in banks of 15 or more with loops being formed over one, two or three strips. As each row of pile loops is completed the wire strip at the front is automatically withdrawn and reinserted at the back for the next row of loops. If the wire has a knife edge that cuts the pile loop, a cut pile velvet is created. If the wires are smooth and the loop is not cut, an uncut or loop pile velvet is created. Most carpet known as twist carpet is created by using this method. Usually two or three beams of warp yarn are used. One beam feeds the basic warp yarn that binds the carpet together, another beam supplies the pile yarn and a third beam may be used for the stuffer yarns. The velvet loom is used mainly for solid colour carpets; it can, however, weave carpets in varied colours. One method is to form the pile yarn by twisting together two or more yarns of different colours. These are known as moresque yarns and produce a mottled colour effect. Another method uses two sets instead of one set of lengthwise yarn. This provides an additional weave shed through which a yarn of a second colour may be woven.

Wilton.—The Wilton loom operates on the same basic principle as the velvet loom but has greater versatility because of its Jacquard mechanism. (*See* WEAVING: *Jacquard Attachment.*)



ADAPTED FROM BIGELOW-SANFORD, INC.

FIG. 3.—METHODS OF MANUFACTURING WOVEN CARPETS

Up to six different colours of pile yarn may be used and the appearance of each of these colours in the surface of the carpet may be controlled to create the desired design. When a colour does not appear on the surface, it is buried in the back of the carpet. In addition to variations in colour, wide variations in texture also can be woven by this mechanism. Pile height can be adjusted to form scrolls and other patterns, and cut and uncut surfaces may be achieved. The Wilton process can produce highly intricate patterns. The Jacquard mechanism is controlled by punched cards that determine which yarns will be moved in position for looping over wires. The complete design is punched on a series of cards, which in turn are sewn together and travel as on a continuous belt around the Jacquard mechanism over the loom. As the cards move past a mechanism in the loom, the pile yarn that is to appear on the surface is selected. The cards, as they rotate, control each repeat of the pattern. A 15-ft. Wilton carpet may require as many as 4,800 different cards to complete a 36-in. repeat of the design in the finished carpet. Another form of Wilton weave is the double-face Wilton in which two fabrics are woven simultaneously, with the pile yarn passing backward and forward between the upper and lower cloths. A knife moving to and fro across the front of the loom cuts the pile yarns between the two cloths, thereby producing two separate carpets.

Axminster.—Axminster carpets can be woven on three different types of loom: the spool Axminster loom, the gripper Axminster loom or a combination of these two, the spool-gripper Axminster loom. The spool Axminster loom, unlike the velvet and Wilton looms, draws its pile yarns from small spools that have been wrapped with various coloured yarns to match the pattern to be produced. These spools, which are arranged across the width of the loom, are locked together in a frame and each frame represents one row of tufts across the carpet. Each strand of yarn taken from a spool forms a single pile tuft. As each frame of spools moves into position, it is automatically lowered so that the ends of the yarn strands are inserted between the warp threads in the loom. After insertion the shuttle shoots the weft yarn across the shed and a comb curls the ends of the surface tufts under the weft and back up between the warp strands. Another pass of the shuttle binds the looped strands in place, and a knife resembling a nipper cuts the strands from the spools, leaving the two ends of each strand protruding upward to form the pile tuft. The next spool frame then comes into position and the one used rotates until it again reaches the weaving position. This process inserts each pile tuft separately, thus simulating the technique of hand weaving. Axminster is the only weaving method that can give a different colour for each individual tuft in a pattern repeat, and it has no limitations as to the complexity of design. However, the preweaving preparations for complex designs is extensive, so that this method does not lend itself to other than extended production of the same design.

The gripper Axminster process was developed in Kidderminster, Eng., about the beginning of the 20th century. The variety of colour obtainable is a little greater than with the Wilton, though not as great as with the spool Axminster process; but short runs can be woven economically since the spool setting process is eliminated. In the gripper loom a series of vertically sliding carriers, equal in number to the number of tufts across the width of the carpet, are raised or lowered by a Jacquard mechanism. Each carrier has eight (or sometimes more) apertures, through which pile yarns from bobbins behind the loom are threaded. The movement up or down of a carrier, according to the operation of the Jacquard, brings the desired colour yarn opposite a gripper. The grippers are beaklike instruments, one to each carrier, that rotate about a shaft so that when they are in the upper position they are able to grip the tufts protruding from the carriers. A sliding knife cuts the tufts, and the grippers rotate backward and downward to insert the tufts between the ground warps. The tufts are then fastened around the weft and bound by a succeeding shot in the same way as in the spool Axminster.

The advantages of both types of Axminster loom have been combined in the spool-gripper loom. This is essentially a spool loom that uses a gripper mechanism for inserting the tufts, so that it is possible to obtain, at one and the same time, the variety of colour and design characteristic of the spool Axminster, together with the economy of the gripper.

Chenille.—Chenille carpets are produced by a two-loom operation. The pile surface is woven into a blanket on one loom and then is cut in long furry strips. The second loom weaves the back of the carpet and at the same time forms a shed through which the prewoven strips are inserted, brushed into place and secured. Expert hand labour is required for this process, which has been used only to produce luxurious carpets. Any pattern, colour or shape up to 30 ft. in width can be woven by the chenille method. It is often used for custom-designed carpets.

Tufted Carpet.—The tufting process differs from other basic production methods in that it uses a needle instead of a weave action to form the pile of the carpet and uses a prewoven backing for the basic construction. As the backing moves through the tufting machine, a bank of needles as wide as the carpet inserts individual tufts of pile yarn into the backing. The sewing mechanism locks the tufts in place; later a coating of latex is applied to further secure the tufts. The yarn is supplied to the needles through tubes from cones of yarn set on a large rack or creel back of the machine. Each needle is supplied by an individual cone, which is connected in turn to a "magazine" or "feeder" cone. When all the yarn is used on one of the first cones, a magazine cone takes over automatically so that a continuous flow of yarn is maintained. Machine widths vary from 36 in. to 18 ft. The commonest machine widths are 12 and 15 ft. During the first years this method was in operation narrow machines were used and solid colour loop pile carpet was produced. Electronic and mechanical controls were then developed that made it possible to produce carpet with varying heights of pile and texture design; tweed designs have been achieved by using moresque yarn or pile yarns of different colours.

Knitted Carpet.—Knitted carpet is produced by bringing together the backing yarn, the locking yarn and the pile yarn in one operation by three different sets of needles simultaneously. This is an adaptation of the knitting principle used in the manufacture of many other textile products; either flat or circular knitting machines may be employed. Knitted carpets are usually made of loop construction in either solid or varied colours. The varicoloured effects are created by using moresque yarn or different coloured yarns in a manner similar to that used for velvet or tufted carpets. The height of the pile may be varied, and the knitting machines can achieve textured designs. Both cut and uncut pile can be produced.

Finishing Processes.—The finishing processes for woven and knitted carpets are similar. After the carpet comes from the loom it may be sheared to insure evenness of the pile, steamed to impart a bloom to the finished product, inspected for missing tufts or other imperfections and trimmed and cut to the proper size for shipment. If the carpet has been manufactured in rug units, it may be bound or fringed at the ends. Back sizing or latex is applied to many woven carpets.

Tufted carpet is subjected to the same processing, but it also may be piece dyed if it was not manufactured from pre-dyed yarns. Additional backing fabric may be added and one or two coats of latex applied to the back.

A layer of foam rubber is attached to the back of some woven, knitted and tufted carpets; this obviates the necessity for using padding under the carpet and facilitates the seaming and installing of the carpet when it is used wall-to-wall.

A small volume of thick pile are made with hand-carved designs, which are created with a hand-shearing machine. Special design effects are sometimes created in custom-made rugs with a hand-tufting machine.

Raw Materials.—Carpets were made of natural fibres exclusively until World War II, when man-made fibres began to come into an ever-expanding use.

Wool.—Wool has continued to be the principal raw material for surface yarns. It was always the chief fibre used in woven carpets and is now used extensively in tufted and knitted carpets and rugs. In the 1950–60 decade, the U.S. carpet industry used an average of 135,000,000 lb. of wool annually. Wool traders distinguish between carpet wool and wool for wearing apparel. Carpet wool is obtained from native, unimproved breeds of sheep and is coarser and more wiry than wools used for making wearing apparel. Argentina and New Zealand are the principal sources of carpet wool, but considerable quantities also come from Pakistan, Iraq, Syria and India with small quantities from some European countries. China was a major exporter of carpet wools at one time but wool exports were halted when the Communists assumed control.

Cotton and Man-Made Fibres.—The high price of wool following World War II encouraged the use of cotton as a surface fibre for machine-made rugs and also fostered the use of man-made fibres. After a short while cotton consumption leveled off at approximately 6% of the total carpet fibre consumption. The chief man-made fibres in use in the early 1960s included rayon, nylon yarn, filament nylon, acrylics and modified acrylics. These fibres have been especially developed for the carpet industry and differ from fibres of the same type used for other textile products. Since many of them have proved highly suited for carpets, and, since the world supply of carpet wool is limited, more man-made fibres probably will be used for carpets in the future.

Materials for Backing.—Materials used for carpet backing include those also used for surface yarns and in addition jute, craft cord, cotton and some man-made fibres. Jute yarn is produced principally in India and Pakistan, where the jute is grown, with some spinning being done in Europe and the United States. Twisted craft cord yarns were developed in the United States and are used instead of jute in weaving and knitting and to some extent in tufting. Most prewoven backing for tufted carpets is made of jute and is manufactured in India. Millions of pounds of cotton yarn and some man-made fibres also are used.

The World Carpet Industry.—After about 1950 the carpet industry grew considerably throughout the world.

United States.—In the United States, production increased annually after 1950, with virtually the entire output consumed in the home market. Annual production exceeded 150,000,000 sq.yd. in the early 1960s; the wholesale value of the annual product exceeded $650,000,000. The annual consumption of broadloom carpet per household rose from just under 2 yd. in 1950 to 2.8 yd. in 1960. The use of carpet in commercial establishments and institutions expanded rapidly until by the early 1960s it was commonplace in stores, hotels, motels, theatres, office buildings and churches; it also was sometimes used in schools and libraries. The ability of carpet to prevent and absorb noise, its relative ease of maintenance and its aesthetic appeal led to its wide commercial use.

Tufted carpet was the leading type in the U.S. market in the early 1960s and represented two-thirds of total carpet production. Axminster production dropped from approximately one-half of the total in 1950 to about one-tenth, and during the same period Wilton and velvet production also decreased. Woven and knitted carpet accounted for approximately one-third of the total production at the start of the 1960s.

The U.S. consumer's acceptance of solid colours, tweeds and simple textures contributed to the popularity of tufted carpets and the decline of the Axminster weave. Highly complex texture designs in solid colours remained popular and were found in Wilton, velvet and knitted constructions. Oriental rugs and machine-made rugs of traditional and period designs have continued to be of limited interest. Custom-designed rugs and carpeting in woven and tufted constructions became more popular and influenced mass-produced carpets.

Great Britain.—The British industry ranked second in size after the United States in the early 1960s; in Great Britain, traditional weaves and designs remained popular. Annual production exceeded 62,000,000 sq.yd., valued at nearly £90,000,000. Of the carpet produced in Great Britain, more than 50% was Axminsters, 20% was tufted and 15% was Wiltons. Sales in the home market more than doubled between 1951 and 1960, totaling about 23,000,000 sq.yd. in 1951 and more than 55,000,000 sq.yd. in 1960, or slightly more than 1 sq.yd. per person. Exports were sent principally to other members of the commonwealth, with Australia being by far the largest buyer. Several British manufacturers established or helped to establish carpet factories in Australia, Canada, New Zealand and South Africa.

Canada.—The Canadian industry manufactures approximately one-half of the carpet consumed in Canada; the remainder, except for small amounts brought in from the United States, is imported from England, Belgium and Japan. Canadian plants produce all the woven types with the exception of chenille. Tufted carpets were being produced by some of the plants, and a few new mills were producing tufted carpets exclusively. The Canadian industry was not producing for export in the early 1960s.

Belgium.—The Belgium industry grew remarkably after World War II and became the world's third largest producer and a major exporter of woven carpets. Exports in some years have exceeded 80% of the total production. Chief importers of Belgian carpets have been the United States, Great Britain, Canada, African countries and other European countries. Belgian woolen carpet production was chiefly Wilton and velvet, although Belgian factories also manufactured large amounts of woven cotton carpet, principally inexpensive rugs of traditional design that were particularly popular in the United Kingdom.

Japan.—The Japanese machine-made carpet industry came into existence after World War II when machinery for making Wilton and velvet carpets was imported. The Japanese have become important exporters of Wilton and velvet carpets to the United States, Canada and some European countries. Virtually all carpet made in Japan is exported. Some Axminster equipment was being used in Japan, and tufted carpet was produced on a small scale.

Other Countries.—Carpet industries also exist in Europe in Denmark, France, the Federal Republic of Germany and the Netherlands. Central and South America had not become large carpet consuming areas by the early 1960s. Mexico had a small woven industry, and small plants were located in various places in South America. The near east continued to manufacture and export hand-made rugs, but no machine-made carpet industry developed there. (P. M. J.)

CARPI, GIROLAMO DA (1501–1556), Italian painter and architect whose principal scene of activity was Ferrara, was born in Ferrara and died there. He was a pupil of his father, Tommaso, then of Garofalo. He had a particular admiration for Correggio, several of whose works he copied. He was also influenced by Parmigiano and slightly by Raphael, but chiefly by Dosso Dossi. As a young man he visited Parma and Modena and worked in Bologna; in the church of S. Martino Maggiore in the latter city he painted an altarpiece with the "Adoration of the Magi" (1530). In 1540 he entered the service of Ercole d'Este, duke of Ferrara. His works for the Este family include an allegory representing "Opportunity and Patience" (1541, Dresden) and three frescoes—"Vintage," the "Triumph of Ariadne" and the "Triumph of Bacchus" (all at Ferrara). He also painted portraits. As an architect he is stated by G. Vasari to have prepared designs for a large number of Ferrarese private houses, and he worked on the restoration of the Castello after it had been damaged by fire in 1554. (M. W. L. K.)

CARPI, UGO DA (1479/81–1532), Italian painter and printmaker, the first Italian practitioner of the art of the chiaroscuro woodcut, was born in Carpi and was active in Venice and Rome. Many of his chiaroscuros are after drawings by Raphael and Parmigiano. His claim to the invention of this process has long been contested. Hans Burgkmair and Lucas Cranach were known to have practised it in the north before 1510, whereas there is no definite evidence of Ugo's work in chiaroscuro until 1516, when he appealed to the Venetian senate for protection from his imitators. None of his paintings is extant.

CARPINI, JOANNES DE PLANO (*c.* 1180–1252), a Franciscan friar and traveler, the first noteworthy European traveler in the Mongol empire and the author of the earliest important western work on central Asia, was born in Umbria, probably at Piano della Magione (formerly Pian di Carpini) near Perugia. The date of his birth is not known, but he was a contemporary and disciple of St. Francis of Assisi. By 1220 he was a member of the Franciscan order and subsequently took a leading part in Franciscan teaching in northern Europe; he held successively the offices of *custos* ("warden") in Saxony and of *minister* ("provincial") of Germany, and afterward of Spain, perhaps also of Barbary and of Cologne. He was in Cologne at the time of the great Mongol invasion of eastern Europe and of the disastrous battle of Liegnitz (April 9, 1241).

Fear of the Tatars had not abated when four years later Pope Innocent IV dispatched the first formal Catholic mission to the Mongols, partly to protest against their invasion of Christian territory and partly to gain reliable information about their numbers and their plans; there may also have been the hope of alliance with a power who might be invaluable against Islam. At the head of the mission, the pope placed Friar Joannes, then already more than 60 years of age.

On Easter day, 1245, Carpini set out. He was accompanied by Stephen of Bohemia, another friar, who was left behind at Kiev. After seeking counsel of Wenceslaus, king of Bohemia, the friars were joined at Breslau by Benedict the Pole, another Minorite, appointed to act as interpreter. The mission entered the Tatar posts at Kanev. Thereafter the Franciscans crossed the Dnieper, the Don and the Volga. On the Volga stood the *ordu,* or "camp," of Batu, the supreme commander on the western frontiers of the Mongol empire and the conqueror of eastern Europe. Carpini and his companions, with their presents, had to pass between two fires before being presented to Batu at the beginning of April, 1246. Batu ordered them to proceed to the court of the supreme khan in Mongolia; accordingly on Easter day, April 8, 1246, they began the second and more formidable part of their journey. Their bodies were tightly bandaged to enable them to endure the excessive fatigue of their great ride through central Asia. Their route was across the Ural (Yaik) river and north of the Caspian sea and the Aral lake to the Syr-darya (Jaxartes) and the Muslim cities which then stood on its banks; then along the shores of the Dzungarian lakes and thence to the imperial camp of Sira Orda (*i.e.,* the "yellow pavilion") near Karakorum and the Orkhon river. They reached their destination on July 22, after a ride of about 3,000 mi. in just over 106 days.

On arriving at Sira Orda, the Franciscans found that the interregnum which had followed the death of Okkodai, the imperial ruler, had ended. His eldest son, Kuyuk, had been designated to the throne; his formal election in a great *Kuruttai,* or "diet of the tribes," was witnessed by the friars along with more than 3,000 envoys and deputies from all parts of the Mongol empire. On Aug. 24 they were present at the formal enthronement at the near-by camp of the "Golden" Ordu and were presented to the supreme khan. They were retained until November and were then dismissed with a letter for the pope; this letter, written in Mongol, Arabic and Latin, was little more than a brief imperious assertion of the khan's role as the scourge of God. The friars suffered greatly on their long winter journey homeward and did not reach Kiev until June 9, 1247; they were welcomed as risen from the dead by the Slavonic Christians. Subsequently they delivered the khan's letter and made their report to the pope who was still at Lyons.

Immediately after his return, Carpini recorded his observations in a large work variously styled in the manuscripts extant—*Historia Mongalorum quos nos Tartaros appellamus* and *Liber Tartarorum, or Tatarorum.* He divided his treatise into eight chapters on the country, climate, customs, religion, character, history, policy and tactics and on the best way of opposing them; in a ninth chapter he described the regions traversed. He added four name lists: of the peoples conquered by the Mongols, of those who had successfully to his time (1245–47) remained unconquered, of the Mongol princes and of witnesses to the truth of his *Historia,* including several merchants trading in Kiev. His *Historia* discredited the many fables concerning the Tatars current in western Christendom. Its account of Tatar customs and history is probably the best treatment of the subject by any medieval Christian writer; only on geographical and personal detail is his book inferior to that written a few years later by William of Rubruquis (*q.v.*) or Rubrouck. Carpini's companion, Benedictus Polonus, also left a brief account of the mission, taken down from his dictation. Not long after his return, Carpini was installed as archbishop of Antivari in Dalmatia and was sent as legate to Louis IX. He died on Aug. 1, 1252.

For a long time the *Historia* was only partially known through an abstract in the great compendium of Vincent of Beauvais (*Speculum Historiale*), made a generation after Carpini's own and first printed in 1473. R. Hakluyt (1598) and P. Bergeron (1634) published portions of the text, but the complete work was not printed until 1839: M. D'Avezac (ed.) in *Recueil de voyages et de mémoires,* vol. iv, Geographical Society of Paris.

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CARRACCI, the name of three Italian painters, born at Bologna and blood relations, who possessed markedly individual artistic personalities and were major influences in Italian painting from the end of the 16th century. Agostino Carracci (1557–1602), the more cerebral, and his brother Annibale (1560–1609), the truer artist, were at first led by their cousin Lodovico (1555–1619), a pupil of Prospero Fontana. Mannerist influences at Bologna persisted less in the styles of the two younger men, although Denis Calvaert had his effect on Agostino, and B. Passerotti on Annibale's early genre and portraiture. Tours of northern Italy developed their precocious talents, visits to Venice and to Parma being of particular significance. Agostino was the first to imbibe Venetian art. To Annibale is mainly attributed the rediscovery of Correggio, forgotten outside Parma for a generation. But the mystery of Lodovico's devotional works, and the aristocratic sentiment of his portraits, were unmatched by either cousin. He alone comprehended the tender feeling of the art of Federigo Barocci and mastered the poetry of night. Treatment of landscape in his early works was of importance for Bartolomé Esteban Murillo. His "Martyrdom of S. Angelo" (*c.* 1598) anticipates Francisco de Zurbarán. He became the leading master of the Accademia degli Incamminati, a school which was to include Guido Reni and Domenichino.

Each Carracci evinced his individuality in a monumental painting for an Emilian church. In S. Gerolamo della Certosa, Bologna, Lodovico's "Preaching of the Baptist" (1592) hung opposite Agostino's almost contemporaneous masterpiece, "The Last Communion of St. Jerome," which was to inspire altarpieces both by Domenichino and Rubens. Annibale's "Madonna of St. Matthew" (1588) for S. Prospero, Reggio, glowing with Venetian colour, manifests two persistent characteristics of his genius combined: the noble, classicizing strain in the Correggesque angel seated in the foreground, and the genial and bucolic in the simulated stone enrichment of the Madonna's plinth, a swag of fruits and a harpy. These last, though painted in grisaille, convey those sensations of warmth and colour which radiate from his capital successes, decorations of palace rooms.

In Bologna, the friezes of Palazzo Fava (1584) and Palazzo Magnani (1588–91) were frescoed by the three in concert. In Palazzo Magnani the frieze of Roman history, designed by Annibale, initiates ordered and airy landscape as a principal subject. In heroic landscape Domenichino and Nicolas Poussin were Annibale's heirs. In 1595, with his stupendous proto-baroque "Charity of St. Roch" still unfinished, Annibale was summoned south by Cardinal Odoardo Farnese to decorate his Roman palace. Having decorated the Camerino (study) there, he was joined (1597) by Agostino in his greatest task, the frescoing of the Galleria ceiling (1597–1603/4) with love fables. This was the noblest achievement in the metropolis since Michelangelo's overpowering display in the Sistine chapel. A triumph of classicism tempered with humanity, it became a feeding ground for the baroque imagination of Rubens and Bernini.

Agostino left (1600) to work for Ranuccio Farnese in Parma, where he died. Misinterpretation of Faberio's oration at his funeral occasioned the legend that the Carracci set an eclectic program. Their brilliant renewal of art, however, was made possible by observation of nature, study and revision of poses from life, and boldness of scale in draftsmanship. Such working methods enabled them to profit by visual knowledge won of past masters by drawing and printmaking. Engraving was not an important activity for Lodovico. But it formed a major part of Agostino's total production, his prints after Tintoretto and Titian being of especial significance. Annibale's "Holy Family" of 1590 and "Jupiter and Antiope" of 1592 were prints evidently appreciated by Rembrandt; and his two engravings on silver, "The Christ of Caprarola" of 1598 and the "Drunken Silenus" (for the Farnese dish) rank among the most beautiful and influential designs of the period. Annibale, ill-requited by Cardinal Farnese, died in Rome after four years of melancholic sickness and intermittent production. Lodovico continued painting until 1619.

See Catalogues of "La Mostra dei Carracci" (1956). (Ml. J.)

CARRANZA, BARTOLOMÉ DE (Bartolomé de Miranda) (1503–1576), Spanish Dominican theologian, archbishop of Toledo, unjustly imprisoned for nearly 17 years by the Spanish Inquisition, was born at Miranda, Navarre. He entered the Dominican order in 1520 and had a brilliant scholastic career. As Charles V's envoy he attended the Council of Trent and preached there. In 1546 Carranza published his *Summa conciliorum* and his *Controversiae quattuor*, an important study of the authority within the church of tradition, scripture, the pope and the councils, forestalling the work of Melchor Cano (*q.v.*). He also held positions of responsibility in the Dominican order. In 1554–57 he was in England, as adviser to Philip II at his marriage to Mary I, and in 1557 Philip named him archbishop of Toledo and primate of Spain; he attended the deathbed of Charles V in 1558. In that year he published his *Comentarios sobre el catechismo christiano* and on suspicion of Lutheranism in that work he was arrested by the Inquisition on Aug. 22, 1559.

The accusations of urging Bible reading for lay persons, writing theology in the vernacular and suspected "illuminism" were in line with the fears of the time. Though the Council of Trent in 1563 declared his work sound, Philip and the Inquisition would not yield, mainly (it seems) for reasons of political prestige. Pius V called him to Rome in 1567, but he was not acquitted until April 14, 1576, when he was sent to the Dominican priory of the Minerva. He died there 18 days later, on May 2. Carranza was a man ahead of his time and a pioneer of historical theology. It remains strange that one so esteemed for wisdom and goodness should have been kept so long without redress, especially when the final verdict was for his innocence.

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CARRANZA, VENUSTIANO (1859–1920), president of Mexico, was born on Dec. 29, 1859, in Cuatrociénegas, Coahuila, the son of a landowner who was active in civil and military affairs. Carranza planned a professional career but was forced by eye trouble to abandon his studies. After 1887 he became active in local and state politics. At various times he served as municipal president, state deputy, state senator, temporary governor, national deputy and national senator. Pres. Porfirio Díaz (*q.v.*) intervened to prevent Carranza's election as governor in 1910, and Carranza therefore joined the Madero revolution (1910–11). After Madero's triumph he became provisional governor of Coahuila. Soon he was elected governor and was in that position in 1913 when Madero was overthrown and assassinated by Gen. Victoriano Huerta's forces. As the duly elected governor, Carranza insisted that he, not Huerta, represented the popular will and he assumed the leadership of a revolutionary movement to overthrow Huerta. His "Constitutionalist" army, including such figures as Pancho (Francisco) Villa (*q.v.*) and Álvaro Obregón (*q.v.*), forced Huerta to flee in July 1914.

Within four months after Huerta's overthrow, a split among the victors brought on a new civil war, with Villa and Emiliano Zapata the most important leaders opposed to Carranza's provisional government. By mid-1915 Obregón's successful campaign against Villa assured a Carranza victory. Carranza was hailed as "First Chief" and continued to act as provisional president. At the Querétaro constitutional assembly in late 1916, the fundamental difference between Carranza's 19th-century liberalism and Obregón's welfare state philosophy became apparent. Carranza was forced to accept reluctantly some constitutional provisions that were contrary to his philosophy and that he did not seriously try to effectuate when he became constitutional president on May 1, 1917. Aside from domestic disturbances by Villa and Zapata, Carranza's term was characterized by serious financial problems and political unrest brought on by his reluctance to institute far-reaching reforms. He also had serious diplomatic problems with the United States, generally revolving around the protection of American interests. He maintained Mexico's neutrality in World War I.

Carranza's term was due to expire Dec. 1, 1920. The most plausible candidates were generals whose political philosophy differed materially from Carranza's, and he therefore chose a civilian, Ignacio Bonillas, to succeed him. When it became obvious that Carranza intended to force Bonillas' election, Obregón and his friends started a revolution in April 1920. By early May the president, forced to abandon Mexico City, started for Veracruz; hemmed in, defeated and virtually abandoned, he began an arduous horseback trip to the north, but on the night of May 20–21 he was ambushed and killed at Tlaxcalaltongo, Puebla, by the forces of Rodolfo Herrera. *See* also Mexico: *Independent Mexico*. (C. C. Cu.)

CARRARA (Carraresi), a medieval Italian family who ruled first as feudal lords in the countryside of Padua and then as despots in the city. The basis of their power was land, and they first appear (1027) as well-endowed members of the rural gentry. Subsequently they acquired rights of jurisdiction either as counts or as holders of episcopal fiefs. Thus by the 12th century they had built up a considerable dominion, centred on Carrara, a village and castle (*castellum*) near Padua, from which the family took its name. This lordship, however, soon dissolved, partly through family disunion, but mainly because of conflict with the local commune at Carrara and still more with the urban commune of Padua. In the 13th century the castle and jurisdiction of Carrara were ceded to Padua, where the family was obliged to take up residence.

The Carraresi then transferred their ambitions to Padua itself and, by exploiting the feuds of urban politics first as Ghibelline and then as Guelph leaders, were able to found a new and more illustrious dominion. It began with the election of Jacopo da Carrara as perpetual captain general of Padua in 1318 but was not finally established, with Venetian help, until the election of his nephew Marsiglio in 1337. Meanwhile, Padua had been under the nominal rule of imperial vicars (1320–28) and then of the Della Scala. From *c.* 1348 the Carrara were themselves imperial vicars.

For approximately 50 years the Carraresi ruled with no serious rivals except members of their own family. Marsiglio was succeeded without incident by Ubertino (1338–45), but Marsigliello, who succeeded Ubertino, was deposed and murdered by Jacopo di Niccolò (1345–50). Jacopo was then murdered by Guglielmino and succeeded by his brother Jacopino di Niccolò (1350–55), and Jacopino in turn was dispossessed and imprisoned by his nephew, Francesco il Vecchio (1355–87). The Carrara court was one of the most brilliant of the time. Ubertino in particular was a patron of building and the arts, and Jacopo di Niccolò was a close friend of Petrarch.

The lordship of Padua, however, though it extended to Belluno and Feltre (1361) and to Treviso (1383), was too small and finally too unpopular to survive the cupidity of greater neighbours, especially Venice and the Visconti of Milan. Francesco il Vecchio, reversing the family policy, inclined to the Visconti against the Venetians and formed an alliance (1385) with Gian Galeazzo Visconti against the Della Scala, who were backed by Venice. His policy was ill-conceived: though Verona was taken, the Visconti promptly formed a further alliance with Venice itself and the Este for the conquest of Padua. Francesco had to surrender his dominions (1388) and died a prisoner of the Visconti (1392). Meanwhile his son Francesco Novello, who had also been forced to surrender because of dissension in the city, had made peace with Venice and in 1390 recaptured Padua. On Gian Galeazzo's death in 1402, Francesco Novello also seized Verona and tried to take Vicenza. The result was war again, with the Venetians. First Verona, then Padua fell (Nov. 1405); Francesco and two of his sons (Francesco and Jacopo) were conveyed to Venice and there put to death in 1406 for conspiracy with Venetian traitors. Francesco's third son, Marsiglio, was killed by the Venetians after an unsuccessful attempt on Padua in 1435.

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CARRARA: *see* MASSA-CARRARA.

CARREL, ALEXIS (1873–1944), French surgeon, biologist and sociologist, who was awarded the Nobel prize in physiology and medicine in 1912 for his work in developing a new method for suturing blood vessels, a method which made it possible to perform blood transfusion safely and laid the groundwork for further studies of transplantation of arteries, veins and organs. He was born at Ste. Foy-lès-Lyon on June 28, 1873, received his medical degree in 1900 and for two years was prosector at the University of Lyons. He began there his experimental researches, and continued them in 1905 at The University of Chicago. In 1906 he was appointed to the staff of the Rockefeller Institute for Medical Research in New York, becoming a member in 1912. His work on blood vessels won him the Nobel prize. He also studied the preservation of tissues outside the body and its application to surgery. This work led him to investigate the conditions of tissues when they are living actively outside the organism. Returning to France in World War I, he helped to devise the Carrel-Dakin treatment for wounds, by means of which many lives were saved and countless amputations avoided. At the same time, with Lecomte du Noüy and other collaborators he studied the laws of the cicatrization of wounds. After 1919 at the Rockefeller institute he developed new techniques for the cultivation of tissues and organs in vitro.

In 1941 he promoted in France the Fondation Française pour l'Étude des Problèmes Humains, where under his management all human problems were studied scientifically with a view to reaching synthetic conclusions of practical application. Carrel died in Paris on Nov. 5, 1944.

Among his publications are: *Man, the Unknown* (1935); *The Making of Civilized Man* (1937); *The Prayer* (1948); *The Culture of Organs* (with C. A. Lindbergh; 1938); *Journey to Lourdes* (1950); *Reflections on Life* (1952).

See R. Soupault, *Alexis Carrel* (1952). (JN.-M. C.)

CARREÑO DE MIRANDA, JUAN (1614–1685), Spanish court painter, was born in Avilés, Asturias, on March 25, 1614. He went as a youth to Madrid, where he is said to have been a pupil of Pedro de las Cuevas and Bartolomé Román. A follower of Velázquez, he painted frescoes in the royal palace under his direction, and after his death was appointed painter to the king (1669) and court painter (1671). His many portraits of the queen mother, Mariana of Austria, and the young King Charles II followed the tradition of Velázquez' court portraits. His style and religious compositions were also much influenced by Van Dyck. He died in Madrid in Oct. 1685, leaving several followers.

CARRERA, JOSÉ MIGUEL (1785–1821), leader in the early struggle for the independence of Chile, first president of that country and one of the few Latin-American revolutionary leaders who had visited the United States, was born in Santiago on Oct. 15, 1785. Trained in the Spanish army, fighting against the French invaders, he returned in 1811 to Chile, where his espousal of independence and republicanism won him quick popularity. Supported by his brothers Juan José and Luis, he assumed the leadership of the revolt against Spain; by a *coup d'etat* in 1811 he placed himself at the head of the national government and later the same year made himself dictator. He reorganized the national army and the public finances, created the National Institute and inaugurated the first newspaper, but his instability and thirst for power introduced into the independence movement discordant notes which soon led to internecine strife and permitted the Spaniards to restore royal rule in Chile. Bernardo O'Higgins (*q.v.*) was elevated to the leadership of those forces opposing Carrera and his brothers. In 1813 Carrera was removed from power by the junta in favour of O'Higgins, but early in 1814 he regained control. During the ensuing invasion of Spanish forces from Peru, Carrera and O'Higgins were defeated at Rancagua (Oct. 1814). Carrera fled to the protection of Gen. José San Martín (*q.v.*) in the province of Mendoza, Arg. San Martín sided with O'Higgins, however, and Carrera sought aid against his opponents, first in Buenos Aires and then in 1815 in the United States. On his return to Argentina in 1816 he was not allowed to continue into Chile. This circumstance and the death of his brothers at the hands of the followers of San Martín moved him to lend his military experience to the provincial chiefs in their sporadic revolts against Buenos Aires. He was eventually betrayed by his own men, captured and shot at Mendoza on Sept. 4, 1821. A controversial figure throughout his life, he remains the subject of acrimonious debate among Chilean academicians. (J. J. J.)

CARRERA, RAFAEL (1814–1865), dictator of Guatemala, was born in Guatemala City, Oct. 24, 1814. He had no formal education and remained illiterate all his life, but rose by revolution to become general of the army, protector of the church and president of the republic. With the support of the Indian peasantry and the lower clergy, Carrera overthrew the state government of Guatemala in 1837 and again in 1839. In the latter year he brought about the secession of Guatemala from the United States of Central America, proclaimed it an independent republic and established a dictatorship that lasted for a quarter of a century. In 1854 elections were abolished and Carrera was named president for life.

This regime, which was at once military, theocratic and personal, destroyed liberalism in Guatemala and union in Central America. It helped expel adventurers from Nicaragua led by William Walker (*q.v.*), thwarted two attempts by Mexico to annex Guatemala and set limits to the territorial expansion of neighbouring Belize (British Honduras). The atrocities and reactionary policies of Carrera's government were partially offset by a greater measure of political peace, economic progress and racial equality. He died April 4, 1865. His successor, Gen. Vicente Cerna, whom he appointed, kept the regime intact only until 1871. (M. L. M.)

CARRHAE, BATTLE OF. Carrhae (Harran, now a small village in southern Turkey), in northern Mesopotamia, was the site of the defeat of a Roman army by the Parthians in 53 B.C. War was precipitated by the triumvir M. Licinius Crassus who wanted a military reputation to balance that of his partners, Gnaeus Pompeius and Julius Caesar. With seven legions, but insufficient cavalry, in 54 he invaded Mesopotamia, which in 53 was defended by a Parthian noble of the Suren family (whose personal name is not known). Learning that Surenas was in the desert east of the Euphrates river, Crassus boldly left the cover of the river and struck out toward Carrhae; this move has been condemned by some as rash, yet if Seleucia on the Tigris river was his ultimate objective, he had to cross open country at some time. Suddenly the Parthians were upon him, with a force of 1,000 cataphracts (armoured knights) and 10,000 horse-archers. His troops were neither acclimatized nor adapted to desert warfare. While his son Publius in vain launched a covering attack with his cavalry, the main Roman forces had formed a square against the encircling Parthians, and vainly tried with their shields to cover both body and head against the incessant showers of Parthian arrows; Surenas' brilliant provision of a special corps of 1,000 Arabian camels, one for every ten men, enabled the Parthians to retire by sections and replenish their quivers. After dark Crassus did not risk a counterattack, abandoned 4,000 wounded, and withdrew to Carrhae. Lacking provisions, he was compelled by his demoralized men to negotiate, but was cut down by the Parthians in the attempt. About 10,000 Romans escaped, but the rest of Crassus' 44,000 men were either captured or killed. About 10,000 prisoners were later settled by the Parthians at Merv (*q.v.*) near the Oxus (Amu-Darya) river. At Carrhae the Parthians thus dealt a stunning blow to Roman prestige in the east. The success of the mobile horse-archer, supported by cataphracts, foreshadowed future developments in Roman warfare in the east, while the death of Crassus had most serious repercussions on Roman political life.

See Plutarch, *Life of Crassus*, 20–25; for a theory of possible Roman survivors, H. H. Dubs, *A Roman City in Ancient China* (1957).
(H. H. Sd.)

CARRIAGE, a passenger-carrying vehicle usually drawn by horses or other animals.

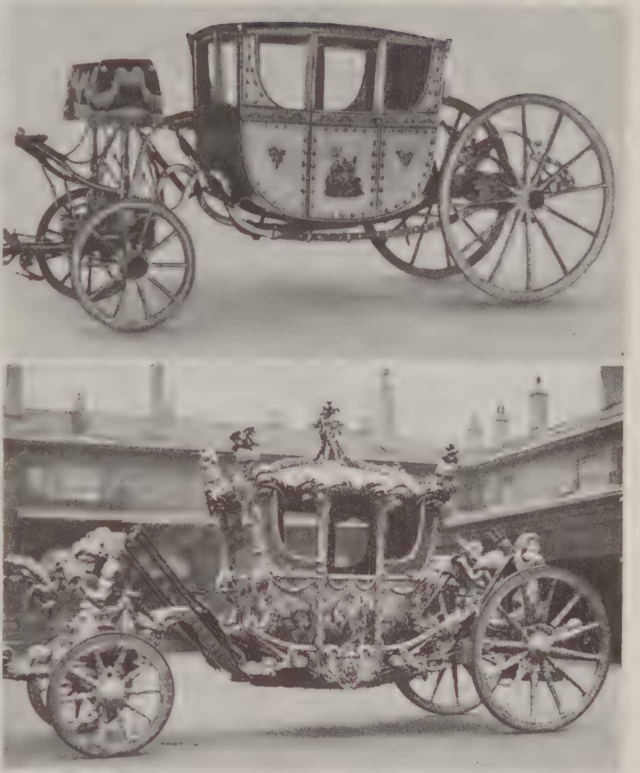
Origin and Early Development.—While it is not possible to determine the exact period at which wheeled, passenger-carrying vehicles were first used, archaeological evidence shows that a crude form had appeared in Sumer as early as 3500 B.C. By 2500 B.C. chariots were being used for military purposes in the middle east. These vehicles had two solid wheels made up of three or four triangular pieces of wood fitted together and bound by a wooden or leather rim, or felly, which was sometimes studded with copper nails. About 1500 B.C. solid wheels gave way to spoked wheels, which made the vehicles much lighter and faster. (*See* also WHEEL.) The chariot was drawn by two horses, over whose shoulders a wooden yoke, attached to a central pole, was placed.

At about the same time chariots appeared in Persia and Asia Minor, and by 1000 B.C. their use had extended into Egypt. Subsequently, chariots were adopted by the Greeks and the Romans for military and sporting purposes. (*See* also CHARIOT.) Primitive carts also were in use in the middle east and southern Europe by 1500 B.C., and funeral hearses have been found in excavations of the royal tombs at Ur, Kish and Susa. (*See* also CART AND WAGON.) The design of such vehicles remained comparatively crude, and it is doubtful that any important improvements were made until Roman times, when better roads and comparatively stable social conditions made travel less hazardous than it had been. The Romans constructed different types of wagons for carrying plunder, baggage or agricultural goods, as well as special carriages, such as the *pilentum* and the *carpentum*, and horse litters, or *basternae*, for ceremonial occasions. They were also responsible for a number of innovations, including tandem draft and metal horseshoes.

Middle Ages.—During the middle ages horse-drawn vehicles became commoner, but, since the Roman roads fell into disrepair and there was little traveling, development of the carriage was slow. There was some advance in the design of harness, however, including the introduction of the padded horse collar, which for the first time made possible the full use of the animal's tractive power. Concurrent similar developments in the middle east may indicate interchange of ideas between Europe and the east.

At the end of the middle ages the basic design of a carriage or cart consisted of a simple rectangular wooden platform with front and rear axles. In some carriages the axles were joined by a long pole, the perch, which at the back was fitted into the solid rear axle and at the front was inserted into the transom, a beam of wood placed above and parallel to the front axle. The front axle was connected to the transom by a strong metal pin that allowed the axle to swivel freely. The floor of the carriage was built up of wooden planks located between the axles, and the sides were made of wood and leather. A unique surviving example of this crude unsprung carriage, the forerunner of the stagecoach, is the 15th-century carriage of the emperor Frederick III in the Joanneum museum at Graz, Aus.

Development After the 15th Century.—The coach, which originated in Hungary in the 16th century, having evolved from the earlier basic design described above, was introduced into England by the earl of Arundel in 1580. It was an ornate vehicle with a painted and gilded body, a flat roof supported by decorated poles, and sides formed by curtains or leather screens. In later forms the body was suspended on leather straps from a wooden chassis—the first form of suspension system.



(TOP) BY COURTESY OF CARRIAGE HOUSE OF SUFFOLK MUSEUM AT STONY BROOK, LONG ISLAND; (BOTTOM) CENTRAL PRESS PHOTOS LTD.

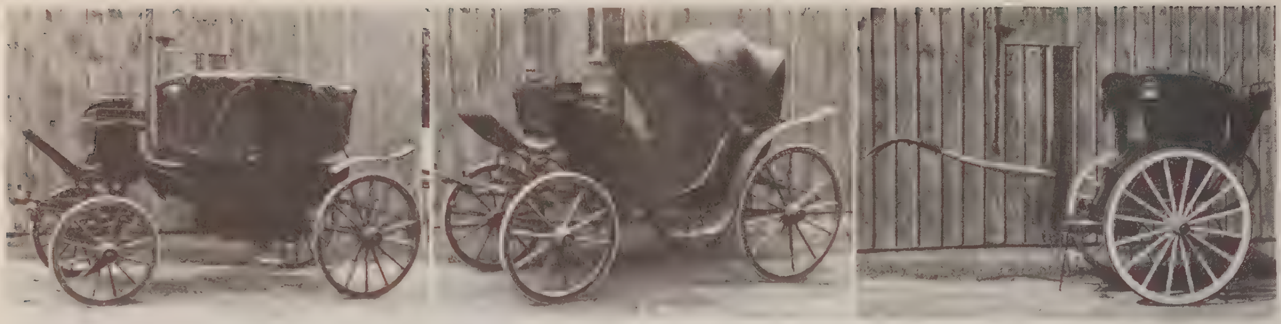
FIG. 1.—(TOP) BERLIN COACH, ORIGINATED IN GERMANY, 17TH CENTURY; (BOTTOM) CORONATION COACH, ENGLAND, 1760–62

In the 17th century the gradual improvement of the roads, together with greater technical knowledge and craftsmanship, contributed to carriage development; for example, plate-glass windows were introduced in 1680. Carriage design became specialized, and general-purpose vehicles were replaced by carriages designed specifically for short or long journeys or for use in towns. They increased in numbers until by the end of the 17th century the streets of London, Paris and Milan were crowded with vehicles; in 1662 Samuel Pepys estimated that there were at least 2,500 hackney carriages in London. The private carriage became a symbol of prestige.

About the end of the 18th century initiative in design and construction passed from the continent to England, where, during the following century, carriage building reached its zenith. In 1787 John Collinge invented an axle that carried a month's supply of oil; previously, oiling had been an almost daily task. In 1805 Obadiah Elliot patented a method of suspending carriages on elliptical springs, which, when used alone or in conjunction with the older C spring (described below), had a decisive effect on the design of carriages. Later Samuel Hobson reduced the size of carriage wheels and lowered the suspension system. All these improvements made carriages more comfortable, neater in appearance and easier to control.

Types in Use, 17th–19th Centuries.—The *corbillard*, four-wheeled with a flat bottom and half-open, curtained sides, was a popular carriage in France in the early 17th century. It was succeeded by the *sociable*, a low-slung carriage of German origin with two facing seats and an opening hood.

The *berlin* originated in Germany about 1660 but was adapted and improved in France. The body had a curved base that hung easily in leather braces suspended from metal strips bent into the shape of the letter *C*. These C springs absorbed much of the road shock, the berlin thus being one of the first vehicles to have good springs. It was constructed with two perches instead of the single perch formerly used. This made for greater safety, since the perch sometimes broke, and, as the two long poles afforded a certain amount of spring when weighted only in the middle, it also contributed to ease of movement. In appearance, the berlin was well-proportioned. Its four-wheeled, closed body carried four passengers sitting face to face in pairs. There was a box seat for the coachman and, at the rear, a platform where two



BY COURTESY OF CARRIAGE HOUSE OF SUFFOLK MUSEUM AT STONY BROOK, LONG ISLAND

FIG. 2.—(LEFT) LANDAU, GERMAN TOWN CARRIAGE, 17TH–18TH CENTURY; (CENTRE) VICTORIA, ENGLISH HOODED CARRIAGE, 19TH CENTURY; (RIGHT) HANSOM CAB, ENGLISH ENCLOSED CAB, 1834

grooms stood; it usually was drawn by four horses. There were numerous variations on the basic berlin design. A berlin with an especially light chassis, built for rapid travel, was known as a *diligence*. With the front seat omitted it was called a *berlin coupé*. The *vis-à-vis* was another type of berlin and carried two passengers sitting face to face.

The generic terms *coach* and *chariot* are applied to many varieties of vehicle. Specifically, during the 17th, 18th and 19th centuries, the coach and the chariot were carriages of similar design, the chariot being somewhat the smaller. The coach had seating accommodations for four people, who sat facing each other in pairs and generally was drawn by four horses. Either one or two pairs were used to draw the chariot, in which either one passenger or two sat on a single seat facing forward.

The *barouche*, *landau* and *landaulet* were large open four-wheeled carriages. The barouche had a folding hood, a high driving seat and was generally used in town. The landau and its smaller version, the landaulet, were distinguished by their hoods, which opened in the middle of the body and folded back to either end. These elegantly appointed vehicles were favourite town carriages in the 17th and 18th centuries.

For private travel over long distances the well-to-do often used the *Briska*, a four-wheeled Austrian carriage with a long body that was designed to give the passengers plenty of room.

The name *phaeton* refers to a family of vehicles, nearly all of which had speed and elegance. Light in construction, with no doors, high seating and large wheels, they were ideal for the gentleman driver. The first patent for a phaeton vehicle was granted in 1788. One of the most important types, the *mail phaeton*, introduced early in the reign of George IV, was the first fashionable two-horse vehicle designed to be driven by its owner. The *stanhope phaeton* was lighter than the mail phaeton; the *American spider phaeton*, like the *tilbury phaeton*, was used for horse-show work.

The *post chaise* originated as a two-wheeled French carriage specially designed for speed and comfort on long journeys. The four-wheeled version was copied and used extensively in England during the 19th century. Early examples were fitted with C springs, elliptical springing being introduced in 1804. An enclosed body accommodated two people comfortably on a single seat facing forward. A view of the surrounding country was obtained through large front and side windows. The post chaise generally was drawn by four horses controlled by two postilions and so had no coach box. Relays of horses were required, since the vehicle was employed in long-distance travel, and these were obtained from "posts" established along the route. The post chaise provided a faster and pleasanter method of public travel than did its contemporary the stagecoach; average speeds of up to ten miles per hour could be maintained. "If I had no duties and no reference to posterity," said Dr. Johnson, "I would spend my life in a post-chaise driving briskly with a pretty woman."

The *charabanc* originally was a four-wheeled vehicle, driven by its owner and used to carry guests to hunting expeditions and on excursions to the races. Early models had a high coach box and up to four rows of seats facing forward. In England it was pulled by two horses, though in France, where it originated, up to six horses were used over rough country. Later the charabanc was modified for public transport. It was entered from the rear and had five or more rows of seats facing forward.

Two of the most important carriages introduced during the 19th century were the *brougham* and *victoria phaeton*. The former, first built for Lord Brougham, to his own design, in 1838, later became the most widely used town carriage. It had a rather heavy body suspended on Elliot elliptical springs and reached by a single step. The passenger seat, completely enclosed, faced forward. The brougham, the first four-wheeled vehicle meant to be drawn by one horse, was both safe and economical. When two horses were used, the coachman generally was accompanied by a groom.

The *victoria*, whose great popularity was attributable partly to the fact that it was Queen Victoria's favourite carriage, was a low, comparatively light, four-wheeled vehicle with a single forward-facing seat that could be covered with a large hood. Driven by a coachman from a high seat over the front axle, it was drawn by one or two horses. The most elegant victorias were finished in black with no ornamentation. Some types are still in use in Europe as horse-drawn cabs. The victoria was sometimes known under the slang name of *growler*, which was also applied to the brougham.

Two-Wheeled Vehicles.—The *gig* first appeared in Paris in the 17th century, and the basic design of this simple vehicle has been little modified. The first gigs had light, shell-like bodies attached to two long, curved shafts, and were drawn by one horse. Because of their high centre of gravity, they overturned easily; their popularity was attributed to the fact that they were light, fast and comparatively cheap. They were the forerunners of the *cabriolet* in France, the *whisky* or *chaise*, the *tilbury* and *stanhope gig* and the *dogcart* in England, and the *shay* in America. A gig drawn by two horses was called a *curricle*. The dogcart was originally a small one-horse carriage designed for shooting parties, with seats built high over lockers large enough to hold the gun dogs. It was found to be so safe and comfortable that its original purpose was forgotten; it was built in a great many different styles and frequently was used by women and children. The stanhope gig, carrying only two people and drawn by one horse, had a simple semicircular wooden seat, not unlike a rib chair, that hung on four springs; the tilbury was very similar. The cabriolet, a luxury carriage with, in some cases, a small rear platform for a groom to stand on, was introduced into England about 1815 and later modified in design and used for hire (*see* below).

Public Transport.—Carriages for hire, known as *hackney carriages*, first appeared in London in 1605 and grew so numerous that in 1634 their numbers were limited by act of parliament. All types of carriages were used. Later, *sedans* and *brouettes* (a sedan on wheels drawn by a man) were serious rivals, but these fell from favour in the beginning of the 18th century.

In the early 19th century a modified form of the cabriolet was introduced. This was a curious-looking vehicle in which the driver sat beside the passengers, who were shrouded in a hood that protected them from the weather and safeguarded their privacy. Although it was more unstable than the four-wheeled hackney, it was much faster and also more economical, since it was drawn by a single horse. The cabriolet was soon superseded by the hansom cab, but the popular form of its name, "cab," remained, being used by extension to denote all forms of horse-drawn and motor vehicles plying for hire.

The two-wheeled, one-horse *hansom cab,* designed in 1834 by Joseph Aloysius Hansom, was an enclosed cab with a single forward-facing seat and a coach box perched high at the rear. Communication between the "cabby" and his fare took place through a small trap door in the roof. The entrance was close to the ground and the doors could be operated by the driver from his lofty seat. The hansom was particularly stable and easy to maneuver and was used widely in the latter half of the 19th century.

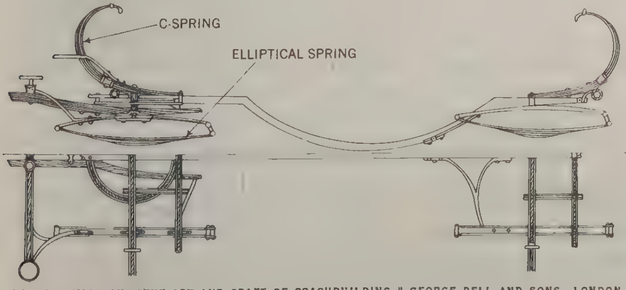
The *omnibus,* not unlike the charabanc in design, was first introduced into London in 1829. It was at first an enormous four-wheeled vehicle drawn by three horses abreast, this later being superseded by a narrower vehicle drawn by a pair of horses and carrying 14 passengers. In 1847 a seat was added along the centre of the roof. By the latter half of the 19th century the omnibus was a tolerably efficient form of transport, carrying 28 people at up to eight miles per hour.

Public transport outside the towns remained in a rather primitive condition until the 19th century. The *stagecoach,* which was introduced into England in 1640, replacing the older stage wagon, was a large, cumbersome vehicle, very heavy and usually unsprung. It had seats for six or eight passengers inside; second-class passengers sat in a large basket at the back and third-class traveled on the roof, clinging to a rail. The vehicle usually was vastly overcrowded and notoriously subject to difficulties and delays. Four or six horses were used and were changed at stages as much as 20 mi. apart; and average speed often was no more than four miles per hour. Various innovations were attempted, but there was little progress until the roads began to be improved in the early 19th century.

In 1784 the *mail coach* system, devised by John Palmer, was introduced. A four-horse diligence was used, driven by an armed coachman, accompanied by a guard, and drawn by four horses that were changed every six or eight miles and averaged eight miles per hour. The mails thus provided a quicker and safer method of travel than did the stagecoaches, which they gradually superseded. At first they carried only four passengers, but later accommodation was made for passengers in the boot and on the roof. Mail coaches were painted red, with the royal arms and the destination of the coach painted on the door panel.

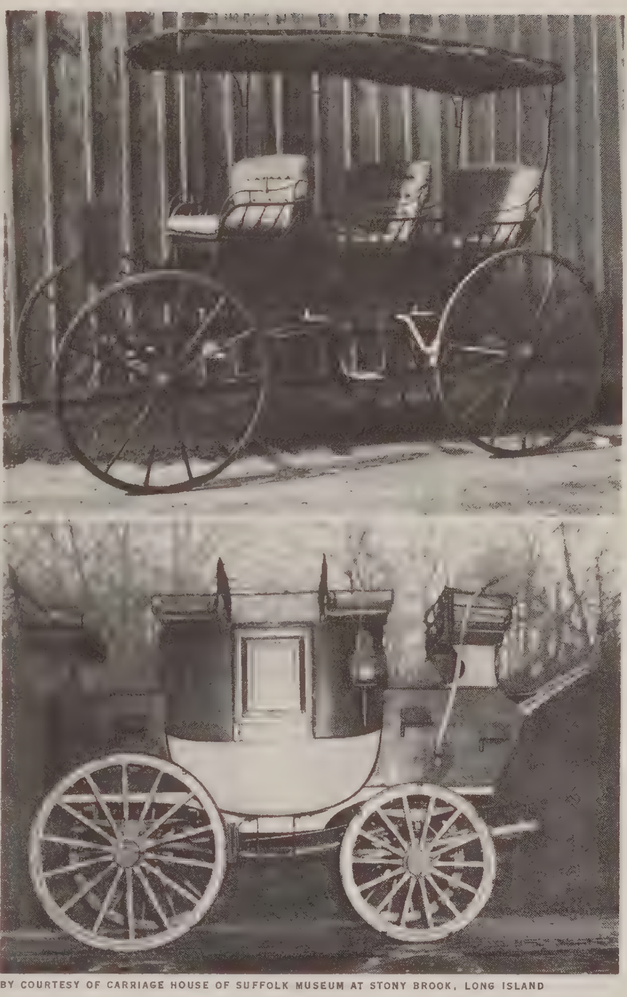
The success and influence of the mail coach in Great Britain can be gauged by the fact that though only 80 new coaches were introduced in 1797 there were no fewer than 700 in general use throughout the country by 1835. After they were displaced by the railways, beginning in the 1840s, coaching was to some extent carried on as a sport by amateurs, especially in southern England and on the famous London-Brighton run. The end of the 19th century saw the foundation of the four-in-hand clubs that have carried on the art of coaching. (*See* also DRIVING AND COACHING.)

The *jaunting car,* first built in Dublin at the beginning of the 19th century, remained a purely Irish vehicle. Two-wheeled and open, it was drawn by a single horse. The passengers, usually four or six, sat sideways and back to back on a long seat that ran down the centre of the car. It was sometimes used also as a private carriage.



FROM J. PHILIPSON, "THE ART AND CRAFT OF COACHBUILDING," GEORGE BELL AND SONS, LONDON, 1897

FIG. 3.—18TH-CENTURY CARRIAGE SPRINGS MOUNTED ON PERCH



BY COURTESY OF CARRIAGE HOUSE OF SUFFOLK MUSEUM AT STONY BROOK, LONG ISLAND

FIG. 4.—(TOP) BUCKBOARD SURREY, U.S., 1900; (BOTTOM) TALLY-HO, FOUR-IN-HAND PLEASURE COACH, ENGLAND, 1875

State Carriages.—Although carriage builders of the 17th, 18th and 19th centuries were concerned chiefly with producing lighter and more practical vehicles, carriages of great size and richness continued to be built for royalty and for the aristocracy. The influence of the early Hungarian and German state carriages spread to Italy, France, Spain and England, and state carriages of great magnificence were built. Gilded, richly painted and ornamented, they are still sometimes used on state occasions. The English monarch's state coach, built in 1760–62 for King George III and painted by G. B. Cipriani, cost nearly £8,000. Its official description is as follows:

> The whole of the carriage and body is richly ornamented with laurel and carved work, beautifully gilt. The length, 24 ft.; width, 8 ft. 3 in.; height, 12 ft.; length of pole, 12 ft. 4 in.; weight, 4 tons. The carriage and body of the coach is composed as follows:—Of four large tritons, who support the body by four braces, covered with red morocco leather, and ornamented with gilt buckles, the two figures placed in front of the carriage bear the driver, and are represented in the action of drawing by cables extending round their shoulders, and the cranes and sounding shells to announce the approach of the monarch of the ocean; and those at the back carry the imperial fasces, topped with tridents. The driver's foot-board is a large scallop shell, ornamented with bunches of reeds and other marine plants. The pole represents a bundle of lances; the splinter bar is composed of a rich moulding, issuing from beneath a voluted shell, and each end terminating in the head of a dolphin; and the wheels are imitated from those of the ancient triumphal chariot. The body of the coach is composed of eight palm-trees, which, branching out at the top, sustain the roof; and four angular trees are loaded with trophies allusive to the victories obtained by Great Britain during the late glorious war, supported by four lions' heads. On the centre of the roof stand three boys, representing the genii of England, Scotland and Ireland, sup-

porting the imperial crown of Great Britain, and holding in their hands the sceptre, sword of state, and ensigns of knighthood; their bodies are adorned with festoons of laurel, which fall from thence towards the four corners. The panels and doors are painted with appropriate emblematical devices, and the linings are of scarlet velvet richly embossed with national emblems.

The coach of the lord mayor of London, built a few years earlier, is only a little less resplendent.

United States.—Horses were introduced into America by the Spaniards, who also imported the first carriages. By 1660 carriages had arrived independently in New England, where the most widely used vehicle was the two-wheeled cabriolet; Italian *curricles*, also two-wheeled and driven by horses harnessed in tandem, became popular.

Public transport was provided by the *stage wagon*, a carriage with a long high body, large rear and smaller front wheels and drawn by four or six horses. It carried from 4 to 12 persons, who sat on wooden benches. The front was open and the sides were no more than a frame for leather curtains that were rolled up when the weather was suitable. All the passengers had to scramble over the driver's seat, and the wagons had a reputation, at any rate among European travelers, for being awkward and uncomfortable. By the end of the 18th century long-distance travel in the United States was developing along the same lines as that in Europe, and there were regular coaches between Boston, New York and Philadelphia. In 1792 a weekly mail route was established from the Washington district to the Maro district in Tennessee.

In the 19th century private carriages in the United States developed along lighter and racier lines than their European counterparts. The cabriolet was quickly modified; the *one-horse shay* (the word is a corruption of "chaise") appeared and then the light two-wheeled *dogcart*, the *runabout* and the *buggy*, all designed to be pulled by one horse. The American buggy originated in India from a kind of one-horse gig with a hood to protect the traveler from the sun. In the United States it became a four-wheeled carriage with one seat fixed on a long shallow tray; its phenomenal popularity was rivaled only by that of the *wagon*, which was similar in construction but had two or more seats. Buggies were light, comparatively inexpensive and traveled easily over rough roads. They were so commonly used that in 1910 Ralph Strauss wrote, "the tourist in America will come away with the impression that there is hardly a family on the continent that does not possess at least one buggy or wagon." There were many local variations: of structure, as in the *bike wagon* of the middle west; and in name, as in Massachusetts, where a two-seater wagon was known as a *bargee*. Other favourite vehicles were the four-wheeled *surrey*, whose seats were arranged like those in a wagon except that they were not on a tray, and the four-wheeled *station wagon*, a covered carriage that carried two passengers and a footman and was famed for its comfort.

In 1822 a New York coachmaker named Miln Parker began building *volantas* for the Cuban and Mexican markets. These vehicles were a type of gig, the body being perched upon two very high wheels. The great demand for these light carriages made the carriage-building industry of the United States the largest in the world. In 1810 there were 28 factories engaged in coachbuilding in New York alone, and later in the century carriages were exported to South America, Australia and other countries.

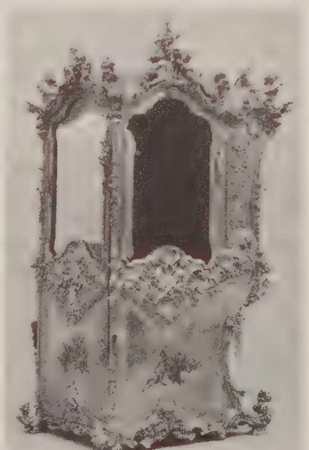


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FIG. 5.—ITALIAN SEDAN CHAIR, ABOUT 1730

Vehicles Using Manpower.—The *litter* was a bed or couch mounted on poles. In Greece or Rome it was carried by slaves, but during the middle ages it was adapted so that it could be harnessed to horses, for use by invalids and ladies of noble birth. In the 16th century the horse litter was gradually replaced by the coach. Litters borne by men were forerunners of the *sedan chair*.

At the end of the 15th century the sedan chair consisted simply of a chair with metal clasps for poles at either side. By 1700 the chair was mounted on a platform, covered by a leather roof and enclosed with curtains of velvet, damask or canvas. As the construction became more substantial, privately owned chairs became richly ornamented with baroque moldings and gilt and were often painted by prominent artists. Sedan chairs for hire remained modest in appearance but were so popular in London and Paris that for a time they were a serious rival to hackney carriages. Sedans began to go out of fashion in the early 19th century.

The *ricksha* is a light two-wheeled carriage that has two shafts, seats two passengers and is drawn by a man. Until the 1950s it was commonly used in the far east and in some cities in southeastern Africa. In the 18th century it appeared in Europe as the *brouette*, which, like the sedan chair, enjoyed a brief vogue as a hired vehicle.

Collections.—The principal collections of carriages are at the Suffolk Museum and Carriage House, Stony Brook, Long Island; the Science museum, London; the Musée de la Voiture au Château de Compiègne, near Paris; the Museu Nacional dos Coches, Lisbon; the Schönbrunn palace, Vienna; and the Schlossmuseum, Berlin.

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(L. P. S.)

CARRICKFERGUS, a seaport and borough of County Antrim, N.Ire., on the northern shore of Belfast lough, 9½ mi. N.E. of Belfast. Pop. (1961) 10,211. The name, meaning "rock of Fergus," commemorates King Fergus who was shipwrecked off the coast *c.* 320 A.D. Because of the strategic position of Carrickfergus castle, the town played a large part in the history of Ireland. The castle, in a perfect state of preservation, is of outstanding archaeological interest as a notable relic of the Norman period. The parish church of St. Nicholas was built by John de Courci at the end of the 12th century and is renowned for the Chichester monument (1625) in the north transept. The castle was besieged and taken by Edward Bruce in 1315. Under Charles I many Scottish Covenanters settled there to avoid persecution. In the Civil Wars, from 1641, Carrickfergus was one of the chief places of refuge for the protestants of Antrim, and in 1642 the first presbytery held in Ireland met there. It was later held by partisans of James II, but it surrendered in 1689 to the duke of Schomberg and in 1690 William III landed there on his expedition to Ireland. In 1760 the castle was taken by a French squadron under François Thurot and held for seven days. John Paul Jones entered Belfast lough in the "Ranger" in 1778 and defeated the English naval vessel "Drake." Elizabeth I gave the town a charter, which was confirmed by later monarchs. The corporation, however, was superseded in 1840 by a board of municipal commissioners. Carrickfergus was a parliamentary borough until 1885, a county of a town until 1898 and the county town of Antrim until 1850. Borough status was regained in 1949, and after World War II the population doubled. Local industry consists of a large viscose rayon factory, flax spinning mills, bleach works, printing and dye works, wrought-iron works and sheet-metal works. Rock salt, found in Triassic sandstone, is worked in the form of brine.

CARRICKMACROSS (CARRAIG MHACHAIRE ROIS), a market town in County Monaghan, Republic of Ireland, 57 mi. N.N.W. of Dublin by road. Pop. (1961) 1,940. There are remains of an Elizabethan castle, destroyed in 1641. Carrickmacross is an agricultural centre and produces industrial alcohol from potatoes. Carrickmacross lace made the town famous and is still produced to a small extent, notably at the convent of St. Louis.

CARRICK-ON-SHANNON (CARA DROMA RÚISG), a market town and the county town of Leitrim, Republic of Ireland, is 101 mi. N.W. of Dublin by road. Pop. (1961) 1,497. It is situated on the upper Shannon near Loughs Gara, Key, Allen and Bofin, the area being a fishing centre. It is an assize town and has some river trade. Part of the town, in Killukin parish, is in County Roscommon.

CARRICK-ON-SUIR (Carraig na Siúire), a town on the banks of the Suir, lies 98 mi. S.W. of Dublin in County Tipperary, Republic of Ireland. Pop. (1961) 4,667. A town of Danish origin beside the wooded foothills of the Comeraghs, it has two bridges spanning the Suir connecting with its southern suburb Carrickbeg in County Waterford. Carrickbeg has narrow, hilly streets and a parish church believed to be the only 14th-century church still used in Ireland.

Ormonde castle, seat of the Butlers, begun in 1309, was fully restored after 1960. Margaret, daughter of the 7th earl of Ormonde, married Sir William Boleyn of Blickling and her granddaughter, Anne Boleyn, is said to have been born in the castle. (*See* Butler.)

In the 19th century Carrick-on-Suir was a flourishing industrial town, manufacturing furniture, boots, cotton and woolen goods. The American Civil War and the industrial revolution spelled doom for these industries. The population dropped from about 11,000 to 5,000 at the beginning of the 20th century. The chief industries are now tanning and leather manufacture; more than half the finished products are exported. (S. B. C.)

CARRIER, JEAN BAPTISTE (1756–1794), French Revolutionary terrorist, notorious for his atrocities against counterrevolutionaries at Nantes, was born at Yolet, in Haute Auvergne, on March 16, 1756. In 1792 he was chosen to represent Cantal in the Convention. He was already known as one of the influential members of the Cordeliers club and of that of the Jacobins. In March 1793 he took part in establishing the Revolutionary tribunal. After a mission into Normandy in July, Carrier was sent into Brittany in August. There he received orders to secure Nantes against the insurgents of the Vendée. Arriving on Oct. 7, he established a tribunal and formed a body of desperate men, the Compagnie Marat, to destroy in the swiftest way the crowds of prisoners in the jails. The formality of trial was soon discontinued, and the victims were sent to the guillotine or shot or cut down in the prisons en masse. He also had large numbers of prisoners put on board vessels with trap doors for bottoms, which were then sunk in the Loire. These *noyades* of Nantes made Carrier notorious, and he was recalled by the committee of public safety on Feb. 8, 1794. He took part in the Thermidorian attack on Robespierre, but was himself brought before the Revolutionary tribunal in November and guillotined on Dec. 16, 1794.

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CARRIER, a transporter of passengers or goods for compensation or without charge, by water, land or air. Carriers are commonly divided into three groups: those that transport passengers only, those that transport goods only and those that transport both. Carriers of goods are subdivided into common carriers and contract carriers. Common carriers of passengers and of goods are those which "hold themselves out" to serve all.

Common carriers of passengers, whether by boat, rail, motor vehicle or air, are regulated with respect to equipment, routes, schedules and fares. They are bound to serve all who would be patrons without discrimination, to protect passengers from improprieties of others and to avoid negligently injuring them. Such carriers are, except as modified by statutes, insurers of passengers' baggage against loss or damage.

While taxicab operators are common carriers, they are generally regulated as to equipment and charges but not as to routes. They must obtain permission to operate on the public streets, in the form of "certificates" or "franchises."

Common carriers of goods are also generally required to operate on fixed routes and schedules. Their charges are regulated, but they are entitled to charge rates sufficiently high to provide a fair return upon the value of the property with which they serve the public. No person may undertake such service in the United States without first obtaining a "certificate of convenience and necessity" from the commerce or public utilities commission of the state or states in which operations are to be carried on. If interstate business is done, it is subject to regulation by the Interstate Commerce commission.

The contract carrier of goods by truck is not restricted to serving on fixed routes and at regulated rates. Generally speaking, it is free to contract such times, routes and charges for transportation as may be acceptable to shippers. However, in some locations contract carriers are restricted as to rates, routes and schedules, and they may be excluded from certain termini for the purpose of protecting common carriers of goods from competition when that is essential to the public welfare.

At common law the common carrier of goods was bound to serve for a "reasonable reward" and to carry all goods for which he had space. He was an insurer of goods entrusted to him, but was not liable if they were lost by act of God or the king's enemies or by reason of an inherent defect of the goods. The English Common Carriers' act relieved such carriers of liability for the loss of goods above a specified value unless their full value was disclosed and unless an added charge based on such value was paid. This specified value to which liability was limited has been several times increased. Similar rules apply with respect to some commodities in the United States under state and federal statutes and regulations.

Transportation by air is regulated in the United States under the Civil Aeronautics act and in Great Britain under the Carriage by Air act. Similar legislation is common throughout the world.

See also Public Utilities; Interstate Commerce; for carriage of goods by sea, *see* Affreightment. (C. M. U.)

CARRIER. Many persons who recover from apparent or inapparent infections continue to harbour the causative microbes in their bodies after they have recovered from the disease. Such persons are termed carriers. Though the carrier has become immune to the harmful effects of the germs, the latter are capable of producing disease in other human beings to whom they may be transferred. Although this article is concerned only with human carriers of disease germs, it should be pointed out that many diseases are transmitted by animal or insect carriers. These infections include typhus fever, yellow fever, tularemia, brucellosis (undulant fever) and others. The first direct evidence of the existence of carriers was provided in 1893 by W. P. Dunbar, working with Robert Koch, who during a cholera epidemic in Hamburg showed that not only did convalescent patients harbour cholera bacilli but persons who had not been ill also excreted the germs in their feces. The habitat of microbes associated with the carrier state may be the alimentary tract, the respiratory tract or, as in malaria and homologous serum hepatitis, the blood.

It has been believed that some carriers may be capable of transmitting infection to others even though they have not been infected themselves. Studies carried out in the second quarter of the 20th century indicated, however, that ostensibly symptomless carriers who are able to transmit infection have probably had biological contact with the microbe concerned and have suffered an inapparent infection that led to the carrier state.

Not all carriers are equally capable of disseminating infection. For example, new cases are more likely to occur from contact with nasal carriers of hemolytic streptococci or staphylococci than from contact with throat carriers. The personal habits of a carrier undoubtedly play a role in determining whether or not the germs he harbours will be transferred to another human being. Unprotected coughs and sneezes are potential hazards. Also, since microbes carried in the nose, throat or intestines are often present on the hands in large numbers, careless use of the hands tends to propagate disease. Thus, cooks and food handlers are in a position to disseminate infectious diseases. Concurrent epidemics of scarlet fever and streptococcal sore throat caused by bacteria dispersed from the nose, and epidemics of typhoid fever spread by bacteria harboured in the small intestine or gall bladder, have been traced to common, single sources among cooks and food handlers.

The following diseases are known to be spread by human carriers: pneumonia, scarlet fever, streptococcal sore throat, epidemic meningitis, diphtheria, impetigo, typhoid fever, dysentery, cholera, whooping cough, gonorrhea, syphilis, a form of jaundice called homologous serum hepatitis or infectious hepatitis, poliomyelitis, amebic dysentery and, in part, malaria. Other diseases, particularly some of the virus infections, may later prove to be transmitted by human carriers.

Formerly, isolation was the only practical means of dealing with carriers. After the discovery of antibiotics, however, the body could be rid entirely of the causative microbes of some diseases by drug treatment. In certain infections, discussed below, enough was known about various aspects of the carrier state in the early 1960s to warrant special comment.

Typhoid and Paratyphoid Carriers.—The germs are harboured in the small intestine or the gall bladder and discharged in the stools; a few carriers are chronic and may harbour the microorganisms for years or even a lifetime. Typhoid and paratyphoid fever are spread by the direct contamination of food or water supply with the specific germ.

One famous carrier in New York city, who became known as "Typhoid Mary," worked as a cook under various assumed names, moving from household to household and from institution to institution. She was finally apprehended and detained until her death 23 years later, 31 years after she was first recognized as a carrier.

Antibiotics proved disappointing in the treatment of typhoid carriers. The growth and dissemination of the germs in a carrier is often inhibited by chloramphenicol as long as this drug is given, but since the drug does not eliminate the germs from the intestine or the gall bladder they grow again when treatment is discontinued. In the course of time most carriers undergo spontaneous cure.

Dysentery.—In bacillary dysentery bacteria persist in the lower part of the intestines. They are excreted intermittently as a rule. Treatment of these carriers was unsatisfactory in the early 1960s, though success was sometimes claimed following the use of sulfonamide drugs or oxytetracycline.

In amebic dysentery carriers, the parasites that live in the large intestine pass into a resistant resting state during which they are encysted. These cysts do not multiply but remain quiescent until they are carried by food or water into the intestinal canal of another person, when the actively growing state is resumed with a resultant attack of dysentery. Many but not all carriers can be cured by drug treatment.

Cholera.—The cholera germ persists in the upper part of the intestines and the condition is similar to that in the typhoid carrier. The germs are excreted from the bowels only.

Diphtheria.—In this disease the germs are present in the throat and nose, and infection is spread directly from one person to another, either by coughing, sneezing, etc., or by contamination of drinking vessels. The carrier state is usually not so persistent in diphtheria as in typhoid fever. Young children are more likely to become carriers than adults. In the throat the germs are found in the tonsils, while in the nose they are associated with a chronic inflammatory condition.

Many persons harbour harmless bacteria that closely resemble diphtheria bacilli. Therefore, when diphtheria bacilli are found in the nose or throat of a supposed carrier, it is necessary to test them in the laboratory to prove that they are capable of causing disease.

Most diphtheria carriers can be successfully treated with penicillin.

Epidemic Meningitis.—The meningococci, the germs that cause this disease, are carried in the back of the throat. Surveys showed that many ostensibly normal persons are carriers of meningococci. During epidemics the carrier rate may rise to as high as 90%. Though it was believed in the early 1960s that coughing and sneezing were the chief modes of spread, this theory had never been directly authenticated. Epidemics are likely to occur where people are crowded together, as in boarding schools and military barracks.

A great advance in the control of meningococcus carriers was made during World War II when it was discovered that the carrier state could be eliminated by a few days' treatment with sulfadiazine.

Streptococcal Infections.—Hemolytic streptococci, the bacteria that cause scarlet fever and most cases of tonsillitis, are harboured in the noses and throats of sick and convalescent patients and of persons who have suffered inapparent infections. The bacteria are present in large numbers in the nasal discharges of about a third of the carriers and are found on the hands, on the clothing and in the environment of such persons. Despite much research carried on during World War II and thereafter, the precise pathway that streptococci take from the nose of the carrier to the throat of the susceptible person was not elucidated.

Penicillin in proper dosage effectively eliminates the streptococcus carrier state. It was found during epidemics in military installations that penicillin given for a few weeks to all personnel would control the vast majority of carriers and stop an epidemic.

Pneumonia.—The pneumococci, the germs that cause most cases of pneumonia, are carried in the throats of convalescent patients and in many normal throats. It was generally believed that the pneumococci were transferred from the carrier to the patient by coughing. It is not ordinarily practical to look for pneumococcus carriers, but when they are discovered they can usually be successfully treated by penicillin.

Poliomyelitis.—Research during the 1940s and 1950s demonstrated that poliomyelitis virus is excreted in the stool. The carrier may be a person with the active disease or someone who has contracted an inapparent infection but continues to shed virus in the feces. The amount of virus excreted in the feces varies considerably from one carrier to another. There was no effective drug treatment for poliomyelitis carriers in the early 1960s.

Malaria.—Where malaria is endemic many persons harbour the malarial parasites in their bodies for months or years, particularly inside the red blood corpuscles. In other human infections spread by insects, the insect must bite the patient during the active stage of his disease in order to transmit the infection to another human being. Malaria can be transmitted via the appropriate mosquito vector, or by direct transfusion of the carrier's blood into a human donor. The mosquito that bites the carrier transfers the malarial parasites, in a changed form, to another person via the bite. The human malarial carrier can be rid of his parasites by a few days' treatment with the drug chloroquine.

See also Bacteria and separate articles on diseases such as Cholera; Dysentery; Malaria; Meningitis; Typhoid and Paratyphoid Fevers; Venereal Diseases; etc.

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CARRIERA, ROSALBA (1675–1757), Italian painter, owes her fame to the art of pastels which she made stylish. She was born in Venice, Oct. 7, 1675, and died there April 15, 1757. She became first known for her miniature portraits on snuffboxes. Sovereigns and important personages going through Venice frequently had her paint their portraits. Augustus II the Strong, king of Poland, bought from her no less than 40 pastels for his Dresden collection. The great collector and financier Pierre Crozat, during a trip to Venice, encouraged her to go to Paris. She did so in March 1720, accompanied by her family, became the idol of the French capital and painted 36 portraits, among them one of Louis XV as a child. She became a member of the Royal academy in 1720 and the next year, returned to Venice. When she went to Vienna in 1730, the empress became her protectress and pupil. After 1750 her sight failed. Her art flattered the refined and affected taste of her time.

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CARRIÈRE, EUGÈNE (1849–1906), French painter and lithographer, known for his scenes of domestic intimacy, was born at Gournay, Seine-Maritime, on Jan. 17, 1849, of Flemish-Alsatian parentage. He lived first at Strasbourg, moving to St. Quentin in 1868. The pastels of Maurice Quentin de La Tour aroused his interest, and in 1870 he entered the Paris École des Beaux-Arts. Taken prisoner in the 1870 war with Germany, his enforced stay at Dresden enabled him to see the gallery there. Returning to Paris, he studied under Alexandre Cabanel (1872–76). After 1877, his wife recurs frequently as the model in his family groups and pictures of maternity. At first influenced by the colour of Rubens and Velázquez, by 1890 his art developed a distinctive character; figures appear shrouded in a pearly mist. sharp chiaroscuro is replaced by delicate predominantly gray tonalities and soft modeling. Among the distinguished literary and artistic personalities whom he painted were his friends Alphonse Daudet, Anatole France and Paul Verlaine (1891; acquired Luxembourg 1910). Carrière taught, and practised sculpture and lithography.

Carrière died in Paris on March 27, 1906. Retrospective exhibitions were held in Paris at the Galerie "Art Nouveau" (1892) and at the Galerie Bernheim (1903).

See G. Seailles, *E. Carrière, Essai de biographie psychologique* (1910); *Mercure de France* (1909–letters and writings); E. Fauré, *E. Carrière, peintre et lithographe* (1908). (D. L. FR.)

CARRILLO DE SOTOMAYOR, LUIS (1583–1610), Spanish poet, was born at Córdoba, of a noble family. As a naval officer he served in the Mediterranean against the corsairs. His verse shows some of the stylistic complexities and imagery associated with Gongorism (so-called after Luis de Góngora; *q.v.*) and he wrote a treatise, on poetic learning, *Libro de la erudición poética* (mod. ed., 1946), to justify his methods. Much of his poetry has, however, real rather than historical value: sonnets, *canciones,* fine *romances* describing action at sea and an ambitious *Fábula de Acis y Galatea.* His work was published by his brother Alonso (1611).

See the modern edition by Dámaso Alonso (1935). (C. C. SH.)

CARRINGTON, RICHARD CHRISTOPHER (1826–1875), English astronomer, who investigated the motions of sunspots, by which he determined the elements of the sun's rotation and made the important discovery of a systematic drift of the photosphere, causing the rotation periods of spots to lengthen with increase of solar latitude. The son of a brewer at Brentford, he was born in Chelsea, London, on May 26, 1826, and educated at Trinity college, Cambridge. He was astronomical observer in the University of Durham (1849–52), and in 1853 established an observatory of his own at Redhill. There he devoted three years to a survey of the zone of the heavens within 9° of the north pole, the results of which are contained in his *Catalogue of 3,735 Circumpolar Stars.*

Carrington died on Nov. 27, 1875.

CARROCCIO, the war chariot of the medieval republics of Italy. A rectangular platform on wheels, drawn by oxen, it carried the city's standard, trumpeters and also an altar, at which priests held services before battle. Its loss in battle was regarded as an irretrievable humiliation. The earliest recorded instance of its use is by the Milanese in 1038. The Florentine *carroccio* was usually followed by a smaller vehicle bearing the *martinella,* a bell to ring out military signals. In peacetime the *carroccio* was in the keeping of some great family distinguished for its services to the state.

CARROLL, ANNA ELLA (1815–1894), a member of a Protestant branch of the distinguished Carroll family of Maryland, was born on Aug. 29, 1815, at Kingston Hall, Somerset county, Md. She has been called a "military genius" and a "great unrecognized member of Lincoln's cabinet." The first appellation is based upon her plan of strategy for the Tennessee campaign of 1862, which was in fact the plan followed by Gen. U. S. Grant, and the second upon her valuable services as a pamphleteer on behalf of the policies of Abraham Lincoln as war president. Prior to her service on behalf of President Lincoln, she had become interested in politics and was influential in the American party. It has been well said that Anna Carroll, who died in Washington, D.C., on Feb. 18, 1894, was one of the most influential American women of her time.

See Hollister Noble, *Woman With a Sword* (1948). (E. E. R.)

CARROLL, CHARLES (1737–1832), U.S. political leader and signer of the Declaration of Independence, was born at Annapolis, Md., Sept. 19, 1737. He was educated in French Jesuit colleges, studied law at Bourges, Paris and London, and in Feb. 1765 returned to Maryland. There he took possession of an estate called Carrollton in Frederick county (hence his signature "Charles Carroll of Carrollton," to differentiate himself from relatives also named Charles), but he lived at Doughoregan Manor just west of Baltimore. Before and during the American Revolution he was a patriot leader, serving on committees of correspondence, committees of observation, the committee of safety and the provincial convention (1774–76). From 1776 to 1779 he sat in the continental congress, rendering important services as a member of the board of war, and signing on Aug. 2, 1776, the Declaration of Independence. In 1776, with Samuel Chase, Benjamin Franklin and his cousin the Rev. John Carroll, he was sent by the continental congress to Canada in a fruitless effort to persuade the Canadians to join the cause of the 13 colonies. From 1777 until 1800 he was a member of the Maryland senate, and from 1789 to 1792 a member of the U.S. senate. After the formation of parties he was a stanch Federalist. After 1801 he lived in retirement, his last public act being the formal ceremony of starting the construction of the Baltimore and Ohio railroad (July 4, 1828). He died at Baltimore, Nov. 14, 1832, the last surviving signer of the Declaration of Independence. He exercised powerful influence, particularly among his Roman Catholic coreligionists, and he used it to secure the independence of the colonies and to establish a stable central government.

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CARROLL, JOHN (1735–1815), American Roman Catholic prelate, first Catholic bishop in the United States, was born at Upper Marlborough, Md., Jan. 8, 1735 He was educated in Flanders and ordained priest in 1769, becoming professor of philosophy and theology at the Jesuit colleges in Liège and Bruges, Belg. After his profession in the Society of Jesus in 1771 he toured Europe for two years as tutor to an English nobleman. The suppression of the Jesuits by the papal brief of July 21, 1773, forced his flight to England whence he returned to Maryland in the spring of 1774. In 1776, at the request of the Continental Congress, he accompanied Benjamin Franklin, Charles Carroll and Samuel Chase on a mission to secure the aid or neutrality of Canada during the Revolution. Thereafter he served St. John's chapel, Forest Glen, Md., and organized the Select Body of Clergy. When the American church became a distinct body Carroll was made the superior of the mission on June 9, 1784, to Franklin's gratification. In 1786 he induced the select body to authorize a Catholic academy (now Georgetown university); on Sept. 14, 1789, he was made bishop. Consecrated at Lulworth castle, England, Aug. 15, 1790, he held his first synod in Baltimore in Nov. 1791. In the same year he founded the Sulpician seminary in Baltimore, and in 1796 he helped found the Baltimore Library company, serving as its president until 1815. With George Washington's aid Bishop Carroll secured federal funds for Catholic missionaries to the Indians of the west. In 1804 he received jurisdiction over the Danish West Indies and the next year became administrator of the diocese of New Orleans. With the erection of four new sees in 1808 (Boston, New York, Philadelphia and Bardstown, Ky.) Carroll became archbishop, receiving the pallium on Aug. 18, 1811. Together with Benjamin Latrobe he planned the Baltimore cathedral, whose cornerstone he laid on July 7, 1806. A stanch patriot, he initiated the public Prayer for the Civil Authorities of Our Country; he tirelessly defended religious liberty from the pulpit and in the press. He died in Baltimore, Dec. 3, 1815.

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CARROLL, LEWIS: *see* Dodgson, Charles Lutwidge.

CARROT (*Daucus carota*), an herbaceous, generally biennial plant of the family Umbelliferae (*q.v.*) that produces an edible taproot. Most of the edible carrot consists of much enlarged taproot; the uppermost part is enlarged hypocotyl, tissue that developed from that part of the plant stem below the seed leaves of the seedling. In a section of root an outer zone or cortex and a central zone of "wood" and pith are clearly visible. A large proportion of cortex is desired because its tissues are more tender and richer in stored foods, carotene, and flavour.

Carrot is native to Afghanistan and neighbouring lands. Wild carrot has become distributed as a weed in Europe, the U.S., and other temperate lands. Carrots were cultivated in the Mediterranean region before the Christian era; in Germany, France, and China by the 13th century; and by about 1600 were grown in fields and gardens in England. The earliest colonists brought them to America. They are now extensively grown throughout the temperate zones. Appreciation of the value of carotene (provitamin A) in the diet greatly stimulated production and use of carrots as a common vegetable in the U.S. after 1920.

Normally, in the first season only an erect rosette of doubly compound, finely divided leaves develops above ground, the edible carrot and attached roots below. After a rest period at temperatures near freezing, large branched flower stalks arise two to six feet tall. Ends of the main stalk and branches bear large compound umbels of tiny white to pinkish flowers. The so-called seeds are one-seeded halves of tiny spiny fruits called schizocarps. Seeds as purchased for planting have had the spines removed.

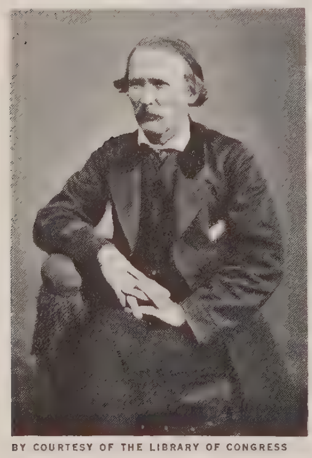
Among common varieties root shapes range from globular to half-long to long, with lower ends blunt to long-pointed. In America only roots with orange-coloured flesh are popular. White-, yellow- and purple-fleshed varieties are known. Orange skin colour is most desired; green shoulders and red and purple skin occur.

Carrots require cool to moderate temperatures and so are grown in the warmer regions only in the autumn, winter, and spring. They require deep, rich, but loosely packed soil. Modern machines sow the seeds thinly in bands to give room for plant development without need for thinning. Weeds are largely controlled by spraying the fields with Stoddard solvent when the carrot plants are small. Stoddard solvent kills most weeds without injuring the carrots, largely eliminating weeding. *See* also Vegetable.

See H. C. Thompson and W. C. Kelly, *Vegetable Crops* (1957). (V. R. B.)

CARSON, CHRISTOPHER ("Kit") (1809–1868), U.S. frontiersman, Indian agent, and soldier, was born in Madison County, Ky., on Dec. 24, 1809. As an infant he was taken by his family to Boone's Lick District, Mo., a frontier region subject to Indian forays. Carson received no formal education and not until late in life did he learn to read and to write a few words. At the age of 15 he began a brief saddler's apprenticeship in Franklin, Mo., but before a year passed he ran away from his master and joined the 1826 Santa Fe caravan.

While at Taos, N.M., the youthful "Kit" became associated with the experienced trader Ewing Young through whom Carson began his remarkable career as a professional frontiersman. He accompanied John C. Frémont on his exploring expeditions of 1842–46. During these years Carson tended to make his home at Taos, where in 1843 he married Maria Josefa Jaramillo. Bent's Fort frequently employed Carson, and at times he served as hunter for this trading post.


BY COURTESY OF THE LIBRARY OF CONGRESS
CARSON, PHOTOGRAPHED ABOUT 1858 BY MATHEW B. BRADY

As a member of Frémont's expeditions, Carson found himself in the midst of California's Bear Flag revolt and involved with Mexican War activities. While carrying some official reports to Washington he encountered Gen. Stephen W. Kearny's California-bound army of the west. The general ordered Carson to retrace his steps to serve as an army guide and scout. In an ensuing battle between Mexican lancers and Kearny's forces at San Pascual, it was Carson who, by eluding the enemy, managed to convey a distress call to American naval forces at San Diego which came to Kearny's rescue.

During the American Civil War Carson served the federal cause in the southwest and was brevetted a brigadier general of volunteers. Thereafter he resumed his earlier activities as Indian agent with headquarters at Taos. He was holding this position when he died on May 23, 1868, at Fort Lyon, Colo. Carson was a soft-spoken, likable man, and a leading frontiersman. His exploits contributed much toward the settlement of the west.

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CARSON, EDWARD HENRY CARSON, Baron (1854–1935), British statesman and lawyer, famous politically as the "uncrowned king" of Ulster, who organized and successfully led resistance to the British government in its attempts to introduce Home Rule for the whole of Ireland. He was also acknowledged to be one of the greatest advocates, though not a profound lawyer, ever to have practised in the Irish and English courts. Although he was to become the champion of the northern province, Carson was a southern Irishman by birth and upbringing. He was born in Dublin on Feb. 9, 1854, the son of a civil engineer. Both his parents were Protestants. He was educated at Portarlington school and Trinity college, Dublin, and after graduating studied law and was called to the Irish bar (1877). There he quickly made his name, becoming a queen's counsel and bencher of the Dublin King's Inns in 1889. Early in his career he came to distrust the Irish Nationalists, who were to be his lifelong opponents.

BROWN BROTHERS
EDWARD H. CARSON

Carson was made counsel to the attorney general for Ireland when A. J. Balfour became Irish secretary in 1887, and later became senior crown prosecutor for Dublin. This put him into the thick of the highly dangerous work of enforcing the 1887 Crimes act. He entered into this with zest, getting convictions for agrarian and other outrages and needing in the process the constant protection of armed detectives. Appointed Irish solicitor general in 1892, he entered parliament as a member for his old university in the general election of that year. He was soon recognized at Westminster as an outstanding debater and his attacks on Gladstone's Home Rule bill were conducted with force and wit. He was called to the English bar in 1893 and became an English queen's counsel in 1894.

He did not take political office in England until after the general election of 1900, when he joined the Unionist ministry as solicitor general and received a knighthood. Through the late 1890s and the first years of the 20th century he was at the height of his powers as a barrister. No man of his generation—and few of any other—could so sway a jury or win over a reluctant judge. He could be devastating, as in his cross-examination of Oscar Wilde, and he could be sympathetic and understanding. He had an intuitive sense of what was going on in the mind of a witness and his conduct of a case was always helped by his striking appearance. Tall and lean, he had a hatchet-shaped face and eyes that seemed to bore through an opponent. High pressure of legal briefs did not lead him to neglect parliamentary duties. He was to the fore whenever Irish affairs came up, throwing his decisive weight against any proposal to weaken the links between Great Britain and Ireland. When Walter Long retired from the leadership of the Irish Unionists (1910), Carson took his place. He might have succeeded Balfour as leader of the Conservative party, being mentioned as one of the several candidates, but he refused to compete, preferring to devote his energies to the cause of Ulster. This soon became a full-time task. In 1912 H. H. Asquith, having succeeded in depriving the house of lords of the right of veto, felt that the road was clear for the passage of a Home Rule bill. Throughout the years immediately before World War I Carson fought against this threat, as he saw it, to the political and religious liberties of Ulster. He stood like a colossus in the way of the Liberal ministry and it failed to get around him. He had no hesitation in appealing to force of arms, no less than to reason. He would hurry from the house of commons, where his speeches were of tremendous effect, to Belfast, where he was equally effective in rousing the Protestants of the northern countries to a mood of defiant and confident resistance.

Carson was determined that Ulster should never submit to the domination of a Southern Irish parliament at Dublin. He was the principal agent in raising a force of volunteers who openly drilled in preparation for taking the law into their own hands if Home Rule were established. At first Carson was laughed at as "an elderly lawyer" playing at soldiers, but the solemn Covenant of Resistance to Home Rule (1912), signed by many thousands of Ulstermen, and the setting up of a provisional government in Belfast in 1913 proved that the Orangemen meant business. The Liberals had to climb down and make more and more concessions to the North, leading ultimately to the complete exclusion of the six counties of Ulster from the operation of Home Rule.

During World War I the progress of the Irish settlement was interrupted. Carson was appointed attorney general in 1915, but resigned soon afterward because he was dissatisfied with the government's conduct of the war. In Lloyd George's coalition government of 1917 he became first lord of the admiralty, and in July 1917 was appointed a member of the war cabinet without portfolio. After the war he gave up his seat for Dublin university and was returned for the Duncairn division of Belfast. In 1921 he took a life peerage as Baron Carson of Duncairn on being appointed lord of appeal in ordinary—an office which he held until 1929, bringing to it his clear mind and ripe experience. He did not hold that this judicial position precluded him from expressing trenchant opinions on politics and he rebutted the charges made against him on this score by his old friend Lord Birkenhead. Carson died at Minster, Kent, on Oct. 22, 1935, and was given a state funeral in Belfast.

See Edward Marjoribanks and Ian Colvin, *The Life of Lord Carson,* 3 vol. (1932–36); H. Montgomery Hyde, *Carson* (1953). (A. P. Ry.)

CARSON CITY, the capital city of Nevada, U.S., is 30 mi. S of Reno by way of the Three Flags Highway. The name is derived from Christopher ("Kit") Carson, famous frontiersman. Established in 1858 as a rival of Genoa, Nevada's first permanent settlement, it was made the seat of Carson County, Utah Territory, effective March 1, 1861, and on the following day the Territory of Nevada was created by the U.S. Congress. On Nov. 25, 1861, Carson City became the territorial capital and on Nov. 29 was made county seat of the newly designated Ormsby County. When Nevada acquired statehood in 1864, Carson City became the seat of the new state government (although Virginia City was at that time the centre of population) but was not incorporated until 1875. On July 1, 1969, the city of Carson City and Ormsby County were consolidated to form one governmental unit, the city and county of Carson City. Until that time Carson City had been the smallest U.S. state capital. Pop. (1970) 15,468. For comparative population figures *see* table in NEVADA: *Population.*

Mormon agriculturalists who settled in the Eagle Valley area influenced the development of the city, as did wagon and stage routes over nearby Sierra Nevada passes into California. In 1859 discovery of silver in the Virginia City area 15 mi. NE rapidly expanded Carson City's economy. At nearby Empire, on the Carson River, mills treated the ore of the Comstock Lode, brought down from Virginia City by the Virginia and Truckee Railroad which maintained extensive shops at Carson City. Along with the Comstock, the Virginia and Truckee declined and in 1950 was completely abandoned. For coining the immense silver output of the Comstock, the federal government established a mint at Carson City which later became the Nevada State Museum. Also there is the capitol, state library, Supreme Court building, governor's mansion, and state penitentiary. A federal Indian school is three miles south of the city.

At an elevation of 4,678 ft., Carson City enjoys a dry, invigorating climate. Fourteen miles west, in the Sierra Nevada ranges, is beautiful Lake Tahoe with surrounding ski resorts and gambling casinos, which are legal in Nevada.* (A. J. Pr.; X.)

CARSTARES (CARSTAIRS), **WILLIAM** (1649–1715), Presbyterian minister and leader of the Scottish Church at the time of the Revolution Settlement, was born at Cathcart on Feb. 11, 1649, and ordained in exile in Holland. During the reign of Charles II he was twice arrested for subversive activities in England and Scotland. At the time of the Rye House plot he confessed his complicity under torture in Edinburgh but was allowed to return to Holland, where he became minister to an English-speaking congregation at Leiden (1685) and chaplain to the prince of Orange. He won the trust of the prince, and his guidance was invaluable during the course of the Settlement. On the accession of Anne he settled in Scotland as minister of Greyfriars, Edinburgh, and principal of the university. He was four times elected moderator of the general assembly. The safeguarding Act of Security in the treaty of union (1707) was largely his work. He spent his last years fighting the Tory ministry's efforts to undermine that act, especially by two acts of 1712, one restoring patronage and the other legalizing Episcopalian worship. He died in Edinburgh on Dec. 28, 1715. Of the leaders of the Church of Scotland he was the most politically minded, but his deepest concern was for the Christian welfare of the land.

See R. H. Story, *Character and Career of W. Carstares* (1894).

CARSTENS, ASMUS JAKOB (1754–1798), German portrait and historical painter, who did much to infuse a classical spirit into the arts of the late 18th century, was born in Schleswig on May 10, 1754, and was active in Copenhagen, Lübeck, Berlin and Rome. A leader of the later school of German historical painting, Carstens disparaged prosaic naturalism and admired the work of Giulio Romano, Leonardo da Vinci, Raphael and Michelangelo. Many of his subjects were taken from the literature of antiquity.

In 1795 a great exhibition of his work was held in Rome, which aroused heated controversy among the theorists but gained him so many supporters that he remained there until his death on May 26, 1798.

CARTAGENA, Caribbean seaport of Colombia, is the capital of the department of Bolívar. Pop. (1964) 217,910. The city is situated on the northern end of the Bay of Cartagena, which has only one navigable entrance, Boca Chica, far to the south of the city. The climate is tropical and generally humid. The old walled sections of Cartagena are divided between a peninsula and the island of Getsemani, but the city now spreads over the islands of Manga and Manzanillo (site of the airport) and the mainland below La Popa, a hill 552 ft. in height. In the old section the streets are narrow and picturesque; there are found the ornate cathedral, the beautiful church of San Pedro Claver, the Palace of the Inquisition, the main plaza and the university (housed in a former monastery).

In 1533 Pedro de Heredia founded the city which later became known as Cartagena de Indias to differentiate it from the Cartagena in Spain. After the middle of the 16th century great fleets stopped annually at Cartagena to take on gold and other products of northern South America for convoy to Spain. The city became

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16TH-CENTURY FORTRESS OF SAN FELIPE DE BARAJAS, CARTAGENA, COLOMBIA

a centre for the Inquisition and a major market for Negro slaves. Beginning in the 16th century Cartagena was increasingly fortified by heavy walls, and fortresses such as the towering San Felipe de Barajas were built near the city, at points on the shore of the bay and on both sides of Boca Chica. Fortification was needed to withstand attacks by such corsairs as Robert Baal, Martin Côtes, John Hawkins and Francis Drake.

In 1697, as local conflicts gave way to international wars, a great French force under the Baron de Pointis and Jean Baptiste Ducasse took the city and almost destroyed it after a 20-day siege. The restored and strengthened bastion was more successful in 1741 when it held out against a large naval squadron under the English admiral Edward Vernon.

Cartagena had to depend upon the Magdalena river for communication with the interior. By 1650 the Dique canal, an improved natural channel between the port and the river, had been opened. Often silted up, it was never fully satisfactory, but it helped to maintain Cartagena as the chief colonial port of northern South America.

On Nov. 11, 1811, the province of Cartagena declared its independence from Spain, and years of war followed. In 1815 the "Heroic City," as Bolívar christened it, was taken by the Spanish general Pablo Morillo after an estimated 6,000 inhabitants had perished. In 1821 it was retaken by patriot forces.

In the early national period Cartagena continued as Colombia's leading port, but was always handicapped by inadequate connections with the interior. By the 1840s it was declining both in population and commerce. The Dique, in disuse since the independence wars, was reopened from 1848–52 and again in 1879–88. By then it was Barranquilla (*q.v.*), situated on the lower Magdalena river, that began to rise, capturing much of Colombia's commerce. Cartagena's trade revived primarily as the result of the completion of a railroad to Calamar on the river in 1894. But Barranquilla had already gained the lead which it still maintains on the north coast.

Cartagena's population was less in 1905 than it had been in 1834. The city later experienced a steady growth—from 51,382 in 1918 to 111,291 in 1951—and trade volume improved. Among the causes for this were dredging of the bay, modern port works completed in 1933, another reopening of the Dique, and the laying of a sewage system in the 1940s. But probably most significant was the exploitation of great petroleum fields in the Magdalena river valley after 1917, and the pipeline completed from the main oil centre, Barrancabermeja, to the Bay of Cartagena in 1926. Since that time Cartagena has been the chief oil port of Colombia. However, Barranquilla, and Buenaventura on the Pacific coast, handle most of Colombia's chief export, coffee. Cartagena's manufactures include sugar, tobacco products, cosmetics, textiles and leather goods. Thousands of Colombian and foreign tourists visit Cartagena annually. (T. E. N.)

CARTAGENA (CARTHAGENA), a city and episcopal see of southeastern Spain, in the province of Murcia (*q.v.*), on the Mediterranean sea, is the terminus of a branch railway from the city of Murcia. Pop. (1950) 110,979 (mun.). Standing on an easily defended natural harbour, it is the chief naval base of Spain with an arsenal and dockyards ranking with those of El Ferrol and San Fernando near Cádiz. The city, on a small lowland at the north end of the bay, is fairly modern and uninteresting except for remnants of old walls and a castle. On the northeast a fertile valley gives access to the interior but on the west, southwest and southeast the port is surrounded by high mountains. The harbour, the largest in Spain after that of Vigo and the finest on the east coast, is a deep, spacious bay, dominated to seaward by four hills, crowned with forts, and approached by a narrow entrance guarded by batteries and a torpedo station. The outer bay is sheltered by the island of Escombrera, the ancient Scombraria ("mackerel fishery"), 2½ mi. S., and the harbour by a breakwater on its eastern side. On the northwest lie the Arsenal basin, often regarded as the original harbour of the Carthaginians and Romans, and the naval shipbuilding yards, with dry and floating docks. There are valuable mines near the town, producing lead, silver-lead, zinc, iron, copper and sulfur, and a mineral railway from Los Blancos, passing through the chief mining and smelting district of La Unión 6 mi. E. of the town, runs on to the quay in Cartagena harbour. The city exports some of the ores and also has important smelting works. Other manufactures include glass and esparto fabrics.

The industrial and commercial progress of Cartagena was considerably hindered during the first half of the 19th century by the prevalence of epidemic diseases, the abandonment of the arsenal and rivalry with the neighbouring port of Alicante. Its sanitary condition, though remaining defective, was improved by the drainage of the adjacent Almajar marsh, and after 1870 Cartagena advanced rapidly in size and wealth. The opening of the railway enabled it to compete for a time with Alicante and revived the mining and metallurgical industries, while the coast and land defenses were modernized and new quays, docks and other harbour improvements were added. As a naval station Cartagena suffered severely in 1898 from the maritime disasters of the Spanish-American War but, after the decree of 1908 ordering the Spanish navy brought up to date, considerable naval construction went on in the port. As a general commercial port Cartagena was adversely affected after the beginning of the 20th century by the increasing importance of Barcelona, Málaga and Alicante on the same coast. It exports some olive oil, dried fruits and esparto grass and ordinarily imports coal, coke and machinery from Great Britain, timber from the United States and dried codfish from Norway and Newfoundland, but it is above all a mineral port. Even this activity was somewhat reduced after the establishment in 1898 of an independent port at Portmán, a mining village on a sheltered bay 11 mi. E.

History.—Cartagena was founded about the year 227 B.C. by the Carthaginian Hasdrubal, probably on the site of a much older town, and was called (by the Romans) Carthago Nova or New Carthage to distinguish it from Carthage in Africa. It lay opposite the Carthaginian territory in Africa and was early noted for its harbour. Its silver and gold mines were the source of great wealth to the Carthaginians and later to the Romans. In 209 B.C. it was the scene of a notable exploit of military history by Publius Cornelius Scipio (*q.v.;* later surnamed Africanus). Displaying an acute strategic instinct, he made a direct attack on this main Carthaginian base in Spain in spite of the presence of Hannibal in Italy. His capture of the city, with its harbour and silver mines, paved the way for the expulsion of the Carthaginians from Spain. The city continued to flourish under the Romans, who made it a colony with the name Colonia Victrix Julia Nova Carthago. In A.D. 425 it was pillaged and nearly destroyed by the Goths. Cartagena was a bishopric from about 400 to 1289, when the see was removed to Murcia. Under the Moors it became an independent principality, which was destroyed by Ferdinand II of Castile in 1243, restored by the Moors and finally conquered by James I of Aragon in 1269. It was rebuilt and fortified by Philip II of Spain

(1527–98) for the sake of its harbour. In the War of the Spanish Succession it was occupied by Sir John Leake in 1706 and by the duke of Berwick in 1707. On Nov. 5, 1823, it capitulated to the French. Cartagena took part in the revolutionary movement of 1844 and in 1873 was bombarded by the Spanish fleet under Admiral Lobo. The city was occupied by government troops on Jan. 12, 1874. It was the loyalist naval base during the civil war of 1936–39.

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CARTAGO, a city of Costa Rica, 12 mi. S.E. of San José on the Inter-American highway at an altitude of 4,765 ft. above sea level, and capital of the province of the same name. Pop. (1960 est.) 17,776. The city is located on the Meseta Central, a fertile region of volcanic origin with mild climate. Earthquakes are not uncommon, and one in 1910 destroyed almost the entire town including the Central American Peace palace, home of the Central American Court of Justice. The basilica of Our Lady of the Angels, patroness of Costa Rica, with its famous black madonna, is a much frequented place of pilgrimage. Cartago was founded in 1563 by Juan Vázquez de Coronado, and was the capital of Costa Rica during the Spanish colonial period. In 1823, two years after independence, the capital was moved to San José. Although poor and backward, Cartago and its surrounding area were believed to be rich by Spain's enemies, and frequent attacks by pirates were fought off in the 17th century.

Cartago province (area 1,004 sq.mi.; pop. [1960 est.] 145,503) contains the town of Turrialba, centre of the world-famed Inter-American Institute of Agricultural Sciences which maintains a vast experimental farm to study methods of increasing food production in Latin-American nations. The chief product of the province is coffee, and Cartago city is an important marketing centre. (T. L. K.)

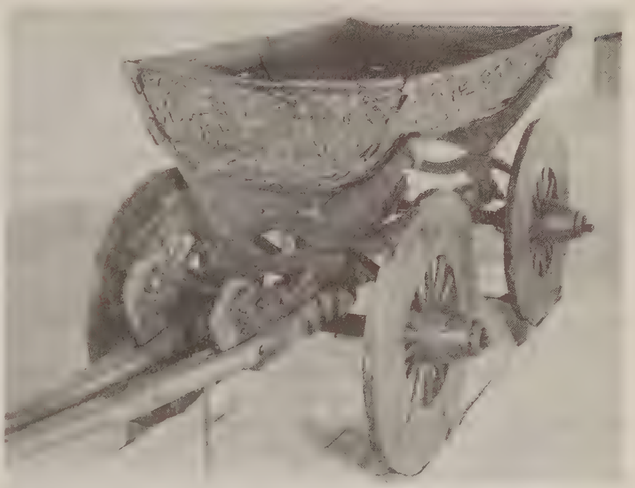
CARTAN, ÉLIE JOSEPH (1869–1951), French mathematician who greatly developed the theory of groups begun by Évariste Galois and contributed much to the theory of subalgebras, was born at Dolomieu, Isère, on April 9, 1869. Having entered the École Normale Supérieure in 1888, he became a lecturer at the University of Montpellier in 1894. There, working along the lines of W. Killing, he produced findings on the determination of simple groups.

He pursued the study of the structure of continuous groups introduced by M. S. Lie; and examined theories of equivalence and their relation to the theory of integral invariants, mechanics and the theory of relativity. Moving to the University of Lyons in 1896, he worked on linear associative algebra, developing general theorems based on the work of Benjamin Peirce of Harvard and exhibiting the Dedekind subalgebra of F. G. Frobenius. In 1912 Cartan became a professor at the Sorbonne, Paris, where he at first taught differential and integral calculus, and later (1924–40) higher geometry.

Although a profound theorist, Cartan was able to explain concepts to the ordinary student with clarity and comparative simplicity. He became a member of the Académie des Sciences in 1931, and a fellow of the Royal society in 1947. Cartan died in Paris on May 6, 1951.

Among his works are *La Géométrie des espaces de Riemann* (1925); *La Théorie des groupes continus et des espaces généralisées* (1935). His *Oeuvres complètes* were published in Paris, in five volumes, from 1952 to 1955.

CART AND WAGON. A cart is a two-wheeled vehicle whose origin is bound up with that of its four-wheeled counterpart, the wagon. Carts and wagons became the common inheritance of Europe in the Late Bronze Age, having first come into use in ancient Mesopotamia where four-wheeled wagons or war chariots were used in the 3rd millennium B.C. Vehicles found in the Protodynastic cemetery at Kish, possibly dating shortly after 3000 B.C., are funerary wagons or hearses with solid, copper-bound wheels. Sumerian pictographs indicate that these early vehicles have some relation to sledges, from which they might possibly be derived, but the earliest models and painted representations on pottery illustrate a high-backed four-wheeled wagon of small chassis drawn by oxen.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VIKING WAGON, 9TH CENTURY, TAKEN FROM THE GRAVE MOUND AT OSEBERG, NOR.

Wagons of basically similar design were in use throughout the middle east by the early 2nd millennium B.C. and had reached Syria, Crete and the Anatolian plateau. In the steppes of central Asia, however, and in the Indus valley, where wheeled vehicles had been in use from the closing centuries of the 3rd millennium, it was the two-wheeled cart that was favoured. Model carts from Chanhu-daro in the Indus valley are small and rather cubical in body and have two oxen yoked to the draft pole. The chassis of these early Indus carts consisted of two concave beams with three horizontal crossbars of wood. Holes in the long beams were sockets for upright stakes which held the wickerwork body in position. Wheels were solid with half-moon openings, and in structure these prehistoric carts differed little from modern peasant carts of Sind.

Among the nomads of the Asian steppes the covered wagon, models of which are found in Syria and Assyria from the 3rd millennium, was used for family transport, while farther west and into Europe, high-sided wagons were in use. The model from Budakalász in Hungary closely resembles Syrian model wagons of the 2nd millennium. Models of covered wagons from graves in the Kalmyk steppe dated *c.* 1250 B.C. are structurally similar to 5th-century B.C. models of Scythian wagons from Kerch and to the reconstructed Scythian ceremonial cart preserved in a tomb at Pasirik in the Siberian mountains. Two-wheeled carts of a type surviving in modern Anatolia were used for family transport by the "sea peoples" who in the early 12th century B.C. invaded Egypt, where previously the cart was unknown.

The small two-wheeled canopied carts used for personal transport in the Indus valley probably remained long in use, and in the last few centuries B.C. they reappear in China, with canopy or umbrella, as the chief means of personal transport.

In Greece and Rome farm carts with solid wheels were in use where conditions allowed, although the heavier four-ox wagon was used in the Etruscan area. Solid wheels discovered in Late Bronze Age contexts in Europe are more suitable for farm carts than any other form of vehicle, although spoked-wheel wagons were already in use in Europe by that time. In Greece the spoked-wheel cart in use for rural transport of people and goods is often illustrated on vase paintings.

Under the Roman empire both solid and spoked-wheel carts were in use in all the Mediterranean lands and western Europe. Carts in use at mid-20th century in Spain, Sardinia, Bosnia, Anatolia and even central Italy preserve the structure of carts used in Roman days. Structurally they can be divided into two types:

with the body sitting on the axle (Spain and Latium, Italy) or on the draft pole (Anatolia, Sardinia). It was the former type, a small affair drawn by mules, that was introduced at the Spanish conquest to the American continent, where formerly wheeled vehicles were unknown.

Pompeian wall paintings show that by the 1st century A.D. small carts drawn by goats or dogs were provided with shafts. In China shafts were being used on large bullock carts by the 2nd century A.D., and this innovation spread more rapidly in the far east than in the west. Carvings of shafted carts of the 3rd and 4th centuries A.D. are rare in Europe, and the first example from the British Isles dates from the 8th century.

Little is known of the structure of vehicles in the dark ages, but the earliest medieval manuscripts illustrating farm vehicles show little apparent advance on Roman models. Both shafts and draft poles were in use, but rarely is there evidence that either shaft or pole could swing horizontally or vertically or move in one piece with the axle as could the draft pole of the 1st-century Celtic wagons from Djebjerg, Den., or of the late Roman leather-hooded traveling coaches.

In the 14th century appear carts consisting of a long frame like a broad ladder carried on a pair of large wheels, basically like the Welsh dray in use until modern times. Traction of these carts, as in Wales and Orkney until modern times, was by traces attached to a beam at the front.

Besides the horsecart and the oxcart in use in Europe for agriculture, small carts such as the tinker's cart in Britain and the Irish jaunting car are still used for personal transport.

In the United States the Conestoga wagon, so-called because it was first built in the Conestoga valley of Pennsylvania, came into general use late in the 18th century in the pioneer movement across the Alleghenies. Its descendant, the prairie schooner, was used first in the Santa Fe trade and later by emigrants moving west to the Pacific coast in the 19th century. In modern U.S. usage the term wagon is also applied to automobiles—such as beach and station wagons—used both for passengers and light freight transport; in South Africa they are called ranch wagons, or shooting breaks—the latter from their use in hunting. The four-wheeled, horse-drawn wagon remains in use in rural areas of the United States, Canada and other countries.

See also CARRIAGE; CHARIOT; WHEEL.

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CARTE, RICHARD D'OYLY (1844–1901), English impresario who successfully managed the first productions of the operas of W. S. Gilbert and Arthur Sullivan, was born in London on May 3, 1844. After some experience in his father's musical instrument business, Carte opened a concert and lecture agency and became manager of the Royalty theatre, London (1870). In 1875 he presented there *Trial by Jury*, a dramatic cantata in which Gilbert and Sullivan had successfully collaborated at Carte's instigation. Carte then formed the Comedy Opera company (1876) to produce other operettas at the Opéra Comique in the Strand. The success of *H.M.S. Pinafore* (1878) ended the necessity for this syndicate and Carte, Sullivan and Gilbert continued as partners. Carte later opened the new Savoy theatre (1881), the first London theatre to have electric lighting, where for many years the Gilbert and Sullivan operettas enjoyed immense popularity.

A less successful venture was the building of a Royal English Opera house, for which Sullivan wrote *Ivanhoe* as the opening attraction (1891). This attempt to establish serious English opera on a permanent basis collapsed and Carte sold the house to Sir Augustus Harris, who turned it into the Palace theatre. Carte died in London on April 3, 1901. His touring companies, which had secured copyright of the Gilbert and Sullivan operettas, were continued in Britain and the United States by his heirs.

See GILBERT, SIR WILLIAM SCHWENCK and SULLIVAN, SIR ARTHUR SEYMOUR.

See F. A. Cellier and C. Bridgeman, *Gilbert, Sullivan and D'Oyly Carte* (1914). (H. RU.)

CARTE, THOMAS (1686–1754), English historian, whose works remain useful source books because of his use of original documents, was born at Clifton-upon-Dunsmoor, Warwickshire, in 1686. A staunch Jacobite, he acted as secretary to Francis Atterbury (*q.v.*), after whose fall in 1722 he lived in exile for six years. His *History of the Life of James, Duke of Ormonde* (1735–36) is of value for its collection of manuscripts, letters and official documents. At the threat of a Jacobite rebellion in 1744 he was arrested for a short time. His *A General History of England* (1747–55) was based on a closer study of documentary sources than earlier histories but it was attacked by the anti-Jacobites because of its account of a cure of the king's evil by the Old Pretender, and this, and its tedious style, prevented popular success. Carte died at Abingdon, Berkshire, on April 2, 1754. His valuable collection of historical papers was eventually acquired by the Bodleian library, Oxford.

CARTEL. In economics, this term denotes an organization of independent firms or individuals for the purpose of exerting some form of restrictive or monopolistic influence on the production or sale of a commodity or group of commodities. If the members of the organization are firms domiciled in one country only it is referred to as a domestic cartel; if they are located in different countries the organization is known as an international cartel. The most common forms of control are created for the regulation of prices or output, or division of marketing areas.

Early History.—In the first treatise on cartels, by the German economist, F. Kleinwaechter, these organizations were compared with medieval artisan guilds. There was some truth in this comparison, for some German cartels were combinations of small producers. However, cartels in Germany and elsewhere soon embraced some of the largest and most powerful producers. These combinations were quite dissimilar to medieval guilds and more closely resembled the mining and trading combines set up under royal or imperial authority by the Fuggers and their contemporaries. Combinations of cartel-like form are at least as old as the middle ages, and some writers allege to have found cartels even in ancient Greece and Rome.

The word "cartel" was not used to describe business combinations until 1879, when it was applied by a liberal deputy of the German *Reichstag*, E. Richter, to a group of producers in the iron industry who dumped their commodities abroad while keeping domestic prices high as the result of a mutual agreement and were enabled to do so because of tariff protection.

German Cartels.—The cartel has been the most common form of monopolistic organization in Germany in modern times. German cartels are usually horizontal combinations of producers (*i.e.*, of firms which turn out competing goods). Sometimes they may also embrace vertical integration (*i.e.*, firms which form integrated enterprises, extending into raw material production, intermediate goods and finished commodities). These organizations are sometimes called "trusts" in Germany, but they are not identical with U.S. trusts. An especially important form in Germany were the so-called *Interessengemeinschaften* which consisted primarily in a pooling of profits. The famous I. G. Farben was such a combination, but other famous *Interessengemeinschaften* were founded in the mining and electrical fields and in the manufacture of iron and steel and their products. The electrical Siemens-Schuckert concern, the Vereinigte Stahlwerke (United Steelworks) and later, in the 1930s, the Hermann Göring works were cartels of this type. They were all vertical and horizontal combinations of producers and resembled closely some large U.S. monopolies in the chemical, electrical and iron industries.

Though some of the early German cartels were formed soon after the Franco-German War (1870), a strong impetus to combination, notably of small and medium-sized producers, was given by Germany's increasing desire to conquer foreign markets in the decade before World War I. These producers profited from tariff protection that enabled them to keep domestic prices high and to sell at a loss abroad. During World War I the German government encouraged cartelization as a means of facilitating the allocation of war orders. At the end of the war in 1918 cartels emerged, therefore, stronger than ever, especially in the heavy industries, and by 1926 it was estimated that about 75% of the German coal and coke output and 79% of the German steel output was controlled by them. In the chemical and electrical industries, as well as in some mining fields, especially the production of alkali, cartel control was even greater.

In view of the vast economic power which these cartels could wield, a decree "against the misuse of monopoly power" was issued in 1923. This so-called "cartel decree" was enacted originally with an intent similar to that of U.S. antitrust legislation. Actually, however, it did not combat cartels but tended to foster them. It did attempt to prevent secret clauses in cartel agreements by stipulating that verbal contracts "which lay down obligations in regard to production and marketing, conditions of business, the nature of price fixing or price lists" were invalid. The decree also set up a cartel court, which was charged with jurisdiction in cartel matters, and stipulated that a cartel could be dissolved if its continued existence or its business practices were against the public interest or seriously damaged consumers or some other section of the German economy.

German practice in regard to cartels varied. During the 1920s the government was not friendly to them, and in 1925–27 some were even dissolved. With the coming to power of the Nazis, cartels were favoured, and in some industries compulsory cartelization was successfully attempted. The reasons were the same as those that induced the German government in World War I to favour cartels. Cartels made easier the transformation of the German economy to war production. With the defeat of Germany in World War II the Allied occupation powers drafted a bill outlawing cartels and other forms of restraint of trade, but there was strong opposition to this law among Germans who favoured a law that would permit cartels to exist but would punish abuses of cartel power. After the end of the occupation the bill outlawing cartels was dropped and legislation against abuses was introduced into the *Bundestag*. There was opposition even to this legislation; counterproposals were made and the debate on cartel legislation continued from 1951 to 1957. A law was finally passed in 1957 that outlawed various forms of "restriction of competition," but exempted from control certain cartel agreements; *e.g.*, export cartels. In general, the 1957 was stricter than the 1923 cartel decree but was not basically different from it. Its main additional differences were that it took due account of Germany's involvement in the European common market and that it incorporated some of the ideas derived from U.S. antitrust legislation.

Cartels in Other Countries.—The German example was followed in other European countries. Not only did combinations in restraint of trade of various sorts develop, but a number of countries enacted legislation patterned after the German cartel decree. Such a law was passed in Norway, for example, in 1926, and drafts for similar laws were submitted in the Czechoslovakian, Polish and Hungarian parliaments in 1929. In Denmark a "trust" law was also in force but it did not provide for as extensive a supervisory authority as the German or Norwegian laws. In Great Britain the rules of common law with regard to monopoly, and in France the provisions of the Commercial code seem to have been considered sufficient to deal adequately with the problems raised by cartels and cartel-like organizations.

International Cartels.—International cartel agreements were first concluded in the period between World Wars I and II and attracted a great deal of attention during the latter war, since U.S. firms had entered into cartel agreements with German firms, and this was thought to influence war production. Whereas domestic cartels may sometimes be concluded by many small producers, international cartels are normally concluded between firms each of which enjoys a monopoly position in its country's industry. They are combinations of giant firms and hence may, in extreme cases, achieve total or almost complete monopolization of an industry on a world-wide basis. They sometimes wield such great economic power as to be able to prevent governments from implementing national economic policies. Most international cartels, especially those in which German firms were partners, were dissolved during World War II, but some continued to exist, and trends were under way in the 1950s in the chemical and allied fields to revive some of the old cartel agreements.

Economic Aspects.—The main reason usually advanced for the establishment of cartels is the existence of "ruinous" competition. It is alleged that this causes profits in an industry to be too low, and cartelization is said to provide a solution by distributing fair shares of the total market among all competing firms. This often maintains inefficient firms in an industry and prevents adoption of cost-saving technological advances that would result in prices to the benefit of the consumer.

The most common practices employed by cartels in maintaining and enforcing their monopoly position are the fixing of prices, the allocation of sales quotas or exclusive sales territories to each member firm or the guarantee of a minimum profit to each member. These arrangements are often buttressed by agreements concerning conditions of sale, rebates, discounts, etc.

With increasing differences of efficiency and profitability among the various firms within a cartel, the cartel becomes, however, increasingly unstable. Although it can eliminate competition on the market, at least temporarily, it does not eliminate competition within itself. The larger and more powerful firms within the cartel will try to influence policy in their interest and may be opposed by weaker member firms. In some cases it may benefit a firm to withdraw from the combination and compete against it. Though a cartel tends to establish a high degree of price stability as long as it lasts, cartelized industries have experienced violent price fluctuations which accompanied periodic breakdowns of the cartel. Only when the government buttresses it and acts as an arbiter—as was done in Nazi Germany—can a cartel maintain long-lasting stability of prices and market conditions.

Wherever government support is absent, member firms have sought to strengthen the stability of cartels. In international cartels this need has been felt especially strongly, for the various partners are located in and subject to the jurisdiction of various countries. Among methods intended to strengthen stability and, simultaneously, to increase the monopoly power, have been allocation of exclusive sales territories to the various members and patent pools combined with cross-licensing of patents among members. In addition, agreements often contain provisions for penalties and sanctions against a firm which breaks the rules of the cartel, or they may provide for the establishment of a head office (usually located in a "neutral" country) which arbitrates disputes and may impose fines. The chief factor determining stability, however, is the common interest of all member firms in exploiting a monopoly position which the combination helps maintain.

Regulation and Control.—One of the most thorny problems of economic policy has been the control and regulation of international cartels. Since different governments view cartels in different lights, some supporting and others combating them with different degrees of vigour, and since the various partners of an international combination fall under different national laws affecting their constitution, duties and privileges, it is difficult to arrive at a uniform policy with regard to international regulation. Among the measures proposed are compulsory registration of international agreements, the conclusion of international treaties in regard to patents and trade-marks on which cartel power may be based and the conclusion of treaties outlawing the establishment of domestic cartels, especially those operative in export markets. Other suggestions include the conclusion of an international agreement outlawing the practice of allocation of markets or sales quotas and the establishment of an international supervisory organ with powers somewhat akin to the German cartel courts. This last proposal was contained in the draft for an International Trade organization (ITO), but the charter of the organization was not ratified. The U.S. may apply unilaterally its antitrust laws against cartels operating within its boundaries, though U.S. courts may lack jurisdiction in cases in which all participating firms in an international cartel are domiciled abroad. *See* also Monopoly; Competition, Economic.

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CARTER, ELIZABETH (1717–1806), English writer, and one of the group of literary "bluestockings" who gathered around Mrs. Elizabeth Montagu, was born at Deal, Kent, Dec. 6, 1717, the daughter of a learned cleric who taught her Latin, Greek and Hebrew. She was not a precocious child, but she persevered, with an industry that affected her health, studying also French, German, Italian, Portuguese, Arabic, astronomy, ancient geography, ancient and modern history and music, as well as the housewifery that caused Dr. Johnson to say "My old friend, Mrs. Carter, could make a pudding as well as translate Epictetus from the Greek, and work a handkerchief as well as compose a poem." In 1734 some of her verses, signed "Eliza," appeared in the *Gentleman's Magazine* and it was through its founder that she met Dr. Johnson. Her *Poems Upon Particular Occasions* were published in 1738 and *Poems on Several Occasions* in 1762. It was her translations, however, which ensured her reputation. In 1749 she undertook her most considerable work, a translation of *All the Works of Epictetus Which Are Now Extant*, published in 1758. It was an immediate success and its value can be judged by Johnson's comment of a celebrated scholar that he "understood Greek better than any one whom I have ever known except Elizabeth Carter."

Her letters to her many friends (the Montagus, with whom she traveled on the continent, Lord Bath, Catherine Talbot, Archbishop Secker, Edmund Burke, Samuel Richardson, Horace Walpole, Hannah More) show her to have been a woman of sound sense as well as learning, and some humour.

She died in London, Feb. 19, 1806.

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CARTER, HOWARD (1873–1939), British Egyptologist and water-colourist, discoverer of the tomb of Tutankhamen (*q.v.*), was born in Swaffham, Norfolk, Eng., and educated privately. At the age of 17 he joined the staff of the Egypt Exploration fund as a draftsman and received training in archaeological surveying under Sir W. M. Flinders Petrie and others. He engaged in excavations on behalf of the fund until 1899, when he became inspector general of the antiquities department of the Egyptian government. From 1902 he supervised the excavations of Theodore M. Davis in the Valley of the Kings and found the tombs of Tuthmosis IV and Hatshepsut. Subsequently, when working in collaboration with Lord Carnarvon (*q.v.*), Carter discovered many tombs, among them those of Amenhotep I and Tutankhamen, during the years 1907–23. He died in London, March 2, 1939.

He gave an account of his discoveries in *The Tomb of Thoutmôsis IV* (with P. E. Newberry, 1904), *The Tomb of Tut-ankh-Amen* (with A. C. Mace, 1923–33) and in contributions to various archaeological journals. (W. R. D.)

CARTER, MRS. LESLIE (born Caroline Louise Dudley) (1862–1937), U.S. actress, associated a number of years with David Belasco (*q.v.*), was born in Lexington, Ky., on June 10, 1862.

She made her stage debut in *The Ugly Duckling*, at the Broadway theatre, New York city, in 1890. Mrs. Carter played the leads in Belasco's *The Heart of Maryland* (1895–98), *Du Barry* (1901) and *Adrea* (1905). After leaving Belasco in 1906 her chief successes were in *Camille, The Second Mrs. Tanqueray, The Gay Lord Quex, The Circle* and *Madame X*. She died Nov. 13, 1937. (S. W. H.)

CARTERET, SIR GEORGE (*c.* 1610–1680), English politician and proprietor of American colonies, was born probably in 1610, and reared on the isle of Jersey. He became a naval captain, then vice-admiral and lieutenant governor of the island. He made it a royalist stronghold and refuge during the English Civil War, privateered in the royalist cause, and thereby won a knightship and baronetcy. After the capture of the island in 1651 by a parliamentary force, he went into exile in France.

Returning to England at the Restoration in 1660, Carteret became a powerful official: treasurer of the navy, privy councilor, vice-chamberlain of the household and member of parliament. Censured by parliament for laxity in account keeping, he gave up the treasurership of the navy in 1667, but subsequently held other important governmental posts.

In 1663 he was one of the eight proprietors to whom the king granted Carolina in North America. The following year the duke of York assigned to him and to John, Lord Berkeley, the American colony of New Jersey, named in his honour. Frictions in the colony and disappointing financial returns led Berkeley to sell out to Quakers in 1674. With them Carteret agreed upon a division of the colony in 1676, he keeping East Jersey. His heirs sold East Jersey to William Penn and other Quakers two years after his death in 1680. *See* also New Jersey: *History*. (W. R. Sl.)

CARTERET, JOHN, Lord: *see* Granville, John Carteret, Earl.

CARTESIANS, the name given collectively to the propagators and continuators of the philosophy of René Descartes (*q.v.*); alternative names for them current in France in the 1670s were Cartistes and Descartistes.

Some of them, who only repeated what Descartes had already stated, laid themselves open to the reproach that they rejected the principle of authority while still depending on the authority of Descartes, and much play was made of the anagram "Cartesius-Sectarius," against which the German Cartesian Johann Christoph Sturm (1635–1703) protested in *De Cartesianis et Cartesianismo brevis dissertatio* (1677).

Henricus Reneri (1593–1639) may have been lecturing on the Cartesian method at Utrecht in the Netherlands just before he died. For Henricus Regius, *see* below. Other early exponents in the Netherlands were Joannes de Raey (1622–1707; *Clavis philosophiae naturalis*, 1654) and Adriaan Heereboord (1614–61; *Meletemata philosophica*, 1659), who introduced the new theses in scholastic form, just as Jacques du Roure did in France (*La Philosophie établie sur des principes évidents*, 1654; *Abrégé de la vraie philosophie*, 1655). Commentaries on the *Meditations* were produced by Joannes Schotan (1643–99; *Exegesis*, 1687, and *Analysis exegetica*, 1688) and Christoph Wittich (1625–87; *Annotationes*, 1688). Wittich, who worked first at Nijmegen, then at Leiden, showed more originality in his *Consensus veritatis in Scriptura divina . . . cum veritate philosophica a R. Cartesio detecta* (1659), in which he considered the application of Cartesian rationalism to Calvinist theology—as also did other Dutch Cartesians, such as Balthasar Bekker (1634–98; *De philosophia cartesiana*, 1661), Abraham Heidanus (1597–1678) and Spinoza's friend Lodewijk Meyer (*Philosophia Scripturae interpres*, 1666).

There were also several Germans teaching Cartesianism in the Netherlands: Alexander Roell (1653–1718; *Institutiones philosophicae de theologia naturali*, 1662, and *De recta ratiocinatione*, 1683) at Franeker; Ruardus Andala (1665–1727); and Tobias Andreae (1604–74) at Groningen, the opponent of Regius and the teacher of Johann Clauberg (*q.v.*). In Germany itself Cartesianism was expounded not only by Clauberg but also by Daniel Lipstorp (1631–84; *Specimina . . .* , 1653). Andreas Petermann at Leipzig and Johann Eberhard Schweling at Bremen wrote in defense of Cartesianism against Daniel Huet's *Censura* (1689), which also provoked defenses from Schotan and from Burchard de Volder in Holland and from P. S. Régis (*see* below) in France. In Switzerland the system was professed by Jean Robert Chouet (1642–1731), a French refugee from Saumur at Geneva, while another French Calvinist, Étienne Chauvin (1640–1725), was publishing the first Cartesian dictionary, *Lexicon rationale* (1692).

Regius.—Long before all the above-mentioned adherents came forward, Henricus Regius (Henri Le Roy, or de Roy; 1598–1679) had incurred the wrath of Gisbert Voet and others by teaching on Cartesian lines at Utrecht. Descartes himself first supported Regius, then disavowed him, so that it may be asked whether

Regius can be called a Cartesian or not. His *Fundamenta physices* (1646; augmented ed., *Philosophia naturalis,* 1654) and his *Explicatio mentis humanae* (1647) propound a mechanistic theory without any allowance for "substantial forms" and follow Descartes on mechanics and astronomy. Moreover, Regius made use of some then unpublished writings of Descartes on physiology, supplementing their findings with his own medical observations. On the other hand he reverses the Cartesian order of investigation, which gave the primacy to metaphysics, and, by presenting the soul as a mode of the body and the senses as the source of all our ideas, destroys the Cartesian proofs of the existence of God.

Regius, a mechanist and an empiricist, was quite as original as Arnold Geulincx (*q.v.*), who also owed much to Descartes. Benedictus de Spinoza, on the other hand, had already a wholly distinct philosophy of his own when he wrote his exposition, *Renati des Cartes principiorum philosophiae pars I et II* (1663).

The Early Editors and the Augustinian Tradition.—The editions of Descartes's posthumously published writings gave rise to more activity. CLAUDE CLERSELIER (1614–84) wrote prefaces for the *Lettres,* three volumes (1657–67), and for the *Traité de l'homme* (1677), the latter work being also prefaced by the Dutchman FLORENT SCHUYL (*d.* 1669) and annotated by La Forge (*see* below) in 1664. The Oratorian NICOLAS JOSEPH POISSON (1637–1710) edited the *Traité de mécanique* and the *Abrégé de musique* in 1668 and used some unpublished material of Descartes's youth in his commentary on the *Discours de la méthode* (1670). A long extract from the manuscript of the *Regulae ad directionem ingenii,* a work not printed until 1701, was included by the great Antoine Arnauld and Pierre Nicole in the *Port-Royal Logic* (1662).

A new feature of Cartesianism appeared in these texts, namely stress on the agreement between Descartes and St. Augustine of Hippo. The Oratorian ANDRÉ MARTIN (1621–95), under the pseudonym "Ambrosius Victor," produced his *Philosophia christiana,* six volumes (1653–71), by cleverly marshaling excerpts from St. Augustine's writings according to the order and principles of Cartesian procedure—though when he arrived at the theory of animals as machines he had to admit that St. Augustine himself had still believed animals to have souls (vol. 6).

Animal Automatism.—The theory of animals as machines was much debated. Pierre Bayle (*q.v.*), in the article "Rorarius" in his *Dictionnaire* (1692), gives a long list of attacks on it and ironically expresses regret that a theory so convenient to Christian teaching should be so improbable. Bayle, whose *Système de philosophie* had been markedly Cartesian, was by this time a thorough skeptic. Animal automatism, however, was defended not only by Poisson and "Ambrosius Victor," but also by Rohault (*see* below; second *Entretien*), by Geulincx in his posthumous *Brutum Cartesianum* and by the Franciscan missionary ANTOINE LE GRAND (d. 1699), of Douai, who went to live in England and there published *De carentia sensus et cognitionis in brutis* (1675; he also published a Cartesian *Institutio philosophiae* in 1675 and an *Apologia pro Des Cartes* in 1679).

Yet another defender of animal automatism was ANTOINE DILLY, a priest of Embrun, whose *De l'âme des bêtes* (1676) was a counterblast to *De la connaissance des bêtes* (1672) by the Jesuit IGNACE GASTON PARDIES (1636–73). The latter work, however, itself incurred some suspicion of Cartesianism, as the first part, expounding the theory of animal automatism, was better than the critical part. In his mechanics and in his optics, however, Pardies is closer to Christiaan Huygens (*q.v.*) than to Descartes, and Huygens, whose father had been a personal friend of Descartes, had very soon shaken off all Cartesian influence, his studies on centrifugal force and on the finite velocity of light being completely destructive of Cartesian physics.

Rohault.—JACQUES ROHAULT (1620–72), Clerselier's son-in-law, is the best of the Cartesian physicists. He corrects Descartes on points of detail by means of ingenious experiments and gives an original account of capillary action. His *Traité de physique* (1672) went through several editions in a short time and was translated into several languages (Samuel Clarke annotated the first English version). Rohault also published *Entretiens sur la philosophie* (1671), discussing the main objections to the Cartesian explanation of transubstantiation and to the theory of animal automatism.

CLAUDE GADROIS (*c.* 1642–78) based his *Système du monde* (1675) largely on Rohault's work. His *Discours sur les influences des astres selon les principes de M. Descartes* (1671), however, shows a curious originality in suggesting a mechanistic explanation for telepathy and for certain influences of the stars.

Cordemoy.—GÉRAUD DE CORDEMOY (*c.* 1620–84) shows more originality than any other Cartesian on the subject of the general principles of physical theory. He introduces a new atomism into the mechanistic system of the Cartesians by linking unity and substantiality: matter is homogeneous but contains a multiplicity of bodies each of which is an indivisible substance (*Le Discernement de l'âme et du corps,* 1666; discours 1). The principle of inertia and the divine origin of everything reduce interaction between bodies to a simple correspondence (*see* OCCASIONALISM), and the same applies between soul and body; belief in the existence of bodies must be a matter of faith. Even so, Cordemoy does not abandon the notion of finality or purpose that Descartes derived from the real unity of body and soul: God warns us by means of sensations of what is useful or harmful to us, as it is vital for us to apprehend objects at a distance. A vast language of perceptible messages is thus built up, and Cordemoy, in his *Discours physique de la parole* (1668), develops the theory of signs—natural in the expression of the passions, conventional in language—language being the unique phenomenon that assures us of the existence of others as thinking beings and not as machines. These two slight works, together with a *Lettre* on animal automatism (1668), constitute Cordemoy's entire philosophical output.

La Forge.—LOUIS DE LA FORGE (d. shortly after 1666), a native of La Flèche who practised medicine at Saumur, began in 1664 by annotating Descartes's *Traite de l'homme* in the light of recent discoveries, such as that of the chyle by Jean Pecquet. His *Traité de l'esprit de l'homme* (1666) serves as a continuation of the unfinished work of Descartes. For this, La Forge makes use of all the hints to be found scattered throughout the books and the correspondence of Descartes, stressing those of his formulas which point the way to the occasionalist account of the soul-and-body relationship. He is most daring where he poses the question of the state of the soul separated from the body after death, Descartes having only affirmed its natural incorruptibility.

Régis.—None of the continuators of Descartes took much interest in ethics. The only Cartesian work exclusively devoted to that subject is *L'Art de vivre heureux* (1667), sometimes questionably attributed to the Oratorian CLAUDE AMELINE (1635–1708), which is a juxtaposition rather than a synthesis of provisional precepts taken from the *Discours* and from the letters of Descartes. Ethics, however, is the subject of part 4 of *Le Système de philosophie* (1690), published by PIERRE SYLVAIN RÉGIS (1632–1707) after he had made his name lecturing in southern France and later in Paris. A great compiler, Régis is the chief exponent of a complete Cartesian system with empirical tendencies. Part I of his book, dealing with logic, borrows something from Port-Royal but something also from Pierre Gassendi. Part 2, dealing with metaphysics, insists that in this life the soul can act and know only in dependence on the body (Régis moreover inclines to faith rather than to reason for his expatiation on the state of the soul after death). This empiricism likewise has features reflecting Gassendi, but it also owes something to the Benedictine Cartesian ROBERT DESGABETS (d. 1678), who published little but whose manuscripts (preserved at Épinal) emphasize how thought depends on the soul-and-body union—in particular the feeling of duration, as only bodily movements can call forth the notion of succession. In part 3 of the *Système,* on physics, Régis makes use of E. Mariotte's recent experiments and also, for anatomy and physiology, of those of M. Malpighi, N. Steno and A. van Leeuwenhoek, but he preserves all the mechanistic principles of Descartes (even including the instantaneity of light) and rejects Gassendi's atomism. Part 4, on ethics, devotes much space to natural inclinations and to self-love (*amour-propre*) and finally discusses absolute power as the guarantor of the state; it thus owes more to Hobbes and to Spinoza than to Descartes.

Later Developments.—His tendency to empiricism brought Régis into conflict with Nicolas Malebranche (*q.v.*). As Malebranche in fact made a new synthesis of Cartesian rationalism with revealed Christian dogma, he was not a Cartesian in the strict sense. For this reason his theory of ideas assimilated to eternal essences and seen directly "in God" was attacked by Régis, Desgabets and, especially, Arnauld.

The thesis of the creation of the eternal truths by God was hardly taken up at all by the Cartesians. Leibniz—who was rather an adversary than a follower of Cartesianism—says that Poiret alone took it up. In fact not only Desgabets but also Pierre Cally (*c.* 1630–1709) did so, the latter making essences depend on God's will in his *Universae philosophiae institutio*, 2 vol. (1695). Pierre Poiret (1646–1719), a Calvinist theologian from Metz who died at Rijnsburg in the Netherlands, regarded the thesis as an acknowledgment of God's total transcendence, but if the first edition of his *Cogitationes rationales de Deo, anima et malo* (1677) is Cartesian, his later writings discard all the rational elements as superficial and uphold pure mysticism.

Bossuet and Fénelon (*qq.v.*) were not uninfluenced by Cartesian thought. In many writers, however, it is hard to distinguish between the Cartesian and the Malebranchian influence: for instance the Oratorian Bernard Lamy (1645–1715; *Entretiens sur les sciences*, 1683); the Benedictine François Lamy (1636–1711; *De la connaissance de soi*, 6 vol. 1694–98); the abbé de Lanion (pseudonym Guillaume Wander; *Meditations sur la métaphysique*, 1684); René Fédé; *Méditations métaphysiques*, 1683); the Italian Franciscan Michele Angelo Fardella (1650–1718; *Universae philosophiae systema*, 1691, *Logica*, 1696, and *Animae humanae natura ab Augustino detecta*, 1698); Melchior de Polignac (1661–1742), who published his *Anti-Lucrèce* in verse; and even the solipsist Claude Brunet (*c.* 1660–1740), who maintained that things existed only insofar as he thought of them. In the 18th century, when Cartesianism had become a bulwark of antimaterialist thought and was being attacked by the Encyclopédistes, the abbé Joseph Adrien Lelarge de Lignac (*d.* 1762) still acknowledged Descartes and Malebranche as his masters, but his *Éléments de métaphysique tirés de l'expérience* (1753) and his *Témoignage du sens intime* (1760) are often close to J. J. Rousseau's philosophy of existence and sometimes foreshadow Maine de Biran. In Italy the Savoyard cardinal Hyacinthe Gerdil (1718–1802) likewise used Cartesian arguments against materialism. Conversely, La Mettrie's *L'Homme-machine* (1747) reflects the mechanistic side of Cartesianism cut off from the spiritual. By this time, however, the Cartesian stage in the history of philosophy had been passed.

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CARTHAGE, one of the most famous cities of antiquity, was founded on the north coast of Africa by the Phoenicians of Tyre and, according to the Sicilian historian Timaeus, in 814 B.C. Today it is a residential suburb of the city of Tunis (*q.v.*). The significance of its Phoenician name *Qarthadasht* ("new town") is not precisely known, but according to ancient historians Carthage was founded by the Phoenicians after nearby Utica at the mouth of the Bagradas river (modern Medjerda), and after Gadir (Cádiz) in southern Spain, both of which, according to Velleius Paterculus were founded about 1100 B.C. Traditionally the "new town" of Carthage was so called because it succeeded the "old town" of Utica.

Various traditions concerning its foundation were current amongst the Greeks, who called the city Karchedon, but the Roman tradition is better known because of Virgil's *Aeneid*. This tells of the city's foundation by the Tyrian princess Dido who fled from her brother Pygmalion, the name of a historical king of Tyre. The inhabitants were known to the Romans as *Poeni*, a derivation from the word *Phoenikes* (Phoenicians), whence the adjective Punic is derived.

Date of Foundation.—The dates of the foundations of Cádiz, Utica and Carthage were probably inflated by the Carthaginians themselves, for they do not agree with the archaeological data. In the case of Carthage, which has been extensively if not systematically explored, nothing earlier than the last quarter of the 8th century has been discovered, a full century later than the traditional foundation date. Dating of the earliest Carthage tomb groups is provided by the presence of proto-Corinthian cups which cannot be earlier than the last quarter of the 8th century B.C. Besides the material from tombs, there are stratified deposits of pottery in an area southeast of the Byrsa, the low hill which dominates the city site, in which were buried the cremated remains of children sacrificed to the Carthaginian goddess, Tanith (Tanit). This area, known as the "precinct of Tanith" in a locality now called Salammbô, has a stratification which covers most of the city's Punic history and can be divided into three periods: 814?–700 B.C., 700/650–350 B.C., 350/300–146 B.C. The beginning of the lowest stratum, here given the traditional historical date, can, however, only be dated by the presence of proto-Corinthian *kotylai* (cups) which are a century later at least. Nor can a deposit of pottery apparently related to the Ionian and Cumaean geometric style made on the virgin soil of this precinct and undoubtedly the earliest pottery hitherto found at Carthage be given a date earlier than about 720 B.C.

Concerning the foundation of Carthage there is a further relevant problem. A town called Qarthadasht was also founded by the Phoenicians at Citium (Kition) in Cyprus. It is mentioned in Assyrian tribute lists of Sargon II (*c.* 720 B.C.) and was a tributary city of Hiram II of Tyre as early as 758 B.C. Josephus records that Citium broke away from Elulaios of Tyre and was refounded by him as Qarthadasht, and it therefore seems possible that it was the Citium-Qarthadasht which was founded about 814 B.C. by Dido, whose other name Elissa means "Cyprus," and that the traditions of its foundation were later transferred to north African Carthage, a "new town" in relation to Citium.

Site of the City.—The site chosen in the centre of the shore of the Gulf of Tunis was admirable from every point of view. The triangular peninsula on which Carthage was built is covered with low hills and backed by the Lake of Tunis with its safe anchorage and abundant supplies of fish, and was easily defensible. The promontory of the city is protected on the north by Cape Carthage and the heights of the modern village of Sidi-bou-Said. On the south the peninsula is connected to the mainland by a narrow strip of land between the gulf and the lake which is broken by a channel at La Goulette connecting the two. The distance between Cape Carthage and La Goulette is about 6 mi.

The Byrsa.—The ancient citadel was on a low hill overlooking the sea. This is known as the Byrsa, a word probably Punic in origin but equated in ancient times to the Greek *bursa* (an oxskin), whence arose the story of Dido's claim to all the territory she could encircle by an oxskin. When her claim was granted she cut the skin into strips and hence encompassed enough space to build her city. It is on the Byrsa, now crowned by the cathedral of St. Louis and the monastery of the White Fathers and known as the Hill of St. Louis, that some of the earliest tombs have been found. For the rest of the town there is only one place name preserved by ancient historians and that is Magara. What or where this was is unknown, but according to Cornelius Nepos the name could be referred to the town lying below the Byrsa. Of domestic and public buildings nothing remains.

Burial Traditions.—From the earliest times both cremation and inhumation were used in the graveyards, implying the same mixed cultural tradition as found on the Phoenician coast. Both skeletons and cremation urns were placed either in stone sarcophagi or in small but carefully built chambered tombs. This multiplicity of burial traditions recurred throughout the history of Punic Carthage.

HISTORY

Colonization and Expansion.—The foundation of Carthage was closely followed by the establishment of other Phoenician cities in the west Mediterranean over which Carthage gradually gained control. Chief of these was Motya, an island city on the west Sicilian coast near Marsala, which according to Diodorus was founded by Carthage. In Sicily the arrival of Greek colonists in the 8th century B.C. caused the Phoenicians to curtail their interests in the island. According to Thucydides the Phoenicians withdrew to the western settlements of Panormus (Palermo), Soloeis (Solonto) and Motya (Mozia). Archaeology has confirmed the truth of this information. There were also a number of Phoenician cities in Sardinia, the majority of which were probably independent foundations.

The first major territorial expansion of Carthage in Sicily took place under the generalship of Malchus in 550 B.C. He succeeded in capturing half of the island before turning his attention to Sardinia. There, in an attempt to spread Punic domination over the eastern part of the island as well as over the south and west, which were already settled by Phoenicians, he was defeated by the Sards. The latter had in all probability allied themselves with the Phocaean Greeks who were anxious to prevent Punic interests spreading too far northward into their own commercial preserves. Rivalry between Greek and Carthaginian in western seas came to a head in 535 at Aleria (Alalia) off the coast of Corsica. There the Phocaeans won a doubtful victory over the Carthaginians and their Etruscan allies. The first treaty between Rome and Carthage in 509 B.C. forbade the Carthaginians access to Italy with which they had close trading contacts and Carthage never again showed any desire to interfere with the Greek program of colonization of Liguria and southern France. Malchus' successor, however, Mago (*q.v.*), the first member of the Barcid house to come to power at Carthage, made certain of continued Punic domination in Sardinia and is said to have wrested the Balearic Islands from the Phocaean Greek sphere. In the Balearics, however, Carthage had already established a strong colony in the island of Iviza which Diodorus says was founded 160 years after the foundation of Carthage; *i.e.*, in 654 B.C. Nothing of so early a date has been found in the numerous tombs near the present town of Iviza. There is in fact nothing much earlier than Mago's own day. Punic remains in Minorca and Majorca are limited to pottery, but Port Mahon supposedly derives its name from Mago. It was also probably under Mago that the first Punic colonies outside Gibraltar were planted on Iberian soil.

Apart from Utica, none of the Phoenician cities of the African mainland are as early as Carthage, but at Sousse (ancient Hadrumetum) on the eastern coast of Tunisia a burial ground is known of the early 6th century. Other settlements in Tunisia and Algeria, at Acholla, Tipasa, Gigthi and Gouraya, begin largely in the 5th century B.C. Farther to the west a trading station was founded on the small island of Rachgoun off the coast near Oran and others followed on the north coast of Algeria (Andalouses, Mersa Madakh).

When about 460 B.C. the Carthaginian admiral Hanno sailed on a voyage of exploration beyond Gibraltar, there were already Phoenician settlements on the west African coast. The city of Lixus (Larache) was probably founded about 600 B.C. A settlement on the island of Mogador also goes back to that date. All these settlements were probably under the domination of Carthage by 500 B.C. and were closely linked about 400 B.C. by the establishment of a string of coastal entrepots on the north African coast between Oran and Tangier.

Sicilian Wars.—During this period of western expansion, Carthage was engaged in a century of almost continual strife with the Greeks for supremacy in Sicily. The first of these operations began in 409 B.C. when the Carthaginians joined their Elymian allies against the Athenian-led Sicilians and destroyed Selinus and Himera. Later, in 406 B.C., Hannibal and Hamilcar captured Agrigentum, Gela and Camarina and came to blows with Dionysius, tyrant of Syracuse. Peace was concluded, but it was short-lived. Dionysius attacked the Carthaginian cities in 397 and destroyed Motya. In the same war, however, in 397, the Carthaginians captured Messana (Messina), defeated Dionysius and laid siege to Syracuse. Again a peace was patched up, Carthage re-establishing the surviving Motyans at Lilybaeum (Marsala). But Dionysius began war again in 383. After his defeat Sicily was divided between the Greeks and the Carthaginians at the Alico river. In 367 Dionysius began war for the fourth time and, although he died in the course of it, campaigns were carried on against the Carthaginians by his successors, Dionysius II, Timoleon and Agathocles. Agathocles in 312–311 carried the war into north Africa and besieged Carthage which was then handicapped by the conspiracy of Bomilcar, but the Greek army was eventually defeated and driven out. After the death of Agathocles the Carthaginians re-established their supremacy in Sicily, and Mago even offered assistance to Rome against the invasion of Pyrrhus (*q.v.*). In 277 B.C. Pyrrhus prepared to sail for Africa and bring Carthage to submission, but he was compelled to return to Italy. Because of his intervention in west Mediterranean affairs, however, Carthage lost its opportunity to dominate Sicily completely.

Religion.—The narrative may here be interrupted by a brief account of the religion of Phoenician Carthage and of its political, cultural and commercial life.

Very little is known of Punic religion except that to the Greeks and Romans it was abominable because of its brutality and human sacrifices. The burials in the precinct of Tanith are certainly those of children sacrificed to the goddess Tanith and the god Baal Amon, although there is only one figural representation of such a sacrifice taking place, a gravestone which depicts a priest offering a human child. The god Moloch, who was supposed to have images of metal containing furnaces in which human victims were burned alive, is perhaps a Greek invention coined from MLK, a type of Punic sacrifice (*cf.* biblical "molech").

Tanith, whose full name *Tanit pene baal* means "Tanith, face of Baal," was the chief goddess of Carthage and is represented on innumerable monuments by her symbols of a disk and crescent moon and by the shape of a triangle surmounted by a crossbar and circle. She is equivalent to the Phoenician Astarte and has some of the aspects of the Egyptian goddesses Isis and Hathor. Punic representations of her show her wrapped in double pairs of wings and wearing the Hathoric disk and horns.

The role and iconography of Baal Amon in the early period are unknown. Representations of male deities are rare at Carthage, but from the 3rd century B.C. onward he was represented as a bearded figure with ram's horns. With him was associated Eshmuṇ, a god of the Phoenician homeland, to whom a large temple was built on the Byrsa.

There were probably a number of other small gods but chief of these was the Baal of Carthage and Tyre who bore the title Melkart (city king). A number of representations reveal him as a bearded figure wearing a tall conical cap and carrying an oriental type of ax.

During the greater part of Carthage's history, temple architecture probably followed Greek patterns. A Punic temple tariff found in Marseilles lists the prices of various animals which could be purchased from the temple for sacrifice and also refers to temple prostitutes, recognized adjuncts of Phoenician temples.

The sacrifice of animals played a considerable part in Punic cult, especially in connection with funerary customs. Bones of cocks, birds and small rodents were frequently interred with the dead.

Gradually from the 5th century B.C. the deities of Carthage became increasingly hellenized: Tanith was associated with Ceres, Eshmun with Asclepius and Melkart with Apollo. The great popularity of Tanith-Ceres survived in Roman times in the cult of Juno after whom the Roman city was named.

Internal Administration.—Close political relationship between Carthage and Tyre probably did not exist. Tyre was content to have religious ties with its daughter city and to let it govern its own affairs by annually electing two judges or suffetes (*suffetim*), a system of government which was followed in other Phoenician colonies. The chief function of the suffete was judicial though occasionally one of them took command of the army. The suffetes presided over a council of 30 members drawn from the rich oligarchy of the city. Important matters governing the affairs of the city were decided by a larger council of 300 members. All citizens of Carthage, other than slaves, were able to elect members to this latter council, but only members of the oligarchy were available for election. Members of the council of 30 and the suffetes were elected by the council of 300. The "oligarchy" was not, however, a closed group: members of the public who were able to show a certain property qualification, of an extent unknown, probably automatically became members of it.

The financial affairs of the city were in the hands of a board of 100 ex-magistrates and officers. Continued re-election to this board formed of it a kind of permanent and professional fiscal body. One of its main responsibilities was the payment of the numerous mercenaries employed in the Carthaginian armies.

Cultural Life.—The standard of cultural life enjoyed by the Carthaginians was probably far behind that of the larger cities of the classical world, but when the Romans sacked Carthage in 146 B.C. they found libraries of extensive literature in Punic. Timaeus also states that Kings Hiempsal and Juba II of Mauretania were interested in Phoenician letters and collected libraries. Of Punic literature, however, all that has survived is the knowledge that a certain Mago wrote a book on agriculture and that Hanno wrote an account of his voyage to west Africa. In the visual arts the Carthaginians were completely tasteless. Their own cultural background was mixed and their artistic abilities devoted to copying the ideas of others, usually the worst ideas, and making serviceable mass-produced goods. Neither the mass-produced pottery nor terra cottas or the surviving bits of jewelry show any appreciation of design and some are frankly hideous. Although at least one Carthaginian sculptor enjoyed a moderate fame in ancient times, no surviving work shows even outstanding ability at modeling or drawing.

Commerce.—It was toward commerce that Punic interests were turned. In Roman times, Punic beds, cushions and mattresses were regarded as luxuries and Punic joinery and furniture were copied. Much of the revenue of Carthage came from its exploitation of the north African and south Spanish silver mines, begun as early as 800 B.C. Lead and silver were also obtained from Sardinia, pitch from Iviza and esparto grass from the Valencian coast. In the Atlas mountains the Carthaginians found the same cedars and junipers which had made the homeland Phoenicians rich. Olives and dates were exported in amphorae to Italy and Gaul, while the city's colonies traded in humbler commodities such as salt and salt fish. The rich fauna of the African hinterland were available for export to the Roman circuses and the trade in African ivory was Carthage's monopoly. At different periods imports included Greek and Etruscan pottery and Egyptian amulets and beads.

The Punic Wars.—(For a full account of these wars *see* PUNIC WARS.) The First Punic War (264–241 B.C.) was fought by Carthage for the defense of its Sicilian possessions and for its supremacy in the Tyrrhenian sea. After Rome's final victory at the Aegates Islands (241 B.C.) Carthage desired to disband its forces, but the mercenaries claimed their arrears of pay and, on being refused, revolted under Spendius and Matho, pillaged the suburbs of Carthage and laid siege to the city itself. The genius of Hamilcar Barca raised the siege; the mercenaries were cut down in the "defile of the axe."

Carthage then undertook the conquest of Spain. This operation lasted nine years up to the date of Hamilcar's death, in 228 B.C. His son-in-law, Hasdrubal, built Carthagena in 227 B.C. and concluded with Rome a treaty by which the Ebro was adopted as the boundary of the Carthaginian sphere. He was succeeded by Hannibal (*q.v.*), son of Hamilcar, who, crossing the Ebro, marched through southern Gaul into Italy, thus beginning the Second Punic War, which lasted from 218 to 201 B.C. The campaigns of Hannibal are famous for their military imagination (for accounts of the principal battles *see* TRASIMENO, LAGO; TREBBIA; CANNAE; ZAMA, BATTLE OF). His final defeat at Zama (202 B.C.) was disastrous to Carthage which, in the period immediately before the Second Punic War, was in the enjoyment of extraordinary prosperity; its land was cultivated to that maximum productivity which was to make it one of Rome's chief granaries and its colonial markets were at their maximum extension. Carthage was able to borrow large sums from the Egyptian Ptolemies and Hannibal built up a strong army equipped, on Ptolemaic lines, with elephants.

Although stripped of its African possessions and having lost its fleet in this war Carthage soon revived and, now with a population of about 700,000 (according to Strabo who gives the only figures on the city's population) never ceased to inspire alarm at Rome. The Numidian prince, Masinissa (*q.v.*), rival of Syphax and a Roman protégé, took advantage of a clause in the treaty of 201 B.C., which forbade Carthage to make war without the consent of the Roman senate, to extend his possessions at the expense of Carthage. In response to a protest from Carthage an embassy including M. Porcius Cato the Censor was sent to inquire into the matter, and Cato was so impressed with the resources of the city that on returning to Rome he never made a speech without concluding with the warning "Carthage must be destroyed."

At this time the popular faction in Carthage, which was turbulent and exasperated by the bad faith of the Romans, expelled the Numidian party and declared war in 149 B.C. on Masinissa who was victorious at Oroscope. Rome then intervened. The Third Punic War lasted three years, and after a heroic resistance the city fell in 146 B.C. The last champions of liberty entrenched themselves under Hasdrubal in the temple of Eshmun. The Roman troops were let loose to plunder and burn. The site was dedicated to the infernal gods, and all human habitation throughout the ruined area was forbidden.

Roman and Christian Carthage.—A quarter of a century after this destruction the Roman senate entrusted C. Gracchus and Fulvius Flaccus with the foundation of the Colonia Junonia on the site (122 B.C.). It lasted only 30 years and was ill-omened from the start, so that the senate finally abrogated the law governing its foundation. Pursuing the last supporters of Pompey, Julius Caesar visited the site and the proposal for a new foundation was taken up by Lepidus during the second triumvirate. Caesar sent there a number of landless citizens and in 29 B.C. Augustus sent a body of *togati cives* and centred the administration of the African province there. Henceforth it became known as Colonia Julia Carthago and the new colony set about acquiring a prosperity which was soon to rank it with Alexandria and Antioch. Pomponius Mela and Strabo describe Carthage as one of the wealthiest and most populous cities of the empire and Herodian puts it second only to Rome. Carthage shared also in the vicissitudes of imperial succession and supported the revolt of Clodius Macer, legate of Numidia in A.D. 68, and proclaimed Piso, governor of Africa, as emperor at the accession of Vitellius (A.D. 69).

Carthage became a favourite city of the emperors, though none resided there. Hadrian, who greatly embellished it, was keen to call it Hadrianopolis. Antoninus Pius gave the city its chief baths. Commodus changed its name to Alexandria Commodiana Carthago and Caracalla added to Julia, Aurelia Antoniniana. Of its history under the later emperors very little is known, but from the mid-3rd century the city began to decline.

In the early history of Christianity Carthage played an auspicious part. From the end of the 2nd century there was a bishop of Carthage; the first historical bishop was Agrippinus, the second Optatus. At the head of the apologists, whom the persecutions inspired, stands Tertullian, who was succeeded (A.D. 248) by a no less famous bishop, Cyprian. About this time the proconsul Gordian had himself proclaimed (A.D. 239) emperor at Thysdrus (El-Djem). Shortly afterward Sabinianus, aspiring to the same dignity, was besieged by the procurator of Mauretania; the inhabitants gave him up and thus obtained a disgraceful pardon. Peace being restored, the persecution of the Christians was renewed by an edict of Decius (A.D. 250). Cyprian escaped, and subsequently caused the heresy of Novatian to be condemned in the council of A.D. 251. In A.D. 257, in a new persecution under Valerian, Cyprian was beheaded by the proconsul Galerius Maximus.

About A.D. 264 or 265 Celsus proclaimed himself emperor at Carthage, but was quickly slain. Under Constantius Chlorus, Maxentius proclaimed himself emperor in Africa, but the garrison of Carthage, which was hostile to the pretender, compelled L. Domitius Alexander to assume the purple. Domitius was, however, captured by Maxentius and strangled. About A.D. 311 there arose the Donatist heresy, supported by 270 African bishops. At the synod of Carthage in A.D. 411 this heresy was condemned owing to the eloquence of Augustine. Two years later the Carthaginian sectaries even ventured upon a political rebellion under the leadership of Heraclinus, who proclaimed himself emperor and actually dared to make a descent on Italy itself, leaving his son-in-law Sabinus in command at Carthage. Being defeated he fled to Carthage where he was put to death (A.D. 413). Donatism was followed by Pelagianism and these religious troubles were not settled when in May A.D. 429 the Vandals, on the appeal of Bonifacius, governor of Africa, crossed the Straits of Gibraltar and invaded Mauretania. Gaiseric appeared in A.D. 439 before the walls of Carthage. He entered almost without a blow and gave over the city to plunder. From this time Carthage became, in the hands of the Vandals, a mere pirate stronghold. Vandal remains are limited to coinage and jewelry. Once, in A.D. 470, the fleet of the Eastern empire under the orders of Basiliscus appeared in the Bay of Carthage, but Gaiseric succeeded in setting fire to the attacking ships and from the Byrsa watched their entire annihilation.

Under Gaiseric's successors Carthage was still the scene of many displays of savage brutality, though Thrasamund built new baths and a basilica and the city enjoyed a final period of economic prosperity. Gelimer, the last Vandal king, was defeated at Decimum by the Byzantine army under Belisarius, who entered Carthage unopposed (A.D. 553). The restored city now received the name of Colonia Justiniana Carthago; Belisarius rebuilt the walls and entrusted the government to Solomon.

At length the Arabs, having conquered Cyrenaica and Tripolitania (A.D. 642), and founded Kairouan (A.D. 671), arrived before Carthage. In A.D. 697 Hasan ibn Noman, the Ghassanid governor of Egypt, captured the city almost without resistance. But the patrician Ioannes retook the city and put it in a state of defense. Hasan returned, defeated the Byzantines again, and decreed the entire destruction of the city. In A.D. 698 Carthage finally disappears from history. Once again only does the name appear, in the middle ages, when the French king Louis IX, at the head of the 8th crusade, disembarked there on July 17, 1270, and founded a shrine. For the history of the site from its final destruction until modern times the only sources are the Arab geographers and the early medieval traveler Victor da Vita.

ROMAN AND CHRISTIAN CITY

Roman Carthage was not fortified until barbarian invasion threatened in A.D. 425, when walls were built by Theodosius II. The outline of these walls is not certain, but traces of a number of fortification walls have been found which were designed to prevent invasion from the *ligula*, the tongue of land between the gulf and the lake. It also appears that the Byrsa was separately fortified. Under Hadrian an aqueduct 138 km. long was built. Part of it is still standing with its arches 40 m. high. There also survive parts of Carthage's two ports.

The Romans adorned the Byrsa with a large temple dedicated to Juno, Jupiter and Minerva, and near it stood a temple to Aesculapius (Asclepius). On the area of the Byrsa overlooking the sea stood an open-air portico, a largely ornamental building, from which elaborate statues of Victory and Abundance, the finest Roman sculptures at Carthage, have survived. On the slopes of the Byrsa a temple was dedicated to the family of Augustus. Besides sharing the temple on the new Capitol, Juno-Caelestis had a special temple beside the sea in front of the Byrsa. Between them lay a temple of Saturn. A Serapaeum lay at Douïmès and a temple of Demeter between Bord Djedid and Ste. Monique. There also existed in an unknown locality a temple of Memoria.

On the periphery of the town east of the Byrsa lay the Odeon designed for musical performances. Of this there are few remains and more survives of the nearby theatre constructed by Hadrian in the early 2nd century A.D. The amphitheatre modeled on the Roman coliseum and capable of seating 80,000 people lay to the northeast. In this St. Perpetua and St. Felicity were martyred in A.D. 203. Over to the west lay the Circus. The site of a stadium mentioned by Tertullian is unknown. Several public baths served the city. The largest were the baths of Antonius (2nd century) at Bord Djedid in the locality called Dermech. Also important are the baths of Gargilus, where in A.D. 411 conferences between the Catholic and Donatist bishops took place, but no ruins correspond to the baths built by Justinian in honour of Theodora.

The Christian buildings within the city, apart from a few Vandal structures, are all Byzantine. The largest basilica is at Bir Knissa which was rebuilt in the 6th century on the site of an earlier basilica. Probably the earliest surviving Christian structure is the small basilica near the Antonine baths which might be that of St. Peter built by Justinian. Certainly churches existed in the 3rd–4th centuries but of these no traces remain, not even of the primatial basilica where St. Augustine preached. From an inscription it is known that there was a basilica of the Theotokos (Mother of God) on the Byrsa and the basilica of Honorius was probably near the temple of Caelestis, but the site of the basilica of Faustus is unknown. Of the earlier basilicas, one dedicated to the Blessed Martyrs at the foot of the hill on which the Odeon stands was perhaps the most beautiful. Its surviving mosaics, the earliest Byzantine mosaics, incorporate the names of unknown martyrs. The relics of the martyrs St. Perpetua and St. Felicity were kept in the confessional of the basilica dedicated to them at Mcidfa and the inscription placed above their tomb was discovered there in 1929. St. Cyprian, who was responsible for their cult, was himself commemorated by three churches.

Much that is known of the antiquities of Carthage—Punic, Roman and Christian—is due to the presence of the White Fathers, the enthusiasm of Cardinal Charles Lavigerie (*q.v.*) and the work of Père Alfred Delattre in the closing years of the 19th century. Besides the antiquities here mentioned others are to be found in the Musée Lavigerie de Carthage, the Musée Archéologique de Carthage (Direction des Antiquités de la Tunisie), the Musée du Bardo, Tunis, the British museum, the Musée du Louvre, and the Leiden Museum of Antiquities. Punic antiquities are also to be found in the museums of Algiers, Constantine, Cádiz, Iviza, Barcelona, Mozia and Cagliari.

See also references under "Carthage" in the Index.

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(WM. C.)

CARTHAGE, a city in southwestern Missouri, U.S., seat of Jasper county, is 17 mi. N.E. of Joplin and 148 mi. S. of Kansas City. It is noted for its Burlington limestone quarries, the largest of their kind in the world. Established in 1842, the city, like ancient Carthage for which it was named, was once completely destroyed. In 1863 Confederate guerrillas, angered by a Union garrison, razed the town. It was rebuilt in 1866 and chartered as a city in 1873.

The municipally owned electricity and water plant is a model of small-town public utilities operation. Carthage is the trade centre for an agricultural area producing strawberries and other small fruits, poultry and dairy products. The manufacture of clothing is the most important industry except the quarrying and finishing of limestone. Operation of the lead and zinc mines, once important in the area, is no longer profitable.

For comparative population figures *see* table in MISSOURI: *Population.* (E. R. ST.)

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